

## Water-related diseases outbreaks reported in Italy

Monica Francesca Blasi, Mario Carere, Maria Grazia Pompa,  
Elvira Rizzuto and Enzo Funari

### ABSTRACT

Water related disease outbreak (WRDO) statistics in Italy from 1998 to 2005 have been discussed in this paper. The true incidence of WRDO is not reflected in the National Surveillance System (NSS), although this study has provided information on pathogens associated to different water sources, incidence in Regions and inadequacy of regulations. 192 outbreaks and 2546 cases of WRD were reported to the NSS, an average of 318 cases per year. Cases were associated to shellfish (58.79%), drinking water (39.94%) and agricultural products (1.25%). WRDs have been detected in 76% of Regions: central and southern Regions showed lower percentage of cases (35.4%) due to under-reporting. Most of WRD cases in the North were related to drinking water; WRDs in marine coastal Regions were mostly related to shellfish. 49% of Districts (Province) notified WRDs, including only 101 Municipalities. Pathogenic microorganisms were identified in a few cases from clinical investigations. They included enteric viruses, Norwalk viruses, *Salmonella*, *Shigella*, *Giardia* and *Campylobacter*. There is the need to improve the existing NSS in relation to WRDs. An adequate WRDs Surveillance System should be based on connection between health and environmental authorities, priority pathogens and critical areas identification, response capability and contingency plans.

**Key words** | crops, drinking water, outbreaks, shellfish, surveillance systems, WRDs

**Monica Francesca Blasi** (corresponding author)  
**Mario Carere**  
**Enzo Funari**  
Department of Environment and Primary  
Prevention, National Institute of Health,  
Viale Regina Elena 299, 00161, Rome,  
Italy  
Fax: 0649902295  
E-mail: [monicafrancesca.blasi@iss.it](mailto:monicafrancesca.blasi@iss.it)

**Maria Grazia Pompa**  
**Elvira Rizzuto**  
Department of Prevention and Disease Control,  
Ministry of Health,  
Via della Civiltà Romana, 7, 00144 Rome,  
Italy

### INTRODUCTION

It is well known that humans can catch illness as a consequence of the exposure to risk factors occurring in water (Eliassen & Cummings 1948; Craun 1986; Parsonnet *et al.* 1989; Proctor *et al.* 1998; Hoxie *et al.* 1998; Proctor & Davis 2000; Hunter & Syed 2001; Hunter *et al.* 2003; Naumova *et al.* 2003; Fong & Lipp 2005; WHO 2005). Several outbreaks have been documented with reference to the exposure to these risk factors through ingestion of contaminated drinking waters (WHO 2004), shellfish (Levine *et al.* 1993; Bean *et al.* 1996; Hlady & Klontz 1996; CDC 1998) and crops (Shuval *et al.* 1986; WHO 1989; National Research Council 1996). Moreover, recreational activities in bathing waters have been associated with some human pathologies, as gastrointestinal and dermatologic infections (Johnson *et al.* 1997; Polo *et al.* 1998;

Montanari *et al.* 1999; Henrickson *et al.* 2001; WHO 2003, 2005; Yoder *et al.* 2004).

The WHO-UNECE Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes defines “Water-related disease” (WRD) as any significant adverse effect 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 (Protocol on Water and Health 1999; Meeting of the Parties to the Protocol on Water and Health 2007). WRDs include all the pathologies caused by 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; WRDs are often complicated

doi: 10.2166/wh.2008.063

to be recognized especially because they are difficult to be distinguished from foodborne diseases, due to the fact that water and food share several risk factors. In order to identify the vehicle responsible for the transmission of the disease a proper epidemiological investigation is envisaged. Furthermore, especially in developed countries, there is a rather general belief that WRDs belong only to a far past. This is reflected in generally inadequate WRD Surveillance Systems (EEA/WHO 2002). A recent study in the European Member States concluded that the respective Surveillance Systems are completely absent in some countries; WRDs are also under-reported due to the different notification forms of countries of the European region (Poullis *et al.* 2002). In spite of this shortcoming, a relevant WRDs burden has been detected also in developed countries (Craun 1986; Calderon & Craun 2004; Craun *et al.* 2006; WHO Final Report 2006). From 1999 to 2006 in the WHO subregion EUR-A (27 countries of European Union + Israel), a total number of 53503 cases of shigellosis, 209 cases of cholera, 11830 cases of enterohaemorrhagic *Escherichia coli* (EHEC), 7045 cases of typhoid and 62020 cases of viral hepatitis A (VHEPA) have been reported for priority WRDs; a total number of 746513 cases of campylobacteriosis, 41718 of cryptosporidiosis and 75950 of giardiasis have been reported for secondary WRDs (WHO-UNECE 2007).

In Europe, a specific mandatory system for WRD surveillance is still missing, yet many legislative tools have been set with regards to the surveillance of communicable diseases. Decision 2119/98/EC (UE 1998) set up a network for the epidemiological surveillance and control of these latter diseases; Commission Decision 2000/96/EC (UE 1999) of 22 December 1999 identified a list of communicable diseases; Decision 2002/253/EC (UE 2002) made mandatory the reporting of clinical description, laboratory criteria for diagnosis and case classification of a large number of pathologies. Evidently, some of these communicable diseases can be transmitted by pathogens also through water, but the identification of this source of exposure is not explicitly requested.

