World Health Organization
REGIONAL OFFICE FOR Europe

UNECE

THE SITUATION OF WATER-RELATED INFECTIOUS DISEASES IN THE PAN-EUROPEAN REGION

PROTOCOL ON WATER AND HEALTH

By Alexandra V Kulinkina, Enkhtsetseg Shinee, Bernardo Rafael Guzmán Herrador, Karin Nygård and Oliver Schmoll

Abstract

The Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes aims at protecting human health and well-being through sustainable water management and the prevention, control and reduction of water-related diseases. Prevention and reduction of water-related diseases is a priority area under the Protocol's programme of work 2014–2016.

A review of the available evidence reveals significant underreporting and underestimation of the true extent of water-related diseases in the pan-European region, indicating a need to strengthen national capacities for surveillance of these diseases. Campylobacteriosis, giardiasis, hepatitis A and shigellosis are the most commonly reported gastrointestinal infectious diseases that could be attributed to water. According to limited published data, about 18% of investigated outbreaks in the WHO European Region may be associated with this source. There has been progress in setting specific targets for prevention and reduction of water-related diseases and for strengthening surveillance and early-warning systems in accordance with the core provisions of the Protocol.

Keywords

DISEASE OUTBREAKS
ENVIRONMENTAL HEALTH
EUROPE
POPULATION SURVEILLANCE
WATERBORNE DISEASES
WATER MICROBIOLOGY

Address requests about publications of the WHO Regional Office for Europe to:
Publications
WHO Regional Office for Europe
UN City, Marmorvej 51
DK-2100 Copenhagen Ø, Denmark

Alternatively, complete an online request form for documentation, health information, or for permission to quote or translate, on the Regional Office website (http://www.euro.who.int/pubrequest).

ISBN 9 789289 052023

Design by Mikhail Romanyuk.
Layout by EDB&RDB.
Cover photo reproduced with permission of Mikhail Romanyuk.

World Health Organization
REGIONAL OFFICE FOR Europe

UNECE

THE SITUATION OF WATER-RELATED INFECTIOUS DISEASES IN THE PAN-EUROPEAN REGION

PROTOCOL ON WATER AND HEALTH

By Alexandra V Kulinkina, Enkhtsetseg Shinee,
Bernardo Rafael Guzmán Herrador, Karin Nygård and Oliver Schmoll

Contents

Acknowledgements

The WHO Regional Office for Europe and the United Nations Economic Commission for Europe wish to acknowledge and thank all who contributed to the publication of this document.

Sincere thanks are due to the Royal Norwegian Ministry of Health and Care Services and the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit) for providing financial support for the development of this document.

Enkhtsetseg Shinee and Oliver Schmoll coordinated the development of this report for the WHO Regional Office for Europe.

The authors are:

- **Alexandra V Kulinkina** (Tufts University, Boston, United States of America);
- **Enkhtsetseg Shinee** (Water and Sanitation Programme, WHO European Centre for Environment and Health, WHO Regional Office for Europe, Bonn, Germany);
- **Bernardo Rafael Guzmán Herrador** (Norwegian Institute of Public Health, Oslo, Norway);
- **Karin Nygård** (Norwegian Institute of Public Health, Oslo, Norway);
- **Oliver Schmoll** (Water and Sanitation Programme, WHO European Centre for Environment and Health, WHO Regional Office for Europe, Bonn, Germany).

Special thanks are due to Márta Vargha (National Public Health Centre, Budapest, Hungary), Tarja Pitkänen (National Institute for Health and Welfare, Helsinki, Finland), Alena Drozdova (Republican Scientific and Practical Centre of Hygiene, Ministry of Health, Minsk, Belarus), Dragana Jovanović (Institute of Public Health, Belgrade, Serbia), Birgitta de Jong (European Centre for Disease Prevention and Control, Stockholm, Sweden) and Bettina Rickert (German Environment Agency, Dessau-Roßlau, Germany) for their detailed review and valuable technical inputs into the report; and to Anyela M Ramirez Canon (formerly WHO European Centre for Environment and Health, WHO Regional Office for Europe, Bonn, Germany) for assisting in data compilation.

Abbreviations

CISID	Centralized Information System for Infectious Diseases
ECDC	European Centre for Disease Prevention and Control
E. coli	*Escherichia coli*
EEA	European Economic Area
EHEC	enterohaemorrhagic *Escherichia coli*
GIDEON	Global Infectious Disease and Epidemiology Online Network
IHR	International Health Regulations
IPC	infection prevention and control
NRL	national reference laboratory
ProMED	Program for Monitoring Emerging Diseases
STEC/VTEC	*Shigatoxin* or *verotoxin* producing *Escherichia coli*
TESSy	The European Surveillance System
UNICEF	United Nations Children's Fund
WRD	water-related disease

Executive summary

Background and objectives

The Protocol on Water and Health is a legally binding international agreement addressing the protection of human health and well-being through linking sustainable water management and the prevention, control and reduction of water-related diseases (WRDs). Amongst other objectives and provisions, the Protocol supports the implementation of the International Health Regulations 2005 (IHR), in particular the requirements to strengthen and maintain core public health capacities for surveillance of WRDs and outbreak response systems.

This publication presents a review to consolidate the knowledge and evidence base on WRDs in the pan-European region with a strategic vision to identify priority activities to support countries in fulfilling their core obligations (under article 8 of the Protocol) for establishing and maintaining effective surveillance systems and reducing the burden of WRDs. The specific objectives of the review were to provide an overview of the available information in the pan-European region concerning the situation of water-related infectious diseases, national WRD surveillance and outbreak response systems, and targets related to WRDs set under the provisions of article 6 of the Protocol.

Data sources

Information from five major sources was reviewed and analysed to provide an overview of reported water-related infectious diseases in the pan-European region and the state of surveillance and response capacity and reporting of WRDs: (i) Global Infectious Disease and Epidemiology Online Network (GIDEON); (ii) Centralized Information System for Infectious Diseases (CISID); (iii) the European Surveillance System (TESSy); (iv) country reports submitted under the provisions of article 7 of the Protocol; and (v) data from the IHR monitoring framework provided to the Global Health Observatory Data Repository. A review of the scientific literature regarding WRD surveillance published between 2000 and 2014 was also conducted.

Main findings

In the pan-European region, systematic and accurate information on WRDs is lacking and the true extent of these diseases is unknown.

Campylobacteriosis, giardiasis, hepatitis A and shigellosis are the most commonly reported gastrointestinal infectious diseases that could be attributed to water. Significant underreporting and underestimation of the true magnitude of WRDs can be explained by the fact that available data from routine surveillance systems and reported through formal reporting channels represent only a small fraction of the total amount of disease occurring in the population. This uncertainty in true incidence – coupled with limitations of surveillance systems related to investigation of sporadic cases, identifying the causal pathogen and distinguishing the transmission vehicle – may compromise the attention paid to WRDs at policy level.

Limited published data indicate that approximately 18% of investigated outbreaks in the WHO European Region may be associated with water.

Leptospirosis, cryptosporidiosis, giardiasis and legionellosis show the highest percentages of outbreaks specifically linked to contaminated water including, but not limited to, public drinking-water supplies, lakes, swimming pools, spas and cooling towers.

National core capacities for surveillance and response to WRDs need to be strengthened.

The majority of countries in the WHO European Region have in place routine passive surveillance systems as well as outbreak alert and response mechanisms. Despite the progress made in implementing core capacities for surveillance and response in line with the requirements of article 8 of the Protocol, many countries continue to face challenges including insufficient laboratory, human and financial capacities; lack of robust epidemiological data; and suboptimal coordination and data management at different levels.

Existing international and national reporting systems and information platforms concerning WRDs need to be better coordinated and harmonized.

Several reporting platforms exist at regional level but reporting systems vary in their definitions of cases and outbreaks, timeliness of reporting and level of detail available to enable efficient investigation and response. Such heterogeneity inhibits not only comparisons across countries, subregions and reporting systems but also accurate understanding of the extent of WRDs in the region. This indicates a need for improved coordination for harmonized reporting and the importance of exploring options to link the reporting of surveillance capacities and targets under the Protocol with the reporting of the IHR core capacity requirements.

Progress is being made in setting WRD targets in accordance with the core requirements of the Protocol on Water and Health.

Progress has been made in setting specific targets for prevention and reduction of WRDs and strengthening surveillance and early-warning systems in accordance with the core requirements of the Protocol. It is important to translate these targets into tangible action and thereby protect public health by preventing and controlling WRDs.