Italy is a country with 57 million people; there is a wide heterogeneity in the distribution of water, some areas in the North are subject to high rainfall with risk of flooding especially in some periods of the year, while some others in

the Southern part suffer water scarcity (WHO 2007). In Italy, eighty per cent of the national drinking water sources derive from groundwater, although surface water constitutes the main source of drinking water in some regions (Ministry of Health 2004). Italy has a coastline of more than 7000 km. Shellfish harvesting is massive (Pasolini *et al.* 2005), in particular for mussel and clam production in some regions; more than 40% of the national shellfish cultures are located in Veneto followed by the Liguria, Emilia Romagna, Puglia, Campania, Sardegna and Friuli Venezia Giulia regions (Ministry of Agriculture 2007). In some of these regions there is a rather consolidated food habit according to which these products are consumed raw or without adequate cooking.

Some studies, in particular areas of the national territory, have reported cases of WRDs (Stroffolini *et al.* 1990; Dettori *et al.* 1994; Manfredi Selvaggi *et al.* 1996; Aureli *et al.* 2000; Ballone *et al.* 2001; Boccia *et al.* 2002; Prato *et al.* 2004; Faustini *et al.* 2006; Le Guyader *et al.* 2006; Montagna *et al.* 2006). Nevertheless a national picture of this issue has never been elaborated.

This paper reports the WRD outbreaks and cases in the period of time 1998–2005, defined on the basis of data notified within the current Italian Surveillance System on Communicable Diseases (NSS).

---

## ITALIAN SURVEILLANCE SYSTEM ON COMMUNICABLE DISEASES

The NSS is defined by a specific Decree (Ministerial Decree 1990). The Decree identifies 5 classes of priority diseases.

The starting point of the Surveillance System is represented by the notification of any new cases of communicable diseases, even if only suspected, from the physician to the Local Health Unit (LHU) of the National Health System. Each of the 197 LHUs is responsible for preparing cumulative tables and forwarding, by ordinary mail, the case report forms (CRF) every month to the Regional Health Authority, which in turn is responsible for forwarding the data to the Ministry of Health. The Ministry of Health provides reports of confirmed cases to the National Institute of Statistics (ISTAT).

For classes IV (which includes “infections, toxic-infections and infestations of food origin”) and V (which

includes zoonosis) the notification of diseases to the local health authorities is requested only when outbreaks occur (meaning that two or more persons have experienced a similar illness).

These pathologies encompass diseases of food and water origin. The reporting form of these notifications should indicate the results of the accomplished investigations, with regards to etiological agents, incubation time, duration of the illness, history of the exposed persons and the identified or supposed sources of exposure, water included.

Our analysis has been performed on data and information derived from notification of “Infections, toxic-infections and infestations of food origin”.

## RESULTS

### Infections, toxic-infections and infestations of food origin

In the period 1998 to 2005, 3622 outbreaks, corresponding to 32435 cases of these pathologies were notified to the Ministry of Health by 21 regions. During this period a decrease of these diseases has been clearly achieved (Figure 1).

The real or suspected source of disease has been identified for 53% of outbreaks, corresponding to 59% of total cases. This allowed an estimate that at least 13.3% of these diseases could be associated to water, their sources

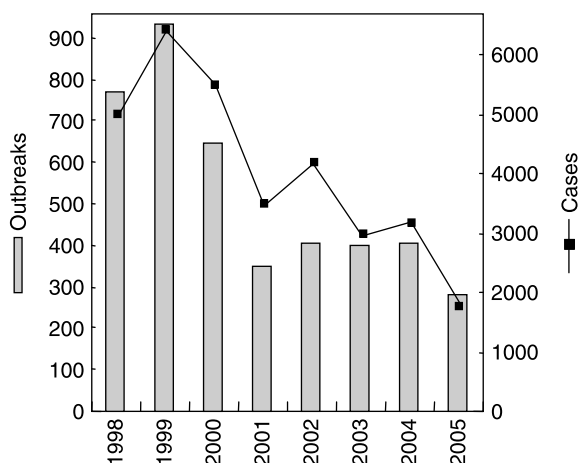


Figure 1 | Infections, toxic infections and infestations of food origin from 1998 to 2005.

being represented by consumption of drinking water, shellfish or agricultural products. We did not consider other food-borne diseases, such as those due to fish consumption, because the latter are likely due to causes which are different from polluted water. Shellfish mostly includes mussels and clams, which are well known filter organisms with a high capacity to accumulate pathogenic microorganisms.

### Analysis of WRDs in Italy

The annual trend of WRD outbreaks and cases notified in Italy from 1998 to 2005 is shown in Figure 2. In total 192 WRD outbreaks were recorded with an average of 24 outbreaks per year.

A total number of 2546 WRD cases were notified, with an average of 318 cases per year and an annual number of cases from 1008 in 2002 to 92 in 2005.

Most of the WRD cases were associated with the consumption of shellfish (58.8%), drinking water (39.9%) and, only a minor part, agricultural products (1.3%) (Figure 3).