List of tables, figures and boxes

Tables

Figures

Boxes

1. Introduction

The Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes is the first international legal instrument on water, sanitation and health (UNECE/WHO Regional Office for Europe, 1999). Its aim is the protection of human health and well-being through linking sustainable water management and the prevention, control and reduction of water-related diseases (WRDs). The definition of WRDs as defined by the Protocol and used in this report is presented in Box 1.

In accordance with the core provisions of the Protocol, Parties are required to:

(a) establish targets for prevention, control and reduction of WRDs, including targets on the reduction of the scale of outbreaks and incidents of WRDs, within two years of becoming a Party to the Protocol (article 6) and to collect and evaluate data to monitor and report on the progress towards meeting these targets (article 7);

(b) establish, improve or maintain comprehensive national and/or local surveillance and early-warning systems for WRDs, prepare comprehensive national and local contingency plans for responses to outbreaks, incidents and risks and ensure response capacities of relevant public authorities to respond to outbreaks, incidents and risks within three years of becoming a Party to the Protocol (article 8).

Box 1. Definition of water-related disease

The Protocol on Water and Health defines water-related disease as, "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".

This report focuses on the infectious diseases that result from exposure to contaminated water (including drinking-water, wastewater and recreational water) through ingestion, dermal contact or inhalation pathways as well as vector-borne diseases in which transmission is associated with water and sanitation conditions (e.g. fly- and mosquito-borne diseases, diseases transmitted through flood waters).

This report contains information on diseases that can be water-related. Other exposure pathways may still be possible as transmission routes for outbreaks and sporadic cases are not always identified and/or reported.

In the pan-European region,[1] the Protocol is an important policy tool for incrementally realizing regional and global commitments relevant to water, sanitation and health. These include the 2030 Agenda for Sustainable Development, in particular Goal 6 targets related to safe water, sanitation and hygiene, and Goal 3 targets related to ending neglected tropical diseases and combating water-borne diseases (United Nations, 2015). It further supports World Health Assembly resolution

[1] This publication uses the term "pan-European region" to refer to the Member States in the WHO European Region and Liechtenstein. The WHO European Region comprises the following 53 countries: Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, the former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Ukraine, United Kingdom and Uzbekistan.

WHA64.24: Drinking-Water, Sanitation and Health (World Health Assembly, 2011) and the regional priority goal related to water and sanitation in the Parma Declaration on Environment and Health (WHO Regional Office for Europe, 2010).

The Protocol's objective and activities are closely linked with, and support, implementation of the International Health Regulations 2005 (IHR) – a legally binding global framework to support national and international activities aimed at preventing, protecting against, controlling and responding to the international spread of diseases and other health risks. IHR requirements can be broadly summarized into two main areas: (i) urgent actions to be taken with respect to acutely arising risks to public health; and (ii) strengthening of national systems referred to as core capacities (Hardiman & WHO Department of Global Capacities, Alert and Response, 2012). In accordance with the IHR, all States Parties are required to strengthen and maintain the core public health capacities for surveillance and response, in particular capacities to detect, assess and respond to public health events and contribute to global health security.

Prevention and reduction of WRDs is a priority area under the Protocol, with the aim of assisting countries to implement the provisions of article 8. The review was conducted with a strategic vision to identify priority activities under the Protocol to support countries in fulfilling core obligations to strengthen national surveillance and early-warning systems, contingency planning and response capacities for WRDs. The main objectives of this report were to provide overviews of the:

- available information on water-related infectious diseases in the pan-European region;
- state of WRD surveillance and outbreak response systems in the region; and
- progress on target setting and reporting on WRDs under the provisions of the Protocol.

To summarize the situation of water-related infectious diseases, Chapter 3 of the report presents the findings of a review of 36 water- and vector-borne diseases in the 53 Member States of the WHO European Region from multiple data sources for the time period 2000–2013. The summaries of available information on the state of WRD surveillance, outbreak response and reporting (Chapter 4) and target setting (Chapter 5) were compiled from the findings of a literature review, complemented by country-specific information provided in the national reports of the Protocol and the IHR annual reports.

2. Information sources and methods

2.1 Assessing the situation of water-related infectious diseases

Three primary data sources were used to extract information on the extent of WRDs and assess reporting trends by disease, country and data source (Table 1): (i) Global Infectious Disease and Epidemiology Online Network (GIDEON); (ii) Centralized Information System for Infectious Diseases (CISID); and (iii) the European Surveillance System (TESSy). Information available in the Protocol on Water and Health national summary reports was also included.

This report describes data on diseases that can be water-related; however, the actual source of transmission is often not known for reviewed disease cases and/or outbreaks. Most of the data sources had no capability to filter cases/outbreaks by vehicle of transmission.

Table 1. Summary of data sources used to assess situation of water-related infectious diseases

	GIDEON	CISID	TESSy
All infectious diseases in database	351	58	59
Infectious diseases that can be water-related	112	22	20
Water-related and endemic diseases in WHO European Region	36	16	13
Countries represented	52*	53	30
Time period data are available	2000–2013	2000–2010	2006–2013

* Serbia and Montenegro are not shown separately.

2.1.1 GIDEON

GIDEON is a global internet-based infectious disease knowledge and management resource (GIDEON, 2016). It is intended for helping clinicians and epidemiologists to diagnose infectious diseases and to stay current with trends and developments in epidemiology and treatments. Among other functions, GIDEON contains an online database of publications related to infectious diseases which enables summaries of documented outbreaks and prevalence surveys to be extracted by disease and by country, with linked lists of citations. Geovisualization of endemic areas is also possible with the inbuilt GIDEON mapping tools.

The outbreak summaries contain published information from national health ministry reports; WHO technical reports; texts and monographs; journals and periodicals; and notifications of the Program for Monitoring Emerging Diseases (ProMED). ProMed notifications are regularly replaced when peer-reviewed publications become available. GIDEON is routinely updated and the information presented in this report was obtained in August 2014.[2]

In the initial stages of the GIDEON search, all diseases documented in the database (N=351) were filtered by the possible vehicle of transmission. This identified 57 diseases that could be transmitted via the water route (i.e. ingestion, inhalation or dermal contact) as well as 37 mosquito-borne and 18 fly-borne diseases in which transmission is associated with water and sanitation conditions. Thus,

[2] Use and distribution of information abstracted from GIDEON requires a formal request and a data use agreement. Permission was obtained for all summary information provided in the report.

according to the definition provided in Box 1, a total of 112 diseases that could be considered water-related were analysed. The geographical distribution of these 112 diseases was reviewed using the mapping tools, resulting in 36 WRDs (28 waterborne, eight vector-borne) that were identified as endemic in some or all of the Member States of the WHO European Region (Table 2). It should be noted that, while salmonellosis is an important infectious disease in the Region, it has been excluded from the report because it is considered foodborne in the GIDEON database. Endemicity was defined as the disease being reported in the country in recent years or human disease being possible due to the ongoing presence of the infecting agent in local reservoirs and/or vectors.

Subsequently, the country summaries of outbreaks and prevalence surveys for each disease with the corresponding citation lists were reviewed and used to construct a matrix of 36 WRDs for 53 countries of the WHO European Region which was used for data analysis. The matrix included three types of data:

1. prevalence surveys conducted in human, animal or environmental reservoirs;
2. outbreaks documented in the country for the period between 2000 and 2013 – it is important to note that the data reflect only outbreaks that were investigated, the causal agent was identified, and the outbreak was documented in the literature with a corresponding citation, hence the number of outbreaks in GIDEON is much lower than the total number of outbreaks; and
3. investigated outbreaks specifically linked to water (i.e. associated with contaminated drinking-water, indoor or outdoor swimming site, spa, water park and cooling tower, etc.).

2.1.2 CISID

Maintained by the WHO Regional Office for Europe, CISID is a database which presents annual counts and incidence rates for selected infectious diseases (CISID, 2016). Data reported in CISID are provided annually by the Member States. At the time of the review, CISID contained consistent publicly available historical data up to 2010, with post-2010 data available offline. Data were reported up to 2012 for some country/disease combinations but, as such cases were rare, 2011 and 2012 data were systematically excluded.

CISID provides information on a total of 58 infectious diseases, 22 of which can be water-related, including 16 diseases that are endemic in some or all Member States of the WHO European Region according to GIDEON. The annual counts and incidence rates for the time period 2000–2010 were extracted for each of the 16 diseases in all 53 Member States; cumulative annual disease counts were analysed.

2.1.3 TESSy

TESSy is a metadata-driven system for collection, validation, cleaning, analysis and dissemination of data maintained by the European Centre for Disease Prevention and Control (ECDC, 2016). A total of 30 countries – 28 EU Member States plus two European Economic Area (EEA) countries (Iceland and Norway) – report their available data on 52 infectious diseases. Of these, 20 can be considered water-related, including 13 diseases that are endemic in some or all of these countries according to GIDEON. The aggregated annual data from TESSy analysed in this report are available in the ECDC Surveillance Atlas of Infectious Diseases[3] and/or annual epidemiological reports.

Annual counts of diseases for the time period 2006–2013 were abstracted from TESSy in two ways: (i) by country profiles (N=30) listing all diseases reported in the country; and (ii) by disease profiles (N=13) listing all countries reporting on that particular disease and the annual disease counts. The

[3] ECDC Surveillance Atlas is publicly available at http://atlas.ecdc.europa.eu/public/index.aspx, accessed 26 September 2016.

Table 2. WRDs identified in GIDEON that overlap with CISID and TESSy

Disease	Vehicle	Agent	GIDEON	CISID	TESSy
Adenovirus infection	Water	Virus	x		
Aeromonas & marine *Vibrio* infection	Water	Bacterium	x		
Amoebic colitis	Water	Protozoan	x	x	
Blastocystis hominis infection	Water	Protozoan	x		
Campylobacteriosis	Water	Bacterium	x	x	x
Cercarial dermatitis	Water	Platyhelminthes, trematoda	x		
Conjunctivitis – inclusion	Water	Bacterium	x		
Cryptosporidiosis	Water	Protozoan	x	x	x
Cyclosporiasis	Water	Protozoan	x		
Escherichia coli diarrhoea	Water	Bacterium	x	x	x
Gastroenteritis - viral	Water	Virus	x		
Giardiasis	Water	Protozoan	x	x	x
Hepatitis A	Water	Virus	x	x	x
Hepatitis E	Water	Virus	x		
Hymenolepis nana infection	Water	Platyhelminthes, cestoda	x		
Legionellosis	Water	Bacterium	x	x	x
Leptospirosis	Water	Bacterium	x	x	x
Listeriosis	Water	Bacterium	x	x	x
Melioidosis	Water	Bacterium	x		
Mycobacteriosis – *M. marinum*	Water	Bacterium	x		
Mycobacteriosis – *M. scrofulaceum*	Water	Bacterium	x		
Mycobacteriosis –miscellaneous non-tuberculous	Water	Bacterium	x		
Plesiomonas infection	Water	Bacterium	x		
Rotavirus infection	Water	Virus	x		
Shigellosis	Water	Bacterium	x	x	x
Trichostrongyliasis	Water	Nematoda	x		
Typhoid and other enteric fever	Water	Bacterium	x	x	
Yersiniosis	Water	Bacterium	x	x	x
Bunyaviridae infections – miscellaneous	Vector	Virus	x		
Dengue	Vector	Virus	x	x	x
Leishmaniasis – cutaneous	Vector	Protozoan	x	x	
Leishmaniasis – visceral	Vector	Protozoan	x	x	
Phleboviruses – Old World	Vector	Virus	x		
Sindbis	Vector	Virus	x		
Tularaemia	Vector	Bacterium	x	x	x
West Nile fever	Vector	Virus	x	x	x
Total			**36**	**16***	**13**

* In CISID, cutaneous and visceral forms of leishmaniasis are combined and reported as one disease.

number of countries that provided data to the system varied for each disease. One objective for using the TESSy data was to compare the reporting trends for diseases overlapping with the CISID database (Table 2). Annual disease counts were plotted for these 13 diseases in 30 countries, with a maximum temporal overlap of five years when data were available from both sources. This enabled direct comparison of reported counts for these five years between the two reporting systems. For diseases that exhibited consistency in the reported counts for the five overlapping years, a temporal trend analysis for the entire 2000–2013 time period was also possible.

2.2 Assessing the state of WRD surveillance and target setting

The state of WRD surveillance, outbreak response systems and target setting was assessed using national reports provided under the Protocol and the IHR annual reports and supplemented with information from the literature.

2.2.1 Reporting under the Protocol on Water and Health

The Protocol requires Parties to establish and publish targets (article 6); to collect and evaluate data on progress towards achieving the targets; and to report on how far that progress has contributed to preventing, controlling or reducing WRDs (article 7). The Protocol reporting guidelines and template require Parties to submit national summary reports every three years, requesting reports of incidents and outbreaks of five WRDs: cholera, shigellosis, hepatitis A, enterohaemorrhagic *Escherichia coli* (EHEC) infection and typhoid fever, as well as any other diseases considered as priorities in the national context.

Of the 26 Parties mandated to submit reports, 25 fulfilled the requirement and submitted the summary reports (in English, Russian or French) for the 2011–2013 reporting cycle reporting on data from the 2010–2012 time period.[4]

For the purpose of this report, national targets set under article 6 of the Protocol were reviewed to gain an overview of WRD-related targets set by Parties. Reviews were also conducted on information related to WRD incidents and outbreaks extracted from the national summary reports submitted under the provisions of article 7 of the Protocol.

2.2.2 Reporting to IHR Monitoring Framework

In accordance with the IHR, all States Parties are required to assess the ability of their national structures and resources to meet minimum national core capacities for surveillance and response and to develop a plan of action to ensure that these capacities will be present and functioning throughout their territories (WHO, 2016a). The States Parties and WHO are required to report annually to the World Health Assembly on the implementation of the IHR. The IHR monitoring framework was established for this purpose and countries provide regular updates on their progress towards meeting the IHR targets via a self-reported annual questionnaire.

Of the 53 WHO European Region Member States, all except two (Albania, United Kingdom) submitted at least one report between 2010 and 2015. Annual summary data for 2010–2015 abstracted from the Global Health Observatory Data Repository (WHO, 2016b) were reviewed to understand more about surveillance and response capacities, with specific focus on three (of eight) core capacities that are most relevant to the scope of this report. For each capacity, a percentage score was reported for each year that the country submitted a report. It is emphasized that the data provide a general

[4] National summary reports are available at: http://www.unece.org/env/water/protocol_second_reporting_cycle.html, accessed 26 September 2016.

overview of core capacities for surveillance and response for all hazards, and are not specific to WRD alone.

- *Core Capacity 3 – Surveillance* includes both indicator-based and event-based surveillance. Indicator-based surveillance refers to routine surveillance that includes an early-warning function. It requires that countries have a list of priority diseases (those with highest public health significance) and a specific department designated for maintaining surveillance. It also requires that baseline estimates and thresholds for alert be developed and that deviations from the baseline or exceedances of the thresholds trigger a response. Regular dissemination of information from the surveillance system to stakeholders and periodic evaluation of the system's function are also part of the capacity. Event-based surveillance focuses primarily on maintaining and executing standard operating procedures for event capture, reporting, confirmation, verification, assessment and notification as well as actively engaging community members and stakeholders in identification of public health threats (WHO, 2016c).
- *Core Capacity 4 – Response* includes rapid response capacity and infection control. Rapid response involves maintaining adequate resources for responding to public health emergencies and developing effective emergency response management procedures, including for WRD. This also includes regular training of personnel and evaluation of the procedures following real or simulated public health response events (WHO, 2016c).
- *Core Capacity 8 – Laboratory* includes confirmation and diagnostic capacity to test for priority health threats; laboratory biosafety and biosecurity practices. Confirmation and diagnostic capacity is relevant to the surveillance of WRD. This involves not only developing and maintaining laboratory quality standards and guidelines and diagnostic and confirmatory laboratory requirements (particularly with regard to the priority diseases) but also maintaining national reference laboratories (NRLs) that comply with international standards (WHO, 2016c).

2.2.3 Literature review

A literature search was conducted in PubMed using the following combination of search terms "water" OR "vector" AND "surveillance" AND "Europe" in the title/abstract and limited to the 2000–2013 time period (251 articles). The articles were further screened for direct relevance to the report. Only articles written in the English language were included. Several additional relevant articles from other sources were included.

In total, 36 publications were reviewed. The literature review was intended to capture information about surveillance systems and not intended to be exhaustive for all combinations of Member States and diseases, a function performed by the GIDEON database.

3. Situation of water-related infectious diseases

The situation of water-related infectious diseases is summarized by first presenting the findings from GIDEON, CISID and TESSy in sections 3.1, 3.2 and 3.3. This is followed by examination of the consistency of reporting between CISID and TESSy data in section 3.4. Section 3.5 provides an overview of data under the Protocol, including targets related to reducing outbreaks and incidents of WRD. Section 3.6 concludes with a synthesis of all reviewed information, including findings from the literature review.