WRDs associated with drinking water ranged from 12 outbreaks in 1999 to 2 in 2004; those linked with shellfish consumption ranged from 27 outbreaks in 1999 to 6 in 2005. Finally, WRDs due to consumption of agricultural products ranged from 27 outbreaks in 1999 to 1 in 2000.

The analysis of the available data on WRDs showed that 76.6% of the outbreaks involved from 2 to 10 cases and 18.2% from 10 to 50 cases. The eight largest WRD

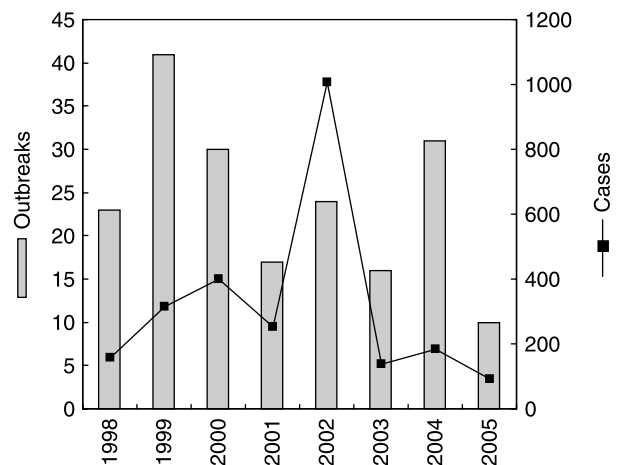


Figure 2 | WRDs from 1998 to 2005.

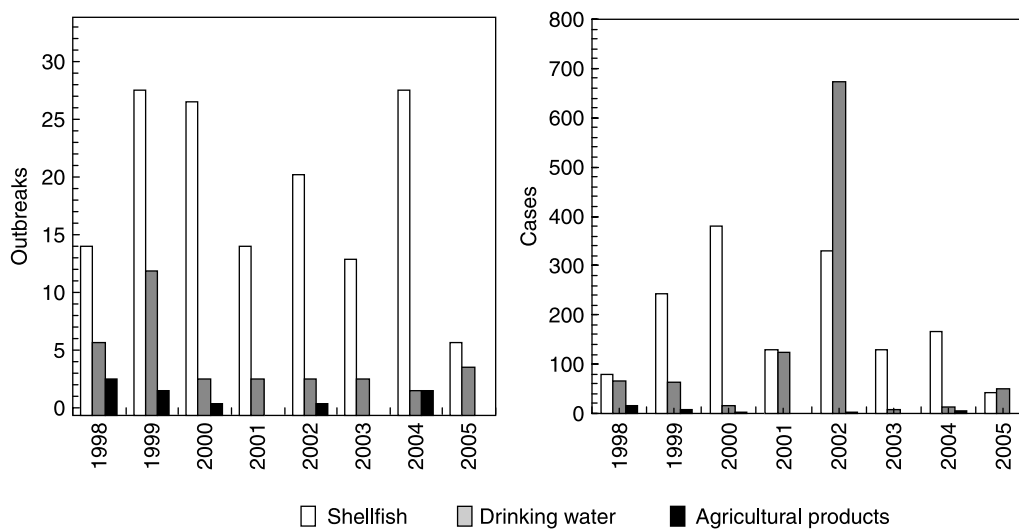


Figure 3 | WRDs for specific vehicles.

outbreaks notified (4.2%) included from 52 to 670 cases, as indicated in Table 1.

WRDs have been notified from 16 regions with the following distribution: 1829 cases (64.3%) from North Italy, 460 (16.2%) from Mid-Italy and 557 (19.2%) from the South, including Sardinia and Sicily.

Some regions (Molise, Basilicata, Valle D'Aosta and Umbria) did not notify WRDs at all during the study period.

Three regions (Veneto, Liguria, Emilia Romagna) and the Provincia Autonoma of Trento, representing 24% of the national population, notified 46.3% of the total WRD cases.

Six Municipalities notified 70.7% of WRD cases for North Italy: Vicenza (25.4%), La Spezia (29.8%), Codigoro (5.5%), Nanno (3.6%), Cento (3.3%) and Ravenna (3%). Six Municipalities of South Italy notified 77.6% of WRD cases

for the southern regions: Gioia Tauro (17%), Ugento (15.0%), S. Giorgio del Sannio (13.6%), Assoro (8.9%), Canosa di Puglia (8.9%) and Gela (7.2%). Finally, in Mid-Italy, five Municipalities notified 43% of WRD cases for these regions: Pescasseroli (15.2%), Roma (11.6%), Latina (10%), Civitavecchia (3.1%) and Viareggio (2.8%).

This analysis clearly points out the considerable heterogeneity in the reporting system among and within Italian regions and hence how much the burden of WRD is underestimated.

#### WRDs and shellfish consumption

A total number of 147 outbreaks and 1497 cases were notified, with an average of 187.3 cases per year. The latter ranged from 380 cases in 2000 to 41 cases in 2005.