3.1 Findings from GIDEON data: disease outbreaks

According to the GIDEON database search, the amount of published literature on WRD varied widely among countries and diseases. This partially reflects the capacities of countries' surveillance systems to detect and investigate outbreaks. More reports of investigated outbreaks were available from countries in the northern, southern and western European subregions[5] (Table 3).

Table 3. Summary of potential WRD outbreaks recorded in GIDEON (2000–2013)

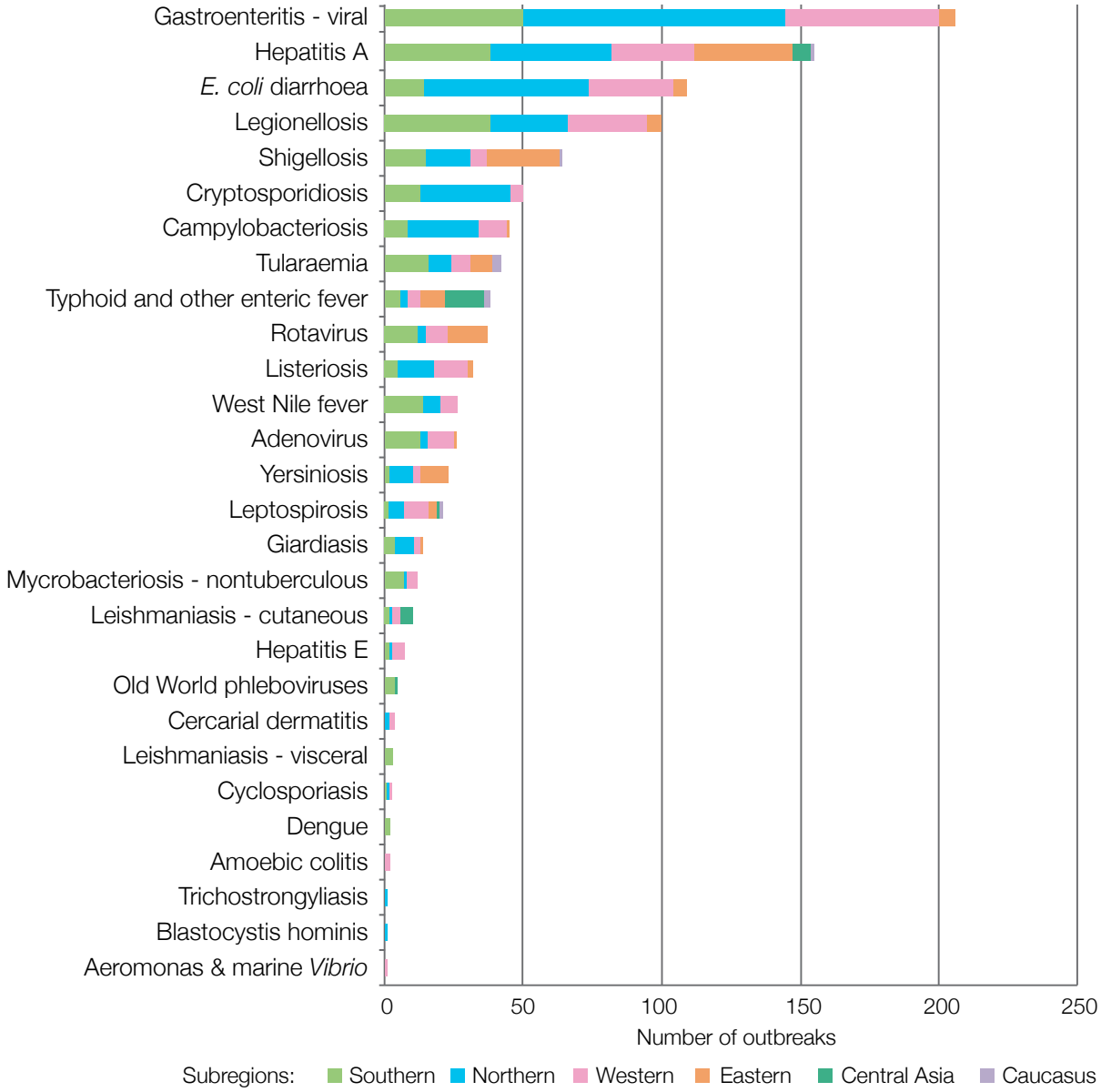
Region	Number of countries	Number of outbreaks*	Outbreaks linked to water	Proportion linked to water (%)
Southern	17	271	52	19
Northern	10	359	64	18
Western	8	241	36	15
Eastern	10	133	22	17
Central Asia	5	27	8	30
Caucasus	3	8	3	38
Total	**53**	**1039**	**185**	**18**

* Outbreaks in GIDEON are those that have been investigated and documented in the literature with a corresponding citation.

Of the 36 diseases selected for review, 28 had at least one outbreak in the WHO European Region between 2000 and 2013. As shown in Fig. 1, diseases with the highest total numbers of outbreaks (100 or more) were viral gastroenteritis, hepatitis A, *Escherichia coli (E. coli)* diarrhoea and legionellosis. It is important to note that these numbers do not account for the number of cases involved. The central Asia and Caucasus subregions had very low numbers of investigated outbreaks with attributed causal pathogen during the 2000–2013 time period.

[5] For the purpose of this report, Member States of the WHO European Region were grouped according to geographical subregions as defined by the United Nations Statistics Division: (a) southern Europe (including three countries classified as western Asia): Albania, Andorra, Bosnia and Herzegovina, Croatia, Cyprus, Greece, Israel, Italy, Malta, Montenegro, Portugal, San Marino, Serbia, Slovenia, Spain, the former Yugoslav Republic of Macedonia, Turkey; (b) northern Europe: Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden, United Kingdom; (c) western Europe: Austria, Belgium, France, Germany, Luxembourg, Monaco Netherlands, Switzerland; (d) eastern Europe: Belarus, Bulgaria, Czechia, Hungary, Poland, Republic of Moldova, Romania, Russian Federation, Slovakia, Ukraine; (e) central Asia: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan; (f) Caucasus (as part of western Asia): Armenia, Azerbaijan, Georgia.

Fig. 1. Summary of potential WRD outbreaks recorded in GIDEON (2000–2013)



A total of 1039 outbreaks were recorded in GIDEON (Table 3). Of these, 185 (18%) were specifically linked to water, with 18 of the 36 reviewed diseases represented (Table 4). The majority of these outbreaks were caused by contaminated drinking-water supplies; other identified sources include lakes, swimming pools, spas, water parks, heating and cooling towers, and fountains. The pathogens showing the highest percentages of outbreaks linked to water are leptospirosis, cryptosporidiosis, giardiasis and legionellosis (Table 4).

It should be emphasized that the above numbers represent only outbreaks registered in GIDEON, including only those that were investigated and documented in the literature, but not all outbreaks that occurred. Therefore, the number of outbreaks presented in this report is expected to be an underestimate of the total number of outbreaks, especially in resource-poor countries where few outbreaks are investigated and results published.

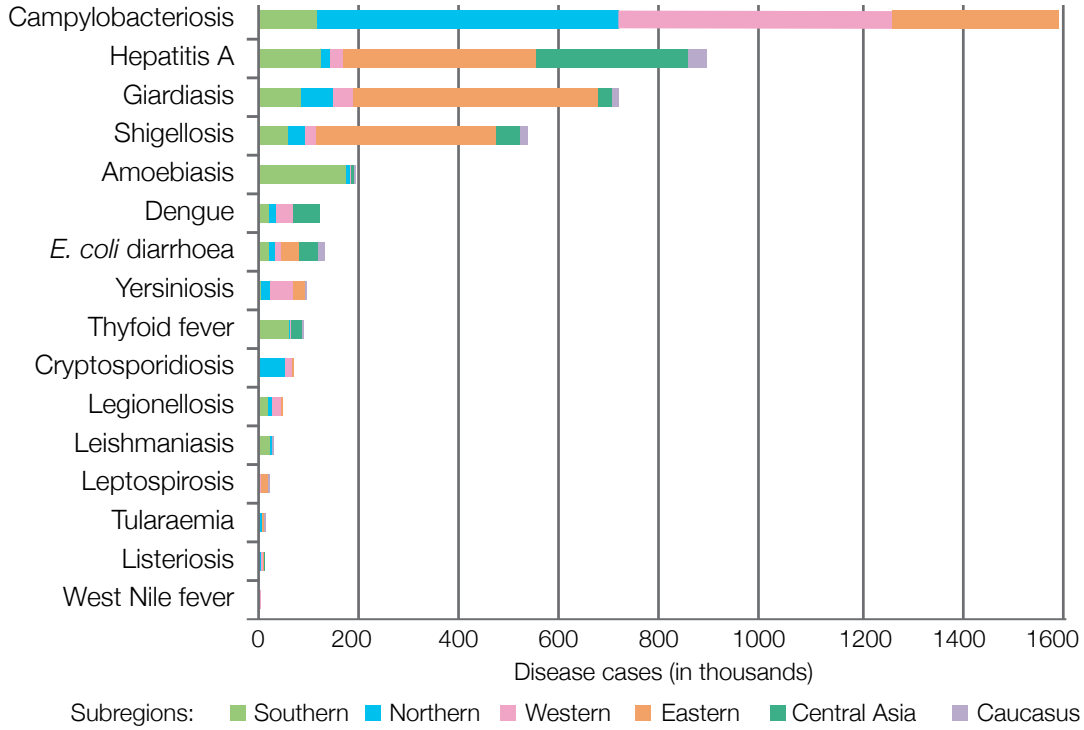
Table 4. Outbreaks attributed to water according to publications in GIDEON (2000–2013)

Disease	Outbreaks linked to water	Number of outbreaks	Proportion linked to water (%)	Countries	Most common sources
Legionellosis	37	100	37	15	Drinking-water, water heater, cooling tower, spa
Gastroenteritis – viral	24	206	12	12	Drinking-water, swimming area, spa
Cryptosporidiosis	20	50	40	6	Drinking-water, swimming pool
Hepatitis A	18	155	12	8	Drinking-water, sauna
Campylobacteriosis	14	45	31	11	Drinking-water
Leptospirosis	13	21	62	8	Drinking-water, outdoor recreational area
Rotavirus	10	37	27	7	Drinking-water
Shigellosis	9	64	14	8	Drinking-water, fountain
Typhoid and other enteric fever	9	38	24	4	Drinking-water
Tularaemia	8	42	19	4	Drinking-water
E. coli diarrhoea	5	109	5	4	Drinking-water, swimming pool
Giardiasis	5	14	36	5	Drinking-water
Cercarial dermatitis	4	4	100	4	Outdoor swimming and bathing areas
Adenovirus	3	26	12	3	Drinking-water, swimming pool
Mycobacteriosis – nontuberculous	2	12	17	1	Swimming pool
Yersiniosis	2	23	9	2	Drinking-water
Aeromonas & marine *Vibrio* infection	1	1	100	1	Swimming area
Blastocystis hominis infection	1	1	100	1	Drinking-water

3.2 Findings from CISID data: disease cases

In CISID, disease counts for the 16 infectious diseases overlapping with the 36 diseases in GIDEON were available (Fig. 2) for the 2000–2010 time period for all 53 countries in the WHO European Region. Campylobacteriosis, hepatitis A, giardiasis and shigellosis were the most commonly reported gastrointestinal infectious diseases in the Region, totalling more than 400 000 cases each during the 2000–2010 time period. Other commonly reported diseases were amoebiasis, dengue, *E. coli* diarrhoea, typhoid fever, yersiniosis and cryptosporidiosis (Fig. 2). By subregion, the highest disease counts were found for campylobacteriosis in the northern, and western, amoebiasis in the southern, giardiasis in the eastern, and hepatitis A in central Asia and the Caucasus. High counts were also seen for giardiasis in the southern, northern and western subregions and campylobacteriosis in the southern and eastern.

Fig. 2. Cumulative potential WRD counts (in thousands) reported in CISID, by subregion (2000–2010)



It should be noted that these are total counts of disease cases and, as CISID provides no information on the vehicle of transmission (e.g. food or water), it is not possible to estimate the number or percentage of cases related to water.

Analysis of regularity of reporting indicates that more than half of the Member States regularly report (i.e. 8–11 reports in 11 years) hepatitis A, legionellosis and leptospirosis (Table 5). However, for many diseases, a substantial number of countries report irregularly (i.e. 4–7 reports in 11 years), rarely (i.e. three or fewer reports) or have no data. Diseases for which more than 20 countries report rarely or not at all are amoebiasis, campylobacteriosis, cryptosporidiosis, dengue, giardiasis, leishmaniasis, West Nile fever and yersiniosis.

Table 5. Regularity of reporting of disease cases to CISID (2000–2010)

Disease	Regular reporting*	Irregular reporting**	Rare or no reporting***	Total
Amoebiasis	16	12	25	53
Campylobacteriosis	19	9	25	53
Cryptosporidiosis	14	10	29	53
Dengue	16	14	23	53
Hepatitis A	40	10	3	53
E. coli diarrhoea	17	18	18	53
Giardiasis	17	13	23	53
Legionellosis	32	9	12	53
Leishmaniasis	18	13	22	53
Leptospirosis	30	11	12	53
Listeriosis	21	16	16	53
Shigellosis	36	9	8	53
Tularaemia	20	20	13	53
Typhoid fever	25	18	10	53
West Nile fever	10	17	26	53
Yersiniosis	15	16	22	53

* 8–11 reports submitted; ** 4–7 reports submitted; *** up to three reports submitted or no reporting/no data available.

3.3 Findings from TESSy data: disease cases

In TESSy, disease counts for the 13 diseases overlapping with the 36 diseases in GIDEON were available (Fig. 3) for the 2006–2013 time period.[6] Campylobacteriosis, giardiasis and hepatitis A were the most commonly reported diseases, each totalling above 100 000 cases between 2006 and 2013. Other commonly reported diseases were yersiniosis, shigellosis, cryptosporidiosis, legionellosis and *E. coli* diarrhoea. By subregion, the most frequently reported infectious diseases in TESSy were campylobacteriosis in the southern, northern, western and eastern; giardiasis in the northern and western; legionellosis in the southern; and hepatitis A in the eastern. It should be noted that these are total counts of disease cases reported to TESSy and it is not known what number or proportion of cases are related to water alone.

Analysis of the regularity of reporting in the TESSy system for the 2006–2013 time period indicates that at least 27 of the 30 countries regularly report (i.e. 6–8 reports in eight years) on campylobacteriosis, hepatitis A, *E. coli* diarrhoea, legionellosis, listeriosis and shigellosis (Table 6). At least five countries report rarely (i.e. two or fewer reports) on cryptosporidiosis, dengue, giardiasis and yersiniosis.

[6] Central Asia and Caucasus subregions do not report to TESSy. Furthermore, the number of countries belonging to the other four subregions is not necessarily the same as in Figs. 1 and 2.

Fig. 3. Cumulative potential WRD counts (in thousands) reported in TESSy, by subregion (2006–2013)

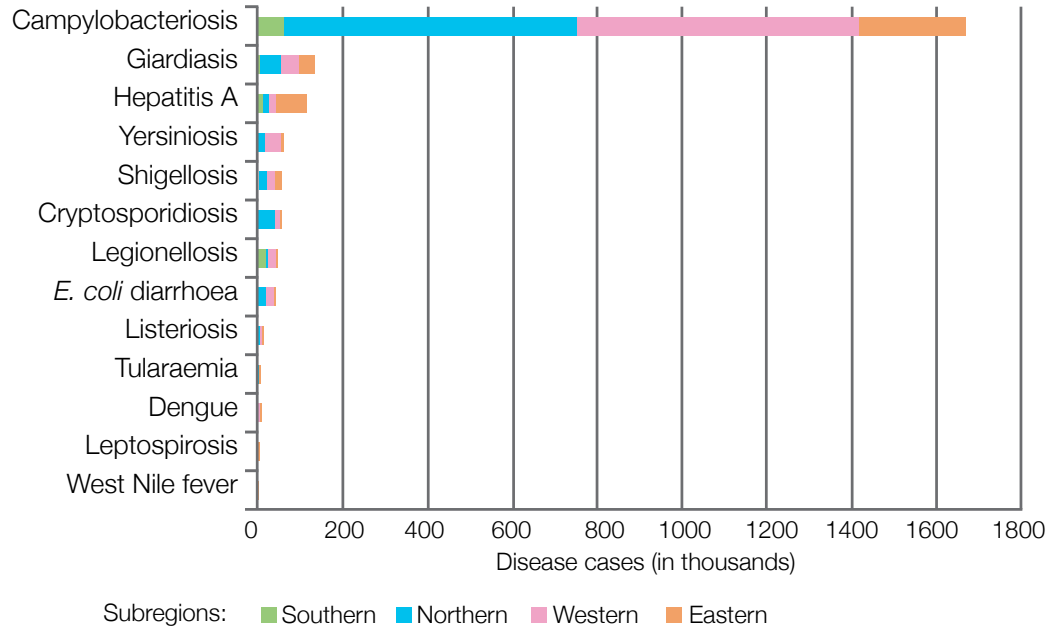


Table 6. Regularity of reporting of disease cases to TESSy (2000–2010)

Disease	Regular reporting*	Irregular reporting**	Rare or no reporting***	Total
Campylobacteriosis	27	0	3	30
Cryptosporidiosis	21	0	9	30
Dengue	21	2	7	30
Hepatitis A	29	0	1	30
E. coli diarrhoea	27	1	2	30
Giardiasis	22	1	7	30
Legionellosis	29	0	1	30
Leptospirosis	26	1	3	30
Listeriosis	28	0	2	30
Shigellosis	28	0	2	30
Tularaemia	26	0	4	30
West Nile fever	23	2	3	28
Yersiniosis	25	0	5	30

* 6–8 reports submitted; ** 3–5 reports submitted; *** two or fewer reports submitted or no reporting/no data available.