Table 1 | Main WRD outbreaks notified in Italy from 1998 to 2005

Year	Etiological agent	Municipality	Source	Cases
2002	Not identified	Vicenza	Water system	670
2002	Astrovirus	La spezia	Oysters	201
2000	<i>Clostridium perfringens</i>	Codigoro	Shell fishes	128
2001	Enteric virus	Nanno	Drinking water	100
2003	<i>Salmonella enteridis</i>	La spezia	Shell fishes	80
1999	Not identified	Latina	Shell fishes	57
2001	<i>Staphylococcus aureus</i>	Riccione	Shell fishes	55
2000	Not identified	San giorgio del sannio	Sea salad	52

In 27% of the notified outbreaks, 2 to 9 people were affected, in 34.5%, 10 to 49 and in the six largest ones (38.3%), 50 to 201.

The etiological agents were identified in 55.4% cases: 24.3% of the WRD cases were attributed to astrovirus, 20.8% to *Salmonella*, 21.0% to *Clostridium perfringens*, and 6.8% to hepatitis A (Table 2). One outbreak due to astrovirus was detected in the Liguria Region (City of La Spezia) causing infection of 201 people (Table 1). Our analysis highlighted also four outbreaks, corresponding to 30 cases, due to *Vibrio parahaemolyticus*.

Most of the cases were described with the general term “shellfish” (53.2%). Actually, out of the 710 notified cases, where the vehicle of infection was precisely defined, 39.2% were attributed to “oysters”, 23.5% to “sea salad”, 13.4% to “clams”, 12.1% to “mussels”, 4.5% to “clams and mussels”, 2.5% to “sponge”, 1.7% to “oysters and clams”, 1.0% to “octopus”, 1.0% to “oysters and warty venus”, 0.7% as “sea urchins” and 0.4% as “warty venus”.

Referring to the number of WRD cases, 958 (64%) were notified in north Italy, 395 (26.39%) in central Italy, and 144 (9.62%) in the South. Three Municipalities, La Spezia, Codigoro and Bologna, notified 28% of the total cases in North Italy; two Municipalities, Roma and Latina, 31% of the total central Italy; three Municipalities, S. Giorgio (BN), Gela (Caltanissetta) and Canosa di Puglia (Bari), 69.44% of the total cases in South Italy.

As expected, coastal areas were mostly affected: Liguria, Sardegna, Marche, Friuli Venezia Giulia and Lazio notified the highest number of WRD due to shellfish consumption (Figure 4).

Note: we also included in some cases aquatic organisms which do not belong to the shellfish taxa.

### WRDs and drinking water consumption

In the period of the study, 36 outbreaks and 1017 WRD cases were notified, with an average of 127 cases per year. These cases represented about 5.3% of those globally registered in the Class IV of the NSS. The etiological agents were identified only in 29% of the reported cases, as follows: enteric viruses (10.3%), *Salmonella* (6.2%), Norwalk virus (4.0%), hepatitis A (2.8%), *Legionella* (1.6%), *Shigella sonnei* (0.6%), *Staphylococcus aureus* (0.3%) and *Giardia*

Table 2 | WRDs etiological agents identified(1998–2005)

Etiological agent	Epidemic focuses	Outbreaks	Cases
Shellfish			
Not identified	85	80	680
Astrovirus	1	1	201
<i>Clostridium perfringens</i>	4	3	174
<i>Salmonella enteridis</i>	5	5	135
<i>Staphylococcus aureus</i>	5	4	71
Hepatitis A	23	23	56
<i>Salmonella</i>	4	4	37
<i>Vibrio parahaemolyticus</i>	4	4	30
<i>Salmonella spp</i>	7	4	24
<i>Vibrio alginolyticus</i>	1	1	24
<i>Salmonella</i> group D	7	7	20
<i>Microcosmus sulcatus</i>	1	1	18
<i>Bacillus cereus</i>	1	1	5
<i>Salmonella</i> group B	2	2	5
<i>Salmonella</i> group C	2	2	5
<i>Campylobacter jejuni</i>	1	1	4
<i>E.coli enteropath</i>	1	1	2
<i>Salmonella</i> group C	1	1	2
<i>Salmonella</i> group D	1	1	2
<i>Salmonella paratyphi B</i>	1	1	2
Total	157	147	1497
Drinking			
Not identified	1	1	723
Enteric virus	1	1	100
Norwalk virus	1	1	41
<i>Streptococcus</i>	1	1	30
Hepatitis A	10	10	28
<i>Salmonella</i>	1	1	23
<i>Legionella spp</i>	1	1	16
<i>Salmonella spp</i>	2	2	13
<i>Non -typhi salmonella</i>	1	1	9
<i>Salmonella</i> group C	2	2	7
<i>Salmonella</i> group B	3	3	7
<i>Shigella sonnei</i>	1	1	6
Enteric virus	1	1	5
<i>Staphylococcus</i>	1	1	3
<i>Salmonella enteridis</i>	1	1	2
<i>Salmonella typhi</i>	1	1	2
<i>Giardia lamblia</i>	1	1	2
Total	30	30	1017

Table 2 | (continued)

Etiological agent	Epidemic focuses	Outbreaks	Cases
	Agricultural		
Not identified	3	3	9
<i>Listeria</i>	1	1	6
<i>Staphylococcus aureus</i>	1	1	6
<i>Salmonella</i>	1	1	4
<i>Clostridium botulinum</i>	1	1	3
<i>Brucella spp</i>	1	1	2
<i>Salmonella</i> group d	1	1	2
Total	9	9	32

*lamblia* (0.2%) (Table 2). The origin of infection was established in 75.6% of cases. That responsible for most of the notified WRD was represented by drinking water distributed by municipal waterworks (68.8%). Other important sources were represented by mineral waters, water systems in thermal stations and private wells.

The most important WRD outbreak occurred in Vicenza, with 670 people affected (Table 1), as a consequence of microbial contamination in the Municipal water system supply; the etiological agent was not reported in the notification form (Tramarin *et al.* 2002). In Nanno (TR) and Ugento (LE), 100 and 41 people, respectively, were also affected by WRD.

Forty-two per cent of WRD cases due to drinking water were notified from northern regions, while a minor part, 20.7% and 33.1%, respectively, in central and southern regions (Figure 4).

### WRDs and agricultural products consumption

WRDs due to consumption of agricultural products were limited to few notifications. During 1998 to 2005 only 9 outbreaks were recorded in the NSS, with 32 cases. Two of these outbreaks occurred in 1998 and accounted for 50% of the reported cases. The following etiological agents were identified: *Listeria* (6 cases), *Staphylococcus aureus* (6 cases), *Salmonella* (6 cases), *Clostridium botulinum* (3 cases) and *Brucella spp.* (2 cases) (Table 2). The vehicle responsible for most of the notified WRD cases was represented by fruits and vegetables contaminated

with polluted water (90.6%). Puglia, Campania and Emilia Romagna were the regions which notified mostly (Figure 4). One remarkable WRD was recorded in S. Severo (FG) (6 notified cases) where *Listeria* was identified as the responsible etiological agent.

### DISCUSSION

The Italian Surveillance System on communicable diseases, currently under revision, is not specifically tailored to catch WRDs. In this condition, the analysis of available data has permitted the identification of 192 outbreaks and 2546 cases of WRD notified between 1998–2005.

Nevertheless, these numbers represent a clear underestimate of the real situation. Indeed:

- (1) only for Class IV of diseases (infections, toxic-infections and infestations of food origin), the notification system requires information on the possible sources responsible for the outbreak, including water;
- (2) only 53% outbreaks and 59% cases of these notifications reported the sources responsible for the transmission of the disease;
- (3) only 55.5% of cases of the WRD notifications reported the etiological agents responsible for the disease;
- (4) some Italian Regions never notified WRDs;
- (5) within the Regions which notified WRDs, only a part of their territory was represented.

Even though it is particularly difficult to estimate a burden of WRDs representative enough of the national situation, it seems quite sure that this is higher, probably much higher, than the notified numbers. Besides the list of shortcomings listed above, it should be considered that in many cases, these diseases are mild and do not require hospitalization, hence they are not counted in any surveillance system on communicable diseases.

As to the etiological agents responsible for WRDs, in most of the notified cases they were not reported. Most of the reported etiological agents are considered of high health significance in water supplies (WHO 2004). In particular, astrovirus, *Clostridium perfringens*, *Salmonella*, Hepatitis A, *Vibrio parahaemolyticus* and *Vibrio alginolyticus* were the main etiological agents identified in WRDs for shellfish consumption; enteric viruses, Norwalk virus, Hepatitis

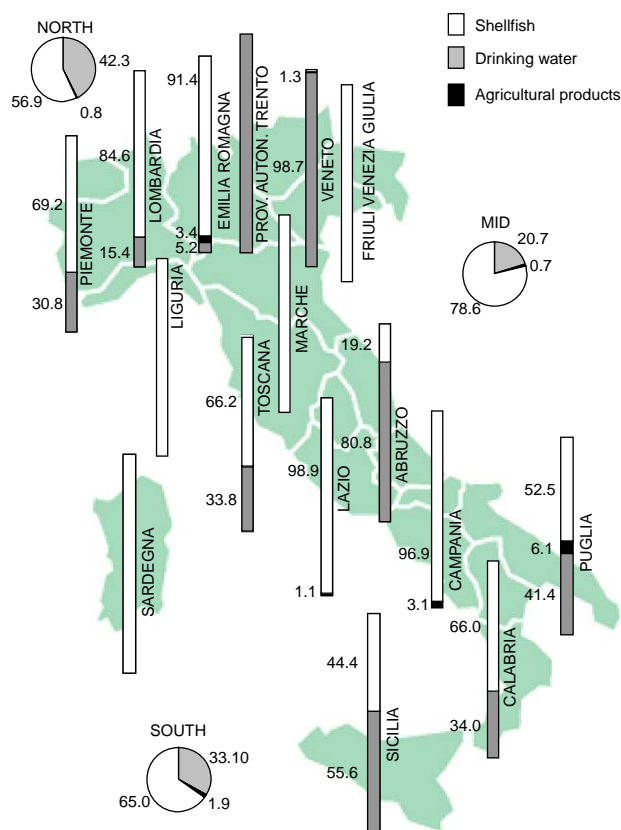


Figure 4 | WRDs in Italian regions for specific vehicles.