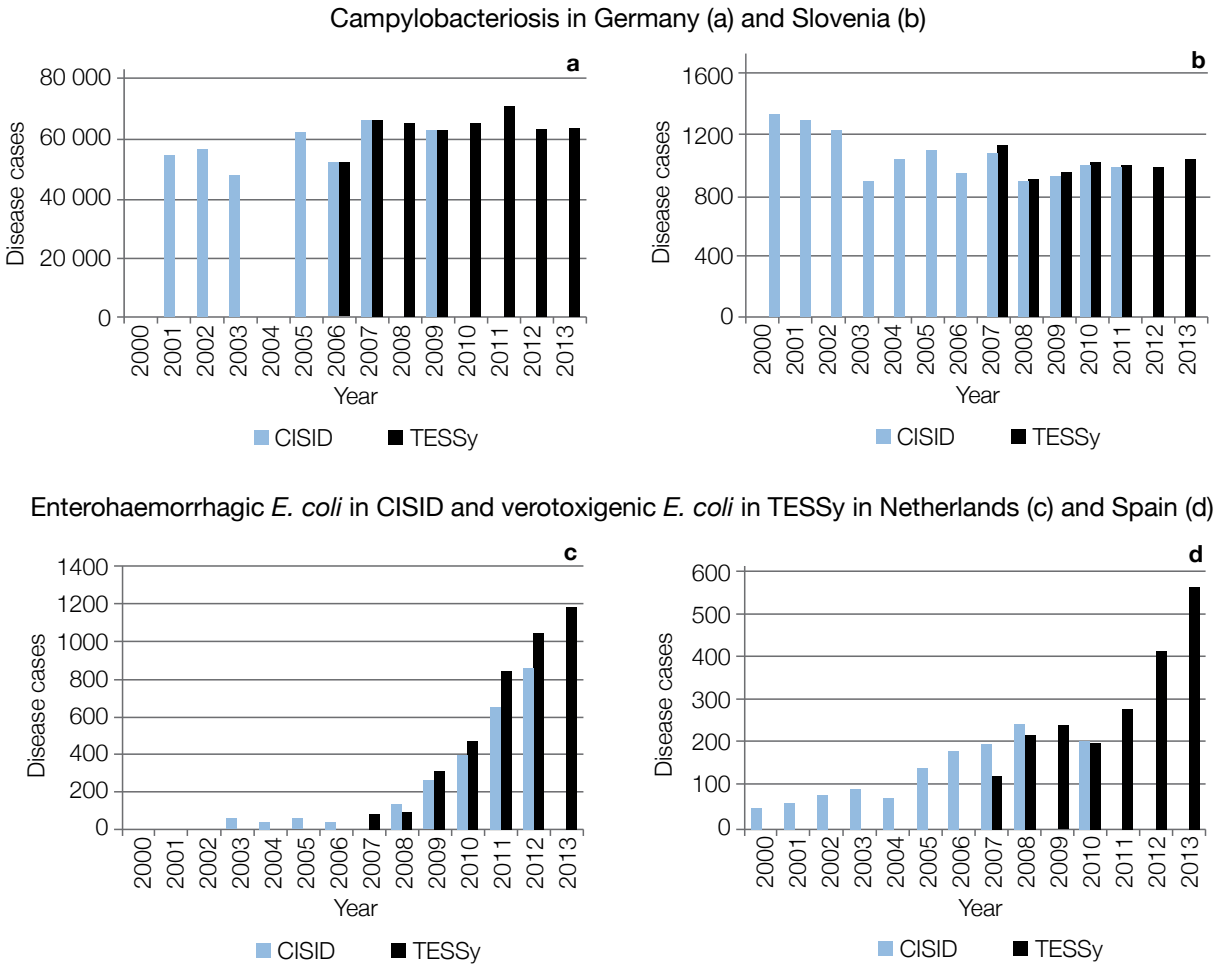
3.4 Consistency of reporting: CISID vs. TESSy

The availability of annual case counts reported to the CISID and TESSy systems for an overlapping time period enabled a limited analysis of reporting consistency between the two sources.

Reported case counts were relatively consistent between the data sources for most disease/country combinations (see two examples in Fig. 4a and Fig. 4b); counts were most consistent for cryptosporidiosis, shigellosis and hepatitis A. Notable disparities in annual disease counts for the overlapping

time period were seen in at least 59 disease/country combinations (see two examples in Fig. 4c and Fig. 4d). Legionellosis, *E. coli* diarrhoea and yersiniosis show the most inconsistent reporting between the two sources. These discrepancies could arise because different departments or institutions are responsible for reporting data to the two databases; from different case definitions; or from the use of different in-country sources of data.

Fig. 4. Examples of annual time series of disease cases reported to CISID and TESSy



With 14 years of annual counts (2000–2013) constructed using data from both CISID (2000–2010) and TESSy (2006–2013), including up to five years of overlap where data from both sources were available, it was possible to perform visual analysis of the temporal pattern of diseases within countries. Many countries exhibited upward trends in disease counts for campylobacteriosis, giardiasis, yersiniosis, listeriosis, dengue and *E. coli* diarrhoea. This may indicate surveillance systems' increasing capability to detect cases over time or actual increases in case numbers. Twelve countries exhibited downward trends in disease counts for hepatitis A and shigellosis. The downward temporal trend is encouraging even though these diseases are still significant contributors of cases and outbreaks, signifying that detection capability for these diseases is relatively high.

In summary, data from CISID and TESSy reporting systems were largely in agreement; however, there were some inconsistencies between the counts that countries reported to the systems. Such cases require coordination of functions within each country, so that the same department or institution is responsible for reporting cases to CISID and TESSy. This will ensure consistent information for both systems and enable better understanding of temporal patterns. The following strengths and limitations were identified for the two reporting systems.

- Data available in TESSy are more recent and more detailed, including information on the number of laboratory confirmed cases and giving some indication of a country's laboratory capabilities to diagnose various diseases.
- TESSy also provides case definitions for each disease, allows disaggregation of data by age and gender and enables examination of the proportion of travel-associated cases.
- Data in CISID allow longer time series analysis of temporal trends (2000–2010).
- CISID contains data for all WHO European Region countries; TESSy covers EU/EEA countries only.

3.5 Data reported and targets set under the Protocol on Water and Health

In the 2010–2012 reporting period, 23 countries provided data on the number of cases and outbreaks of the five diseases required for the Protocol reporting: cholera, shigellosis, EHEC infection, hepatitis A and typhoid fever. A total of 279 outbreaks of these WRDs were reported from nine countries, with the highest numbers of outbreaks attributed to hepatitis A and shigellosis (Table 7). The number of outbreaks presented may be a combination of all outbreaks or only those linked to water, depending on the reporting countries.

The data in Table 7 are difficult to compare with data from other sources because information on disease cases and outbreaks was reported inconsistently and with wide variations between countries: some reporting incidence, some counts and some percentages. In reporting incidence, the denominator was not always clear. Furthermore, in reporting WRDs, some countries perceived all cases to be of waterborne or foodborne origin, some reported only those known to be of waterborne origin and some reported a combination of both.

Table 7. Potential WRD outbreaks reported under the Protocol on Water and Health (2010–2012)

Disease	Number of reported outbreaks	Number of countries
Cholera	1	1
Shigellosis	74	7
E. coli diarrhoea (EHEC)	5	3
Hepatitis A	198	7
Typhoid fever	1	1
Total	**279**	

Aside from systematic reporting on these five diseases, a few countries provided additional information on other WRDs within their national reports, primarily campylobacteriosis (Finland, Ukraine), giardiasis (Georgia), legionellosis (Finland, Georgia, Hungary) and yersiniosis (Ukraine). For example, one to ten confirmed WRD outbreaks were reported annually in Finland, mainly caused by noroviruses or *Campylobacter*. These were reported to be primarily associated with private wells and small groundwater supplies serving fewer than 500 people. In 2011, an outbreak of Pontiac fever associated with spa pool water containing *Legionella anisa* bacterium affected 11 people.