A and *Salmonella* for drinking water; *Listeria*, *Staphylococcus aureus*, *Salmonella* and *Clostridium perfringens* for agricultural products. Moreover, other important pathogens of high health significance have been reported with a lower frequency.

Most of the reported pathogens are indicated in the list of priority diseases of the Protocol Water and Health in the European geographical WHO region (primary diseases: Hepatitis A and *Shigella*; secondary diseases: *Giardia* and *Campylobacter*).

*Vibrio parahaemolyticus*, one of the pathogens most frequently identified in WRD due to shellfish consumption, is considered of special concern in other countries in relation to its possible exposure through shellfish consumption (Su & Liu 2007). Astrovirus is worthy of attention as it is an etiological agent responsible for gastroenteritis as a cause of acute diarrhea in hospitalized children < 10 years old during a 5-year period in the United States (Dennehy et al. 2001; Colomba et al. 2006).

## CONCLUSIONS

This investigation is the first extended work on WRDs in Italy, whose results show that some risky situations do occur. These results and the shortcomings of the actual Italian Surveillance System on the communicable diseases highlight the need to set up a specific, updated WRD Surveillance System, taking into account the European pertinent framework, the experiences of other countries and the guidelines elaborated in the context of the WHO Protocol on Water and Health.

The outcome of this study emphasizes the role of different uses of water for an adequate National Surveillance System on WRDs in order to develop target strategies of action, especially for preventive purposes.

In marine coastal regions close to river mouths it should be addressed more towards the detection of diseases caused by seafood consumption and recreational activities. However, in areas where surface water is used for drinking, the surveillance system should be tailored to WRDs linked to this issue. Furthermore, the possible additional contribution to WRD burden caused by chemical substances, toxic algae and cyanobacteria should be locally investigated, in order to apply specific surveillance linked to this issue. Finally, pathogens which can be an important cause of endemic WRDs (Casemore 2006; Craun et al. 2006; Calderon & Craun 2006) should be carefully considered.

The WRDs Surveillance System should be established with the primary aims of improving an early recognition of outbreaks and the response capability in order to prevent the possible effects and their spreading on human health caused by transmission of important pathogens. A proper Surveillance System should also encourage public health personnel to detect and investigate WRDs creating collaboration among local, regional and national authorities. Furthermore, a WRDs Surveillance System should require epidemiological investigations before outbreaks are reported. Data obtained through a Surveillance System can be also useful for identifying sources of contaminations and water system deficiencies. Information from such a Surveillance System could be useful to identify research priorities and tools for improving water-quality regulations. Finally, a proper Surveillance System on WRDs should promote the application of the WHO "water safety plans"

principles. A project is currently being implemented in Italy where one of the main objectives is the proposal of a national WRDs Surveillance System.

## ACKNOWLEDGEMENTS

The authors wish to thank Dr Liana Gramaccioni of the National Ministry of Health for technical advice.

## REFERENCES

- Aureli, P., Fiorucci, G. C., Caroli, D., Marchiaro, G., Novara, O., Leone, L. & Salmaso, S. 2000 An outbreak of febrile gastroenteritis associated with corn contaminated by *Listeria monocytogenes*. *New Engl. J. Med.* **342**(17), 1236–1241.
- Ballone, E., Fazi, P., Riario Sforza, G., Scasso, E., Di Nicola, M., Ippolito, N., Di Mascio, C. & Schippa, F. 2001 Survey on giardiasis propagation in Pescara. *Ann. Ig.* **13**, 111–120.
- Bean, N. H., Goulding, J. S., Lao, C. & Angulo, F. J. 1996 Surveillance for foodborne-disease outbreaks. United States, 1988–1992. *MMWR* **45**(5), 1–66.
- Boccia, D., Tozzi, A. E., Cotter, B., Rizzo, C., Russo, T., Buttinelli, G., Caprioli, A., Marziano, M. L. & Ruggeri, F. M. 2002 Waterborne outbreak of Norwalk-like virus gastroenteritis at a tourist resort, Italy. *Emerg. Infect. Dis.* **8**(6), 563–568.
- Calderon, R. L. & Craun, G. F. 2004 Estimates of endemic waterborne risks from community-intervention studies. *J. Water Health* **4**(Suppl 2), 89–99.
- Casemore, D. 2006 Towards a US national estimate of the risk of endemic waterborne disease—sero-epidemiologic studies. *J. Water Health* **4**(Suppl 2), 121–163.
- CDC 1998 Outbreak of *Vibrio parahaemolyticus* infections associated with eating raw oysters – Pacific Northwest, 1997. *MMWR* **47**, 457–462.
- Colomba, C., Grazia, S., Giammanco, G., Saporito, L., Scarlata, F., Titone, L. & Arista, S. 2006 Viral gastroenteritis in children hospitalised in Sicily, Italy. *Eur. J. Clin. Microbiol. Infect. Dis.* **25**(9), 570–575(6).
- Craun, G. F. 1986 *Waterborne Diseases in the United States*. CRC Press, Boca Raton, FL.
- Craun, G. F. & Calderon, R. L. 2006 Observational epidemiologic studies of endemic waterborne risks: cohort, case-control, time-series, and ecologic studies. *J. Water Health* **4**(Suppl 2), 101–119.
- Craun, M. F., Craun, G. F., Calderon, R. L. & Beach, M. J. 2006 Waterborne outbreaks reported in the United States. *J. Water and Health* **4**(Suppl 2), 19–30.
- Dennehy, P. H., Nelson, S. M., Spangenberg, S., Noel, J. S., Monroe, S. S. & Glass, R. I. 2001 A prospective case-control study of the role of Astrovirus in acute diarrhea among hospitalized young children. *J. Infect. Dis.* **184**, 10–15.
- Dettori, G., Grillo, R., Falomo, R., Mansueto, S., Miceli, D. & Marcuccio, L. 1994 Survey on the prevalence of *Leptospira* infections in the Italian population. *Eur. J. Epidemiol.* **10**, 173–180.
- EEA/WHO 2002 *Water and Health in Europe*, pp. 109, WHO Regional Publication European Series N. 93.
- Eliassen, R. & Cummings, R. H. 1948 Analysis of waterborne outbreaks, 1938–45. *J. AWWA* **40**, 509.
- Faustini, A., Fano, V., Muscillo, M., Zaniratti, S., La Rosa, G., Tribuzi, L. A. & Peducci, C. A. 2006 An outbreak of aseptic meningitis due to echovirus 30 associated with attending school and swimming in pools. *Int. J. Infect. Dis.* **10**(4), 291–297.
- Fong, T. T. & Lipp, E. K. 2005 Enteric viruses of humans and animals in aquatic environments: health risks, detection, and potential water quality assessment tools. *Microbiol. Mol. Biol. Rev.* **69**(2), 357–371.
- 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**(7), 645–650.
- Hlady, W. G. & Klontz, K. C. 1996 The epidemiology of *Vibrio* infections in Florida, 1981–1993. *J. Infect. Dis.* **173**, 1176–1183.
- Hoxie, N. J., Davis, J. P., Vergeront, J. M., Nashold, R. D. & Blair, K. A. 1998 Cryptosporidiosis-associated mortality following a massive waterborne outbreak in Milwaukee. *Am. J. Public Health* **87**, 2032–2035.
- Hunter, P. R. & Syed, Q. 2001 Community surveys of self-reported diarrhoea can dramatically overestimate the size of outbreaks of waterborne cryptosporidiosis. *Water Sci. Technol.* **43**(12), 27–30.
- Hunter, P. R., Waite, M. & Ronchi, E. 2005 *Drinking Water and Infectious Disease- Establishing the Links*. CRC Press, Boca Raton, FL/ IWA Publishing, London.
- Johnson, D. C., Enrique, C. E., Pepper, I. L., Davis, T. L., Gerba, C. P. & Rose, J. B. 1997 Survival of *Giardia*, *Cryptosporidium*, *Poliovirus* and *Salmonella* in marine waters. *Water Sci. Technol.* **35**(11–12), 261–268.
- JRC Report 2005 *European Commission - Joint Research Centre: Climate Change and the European Water Dimension* (ed. S. J. Eisenreich). Ispra Italy EUR 21553.
- Le Guyader, F. S., Bon, F., DeMedici, D., Parnaudeau, S., Bertone, A., Crudeli, S., Doyle, A., Zidane, M., Suffredini, E., Kohli, E., Maddalo, F., Monini, M., Gallay, A., Pommepuy, M., Pothier, P. & Ruggeri, F. M. 2006 Detection of multiple noroviruses associated with an international gastroenteritis outbreak linked to oyster consumption. *J. Clin. Microbiol.* **44**, 3878–3882.
- Levine, W. C. & Griffin, P. M. 1995 The Gulf Coast *Vibrio* Working Group *Vibrio* infections on the Gulf Coast: results of first year of regional surveillance. *J. Infect. Dis.* **167**, 479–483.
- Manfredi Selvaggi, T., Ponzio, G., D'Ascenzo, E., Montanaro, C., Di Siena, A., Ciarallo, N., Ricci, N. & Greco, D. 1996 Salmonellosi da veicoli inusuali nel Molise. *Annali di igiene, medicina preventiva e di comunità* **8**, 523–530.