Hungary reported that aetiological agents (including norovirus, rotavirus, *Salmonella, Shigella, Campylobacter* and *Clostridium difficile*) were identified for 485 of the 778 outbreaks of gastroenteritis registered in 2011. Drinking-water was confirmed as the transmission medium for only one outbreak. One smaller, presumably pool-water related conjunctivitis, outbreak probably caused by adenovirus

was also reported. In addition, 20 cases of probable or confirmed nosocomial legionellosis were reported (a domestic hot water system being the most likely infective source for 12 cases and a whirlpool for three cases).

The report from France focused specifically on legionellosis as a priority WRD. Available data indicate a sharp increase in reported cases since the late 1990s, with more than 1200 cases reported for 2012. An increasing trend in the incidence of legionellosis in France is supported in the literature (Hartemann & Hautemaniere, 2011).

Several Parties adopted and published national targets on reductions in the scale of outbreaks and incidents of WRDs according to article 6 paragraph 2(b) of the Protocol. Table 8 provides examples of such targets.

Table 8. WRD reduction targets set by Parties under the Protocol on Water and Health

Country	Targets
Azerbaijan*	• Maintain zero incidence of cholera and typhoid fever
Belarus	• Maintain zero incidence of cholera and typhoid fever • Maintain current incidence of viral hepatitis A and dysentery
Estonia	• Eliminate outbreaks of diseases linked to drinking-water
Finland	• Reduce number of people falling ill in WRD epidemics to annual level of 0.01% of population
Hungary	• Low number of identified cases of water-related infectious diseases
Norway	• Outbreaks and endemic diseases caused by waterborne infection shall have low probability and consequence
Republic of Moldova	• Maintain zero incidence of cholera and typhoid fever • Reduce viral hepatitis A and dysentery incidence by 20% by 2020
Slovakia	• Reduce health risks related to bathing water quality by 2020
Ukraine	• Decrease morbidity rate of cholera, shigellosis, acute enteric infection caused by EHEC, hepatitis A, typhoid fever and methaemoglobinaemia by 2020

* Draft target – currently in the process of finalizing targets.

3.6 Summary of information on WRDs

In this section, information gathered from GIDEON, CISID and TESSy is integrated, incorporating additional supporting information from the literature and from the Protocol national reports. Table 9 provides a summary of the most commonly reported diseases by subregion according to GIDEON, CISID and TESSy. The GIDEON column lists diseases with the highest numbers of outbreaks that are investigated; the CISID and TESSy columns show diseases with the highest numbers of reported cases. The three data sources are not consistent in terms of the number of countries per subregion and the represented time period. Hence, the table is not intended for direct comparison but rather to summarize the information presented in Figs. 2–4 inclusive. It should also be remembered that, while these diseases can be water-related, the numbers represent all outbreaks and cases covering all exposure pathways, not just those linked to water. CISID and TESSy collect indicator-based surveillance data and do not provide specific information on confirmed WRDs.

In the southern, northern and western subregions, viral gastroenteritis shows the highest numbers of outbreaks but campylobacteriosis is the leading disease by the number of reported cases. Other important diseases in these three subregions are hepatitis A, *E. coli* diarrhoea and legionellosis

for outbreaks; giardiasis and cryptosporidiosis for cumulative case numbers. Other diseases with high counts are yersiniosis n the western, hepatitis A in the southern and shigellosis in the northern subregions. In the eastern, hepatitis A, shigellosis and rotavirus are the most investigated outbreaks and disease counts are highest for giardiasis, campylobacteriosis, hepatitis A and shigellosis. In the central Asia and Caucasus subregions, typhoid fever and hepatitis A are responsible for the most investigated outbreaks; the highest disease counts are exhibited for shigellosis, hepatitis A and *E. coli* diarrhoea.

Table 9. Most commonly reported WRDs, by subregion

Subregion	GIDEON (outbreaks)	CISID (counts)	TESSy (counts)
Southern	Gastroenteritis – viral Hepatitis A Legionellosis Tularaemia	Amoebiasis Hepatitis A Campylobacteriosis Giardiasis	Campylobacteriosis Legionellosis Hepatitis A Giardiasis
Northern	Gastroenteritis – viral *E. coli* Diarrhoea Hepatitis A Cryptosporidiosis	Campylobacteriosis Giardiasis Cryptosporidiosis Shigellosis	Campylobacteriosis Giardiasis Cryptosporidiosis Shigellosis
Western	Gastroenteritis – viral Hepatitis A *E. coli* diarrhoea Legionellosis	Campylobacteriosis Dengue* Yersiniosis Giardiasis	Campylobacteriosis Giardiasis Yersiniosis *E. coli* diarrhoea
Eastern	Hepatitis A Shigellosis Rotavirus Yersiniosis	Giardiasis Hepatitis A Shigellosis Campylobacteriosis	Campylobacteriosis Hepatitis A Giardiasis Shigellosis
Central Asia	Typhoid Fever Hepatitis A Leishmaniasis – cutaneous	Hepatitis A Shigellosis *E. coli* diarrhoea	N/A
Caucasus	Tularaemia Typhoid fever	Hepatitis A Shigellosis *E. coli* diarrhoea	N/A

* Due to cases in the overseas territories.

Information on outbreaks was available from GIDEON and the Protocol national reports. While not directly comparable, the information from these two sources demonstrates that the number of outbreaks that can be extracted from GIDEON constitutes a very small percentage of all outbreaks that occur in the WHO European Region. For example, a total of 197 outbreaks of shigellosis, *E. coli* diarrhoea, hepatitis A and typhoid fever from 24 countries were recorded in GIDEON in the 2000–2013 period. This compares to 278 outbreaks from nine countries recorded in the Protocol reports for the 2010–2012 period alone. It also highlights the fact that, while standardized information on disease cases is available from CISID and TESSy, comparable information on outbreaks is not. The Protocol provides an opportunity to fill this gap.

GIDEON shows *Legionella* to be one of the most common causes of waterborne outbreaks, yet legionellosis case counts in CISID and TESSy are low in comparison to some other WRDs because these outbreaks tend to affect a small number of individuals. The literature review revealed the need for increased environmental surveillance for *Legionella* bacteria in hospitals and public buildings in a number of countries (Cristino, Legnani & Leoni, 2012; Montagna et al., 2006; Napoli et al., 2010).

Although more common in tropical climates, leptospirosis is becoming an important disease in the European Region, particularly in France (Baranton & Postic, 2006; Picardeau, 2013; Vein et al., 2012). Although Baranton & Postic (2006) did not observe an increasing trend in the incidence of leptospirosis in historical data, incidence is expected to rise due to floods caused by increasingly common extreme climatic events (Picardeau, 2013).

Outbreaks of vector-borne diseases remain relatively rare in the WHO European Region, with the exception of leishmaniasis in the central Asia subregion. However, a leishmaniasis outbreak has occurred in Spain (Arce et al., 2013). Case counts for vector-borne diseases are also low, with the majority of the reported cases likely travel related. However, local transmission of West Nile fever does occur in southeastern Europe and dengue is found in the French and Portuguese overseas territories (Lourenço & Recker, 2014; Semenza et al., 2013). In fact, France reported very high counts of dengue into the CISID system in 2006, 2007 and 2010 (on average 23 000–84 000 cases per year), which contributed to dengue showing the second highest reported case counts in the western subregion. The same reporting pattern was not observed in the TESSy system: only 125 cases were reported in 2010. This discrepancy should be further investigated.

4. WRD surveillance

The Protocol on Water and Health requires Parties to establish, improve or maintain comprehensive WRD surveillance and response systems according to article 8 (see Box 2). The state of WRD surveillance and response systems is discussed in sections 4.1 to 4.3, primarily focusing on core capacities for surveillance, response and laboratory services. This is based on information from national summary reports provided under article 7 of the Protocol, the IHR Core Capacity Monitoring Framework and the literature. Section 4.4 concludes with a summary of targets related to WRD surveillance and response systems set under article 6 of the Protocol.