- Meeting of the Parties to the Protocol on Water and Health 2007 The Convention on the Protection and Use of Transboundary Watercourses and International Lakes; first meeting Geneva, 17–19 January 2007. Report on Surveillance of Water-Related Diseases. January 2007.
- Ministerial Decree, 15 dicembre 1990 Sistema informativo delle malattie infettive e diffuse. Pubblicato nella Gazz. Uff. 8 gennaio 1991, n. 6.
- Ministry of Agriculture, 2007 National Strategic Plan (PSN), art. 15 del regolamento del Consiglio sul Fondo Europeo per la Pesca. Aprile 2007.
- Ministry of Health 2004 Relazione sullo Stato Sanitario del Paese 2003–2004. <http://www.ministerosalute.it/normativa/sezNormativa>.
- Montagna, M. T., Napoli, C., Tato, D., Spilotros, G., Barbuti, G. & Barbuti, S. 2006 Clinical-environmental surveillance of legionellosis: an experience in southern Italy *Eur. J. Epidemiol.* **21**(4), 325–331.
- 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 Microbiology Ecology* **29**(3), 241–247.
- Naumova, E. N., Egorov, A. I., Morris, R. D. & Griffiths, J. K. 2003 The elderly and waterborne *Cryptosporium* infection: Gastroenteritis hospitalizations before and during the 1993 Milwaukee outbreak. *Emerging Infect. Dis.* **9**(4), 418–425.
- 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, D.C., pp. 178.
- Parsonnet, J., Trock, S. C., Bopp, C. A., Wood, C. J., Addiss, D. G., Alai, F., Gorelkin, L., Hargrett-Bean, N., Gunn, R. A. & Tauxe, R. V. 1989 Chronic diarrhea associated with untreated drinking water. *Ann. Internal. Med.* **110**(12), 985–991.
- Pasolini, B., Alessi, E. & De Medici, D. 2005 Workshop on new hygienic aspects in seafood. Istituto Superiore di Sanità. Rome, 24–25 May 2004. Rapporti ISTISAN 05/24 (in Italian).
- Polo, F., Figueras, M. J., Inza, I., Sala, J., Fleisher, J. M. & Guarro, J. 1998 Relationship between presence of Salmonella and indicators of faecal pollution in aquatic habitats. *FEMS Microbiol. Lett.* **160**(2), 253–256.
- Poullis, D. A., Atwell, R. W. & Powell, S. C. 2002 An evaluation of waterborne diseases surveillance in the European Union. *Rev. Environ. Health* **17**(2), 149–159.
- Prato, R., Lopalco, P. L., Chironna, M., Barbuti, G., Germinario, C. & Quarto, M. 2004 Norovirus gastroenteritis general outbreak associated with raw shellfish consumption in South Italy. *BMC Infect. Dis.* **4**, 37.
- Proctor, M. E. & Davis, J. P. 2000 Escherichia coli O157:H7 infections in Wisconsin, 1992–1999. *WMJ: Official Publication of the State Medical Society of Wisconsin* **99**(5), 32–37.
- Proctor, M. E., Blair, K. A. & Davis, J. P. 1998 Surveillance data for waterborne illness detection: An assessment following a massive waterborne outbreak of *Cryptosporidium* infection. *Epidemiol. Infect.* **120**, 43–54.
- Protocol on Water and Health 1999 The 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, done in London on 17 June, 1999. Economic Commission for Europe, World Health Organisation's Regional Office for Europe.
- 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 No 51, prepared by WHO and Leeds University, World Bank Publisher, Washington, D.C.
- Stroffolini, T., Curianò, C. M., Congiu, M. E., Occhionero, M. & Mastrantonio, P. 1990 Trends in meningococcal disease in Italy in 1988. *Public health.* **104**(2), 103–107.
- Su, Y. C. & Liu, C. 2007 *Vibrio parahaemolyticus*: A concern of seafood safety. *Food Microbiol.* **24**(6), 549–558.
- Tramarin, A., Fabris, P., Bishai, D., Selle, V. & De Lalla, F. 2002 Waterborne infections in the era of bioterrorism. *The Lancet* **360**(9346), 1699.
- UE 1998 Decision No 2119/98/EC of 24 September 1998, European Parliament and of the council setting up a network for the epidemiological surveillance and control of communicable diseases in the Community. OJ EC L 268/1.
- UE 1999 Decision of 22 December 1999 on the communicable diseases to be progressively covered by the Community network under Decision No 2119/98/EC of the European Parliament and of the Council. OJ EC L 28/50.
- UE 2002 Commission Decision of 19 March 2002 laying down case definitions for reporting communicable diseases to the Community network under Decision No 2119/98/EC of the European Parliament and of the Council. OJ EC L 86/44.
- 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: Coastal and Fresh waters.* World Health Organization, Geneva.
- WHO 2004 *Guidelines for Drinking Water. Volume 1 Recommendations Drinking-water Quality.* 3<sup>rd</sup> edition. World Health Organization, Geneva.
- WHO 2005 *Kathy Pond, Water Recreation and Disease Plausibility of Associated Infections: Acute Effects, Sequelae and Mortality.* World Health Organization, Geneva.
- WHO 2006 *Regional Office for Europe. Final Report: Consultation on Waterborne Diseases Surveillance (9–10 May 2006 Budapest, Hungary).* World Health Organization, Geneva.
- WHO-UNECE 2007 Regional Office for Europe, Economic Commission for Europe. 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. World Health Organization, Geneva.
- WHO 2007 *Health Risks of Climate Change and Variability in Italy* (ed. in T. Wolf & B. Menne). World Health Organization, Geneva.
- Yoder, J. S., Blackburn, B. G., Craun, G. F., Hill, V., Levy, D. A., Chen, N., Lee, S. H., Calderon, R. L. & Beach, M. J. 2004 Surveillance for waterborne-disease outbreaks associated with recreational water—United States, 2001–2002. *MMWR Surveill Summ.* **53**(8), 1–22.

First received 26 July 2007; accepted in revised form 28 September 2007. Available online March 2008