Box 2. Protocol on Water and Health article 8: response systems

1. The Parties shall each, as appropriate, ensure that:
   (a) Comprehensive national and/or local surveillance and early-warning systems are established, improved or maintained which will:
      (i) Identify outbreaks or incidents of water-related disease or significant threats of such outbreaks or incidents, including those resulting from water-pollution incidents or extreme weather events;
      (ii) Give prompt and clear notification to the relevant public authorities about such outbreaks, incidents or threats;
      (iii) In the event of any imminent threat to public health from water-related disease, disseminate to members of the public who may be affected all information that is held by a public authority and that could help the public to prevent or mitigate harm;
      (iv) Make recommendations to the relevant public authorities and, where appropriate, to the public about preventive and remedial actions;
   (b) Comprehensive national and local contingency plans for responses to such outbreaks, incidents and risks are properly prepared in due time;
   (c) The relevant public authorities have the necessary capacity to respond to such outbreaks, incidents or risks in accordance with the relevant contingency plan.
2. Surveillance and early-warning systems, contingency plans and response capacities in relation to water-related disease may be combined with those in relation to other matters.
3. Within three years of becoming a Party, each Party shall have established the surveillance and early-warning systems, contingency plans and response capacities referred to in paragraph 1 of this article.

4.1 Surveillance and notification

Three main factors at various stages of the process make it inherently difficult to analyse information on WRD surveillance systems across different countries. Firstly, countries show large disparities in the number of notifiable diseases and events within national surveillance systems. Secondly, many surveillance systems lack both a standard definition of “outbreak” and a threshold for the number of cases required for outbreak investigation, thereby inhibiting early-warning and notification functions. Thirdly, surveillance systems may not necessarily contain a mechanism for the reporting of all water-related conditions. For example, Finland has a compulsory notification system in place for suspected waterborne disease outbreaks. Outbreaks caused by drinking-water have been reported to the national electronic database since 1998 but waterborne outbreaks caused by bathing and pool water were added, and reporting templates developed, as recently as 2011.

Electronic notification has greatly simplified the reporting and notification process. An example of the value added by electronic notification and reporting is described in Box 3. In the Protocol reports, Azerbaijan and the Republic of Moldova reported recent implementation of electronic notification systems for infectious diseases. However, paper reports are still in use as electronic notification systems are not yet available in all countries and even those that are set up and functioning are not available in all facilities.

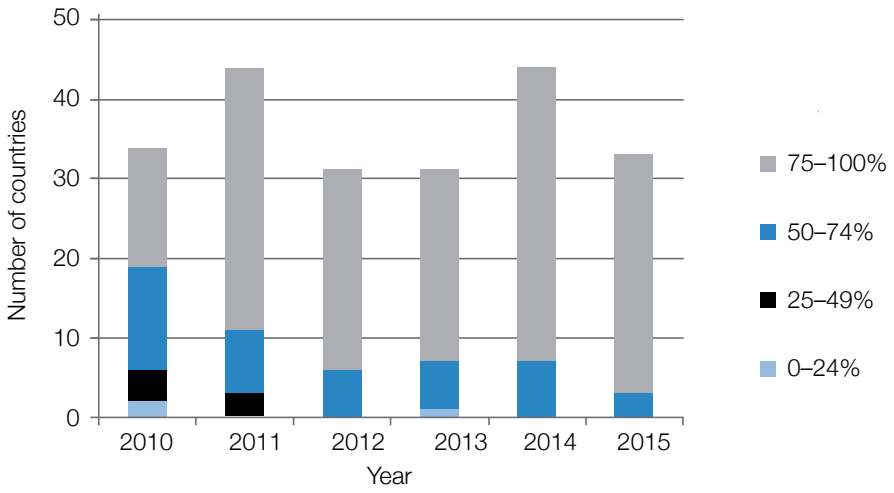
Box 3. Event-based surveillance system, Norway

In 2005, the Norwegian Institute of Public Health established a web-based outbreak rapid alert system. Vesuv is used for mandatory outbreak reporting by municipal medical officers, health-care institutions and food safety authorities. As of 2013, 1426 outbreaks involving 32 901 cases had been notified. A total of 474 outbreaks (33%) were associated with food or drinking-water. Vesuv has enhanced reporting and enabled rapid and efficient information sharing between different authorities at both local and national levels. It is also an important tool for event-based reporting. A national database containing information on all reported outbreaks also enables identification of patterns in places or sources of infection or the predominant causal agents of outbreaks (Guzman-Herrador et al., 2016).

Outbreak detection could be improved if demographic information on patients was included in surveillance/notification systems. Some countries in the northern subregion use a unique identifier linked to a number of a patient's personal characteristics, including current place of residence (Risebro & Hunter, 2007). In many instances, such information is not available.

In the context of the IHR, the surveillance core capacity includes two components: (i) indicator-based; and (ii) event-based (described in section 2.2.2). In the 2010–2015 time period, 51 countries of the WHO European Region submitted core capacity self-assessment data on IHR implementation. Between 31 and 44 of these 51 countries reported on surveillance capacity: in 2010, 44% scored their surveillance capacity at 75% or above; in 2015, 91% of the countries reported capacity at 75% or above (Fig. 5). The self-reported nature of the data makes it difficult to compare the trends and status between the different subregions.

Fig. 5. IHR surveillance capacity in WHO European Region, self-reported by countries (2010–2015)



Source: WHO, 2016b.

4.2 Laboratory capacity

Results from the literature review suggest that laboratory capacity is a significant limitation for WRD surveillance. In 2009, the ECDC conducted a survey of NRL capacity for the following pathogens: *Campylobacter, Listeria, Salmonella, Shigella, Shigatoxin/verotoxin* producing *E. coli* (STEC/VTEC) and *Yersinia* (ECDC, 2012). The survey found that the designated NRL services were most complete for *Salmonella*. *Campylobacter* lacks a designated NRL in many countries, despite being recognized as the most common bacterial cause of diarrhoea and the most commonly reported WRD (ECDC, 2013). The capacity to characterize the pathogen is also limited in existing clinical laboratories. STEC/VTEC, *Listeria*, *Shigella* and *Yersinia* detection and characterization services were found to be very diverse. The survey concluded that the capacity for laboratory detection and confirmation of outbreaks and changing trends in relation to foodborne and waterborne infections is very weak across large parts of Europe. Laboratory capacity related to protozoa was not assessed in the survey but it is believed that many protozoan outbreaks (primarily caused by *Cryptosporidium* and *Giardia lamblia*) are unrecognized and unreported (ECDC, 2012).

Another set of surveys of laboratory capacity was conducted in response to a multicountry STEC/VTEC outbreak that affected more than 4000 individuals in Europe (Rosin et al., 2013). The first survey found that *Shigatoxin* diagnostic testing was available and routinely used in 15–90% of the clinical laboratories in only nine countries; available in some laboratories for use in outbreaks in another three countries; and not available in the remaining 12 countries that responded to the survey. Results of this assessment have shown that several countries lacked the capacity to detect and characterize cases at the national level during the outbreak, with even greater detection gaps at the primary diagnostic level. The survey demonstrated the need to strengthen the microbiological laboratory capacity for timely communicable disease alert and response (Rosin et al., 2013). Also, in the Protocol national reports, three countries specifically stated that *E. coli* species are not typed and are most commonly reported together with other gastrointestinal illnesses.

Even when adequate laboratory diagnostic services are available, WRD surveillance is hindered by the lack of a standard laboratory protocol. In the clinical setting, patients whose condition is not severe enough do not always seek care (Dewaal et al., 2010). Also, general practitioners do not always request a stool sample for analysis if the result is not expected to affect the course of treatment, particularly because patients will not always want to provide a sample for analysis because they may not want to incur unnecessary costs (Risebro & Hunter, 2007). Even when a stool sample is requested from a patient, the general practitioner may not provide clear instructions on what pathogens the laboratory should test for, but will write a generic statement such as “stool culture”. In turn, the laboratory may not record what tests are performed, thereby causing an inconsistency of records between facilities. In stool samples it is more common to culture for bacteria, rather than parasites and viruses. Generally, a few standard pathogens are routinely tested for (e.g. *Salmonella* and *Shigella*); tests for other pathogens are optional and typically not performed because of cost. In addition, the conventional methods employed in laboratories may fail to identify a large percentage of infections, but the full set of molecular methods is costly and time consuming to perform (Hrudey & Hrudey, 2007; Meusburger et al., 2007). If WRD surveillance is to be standardized among countries, this will require a standard laboratory protocol that is within the technological and financial capabilities of all countries.

Case studies of laboratory practices associated with two waterborne disease outbreaks in Austria and in Denmark are described in Boxes 4 and 5.

Box 4. Laboratory capacity case study, Austria

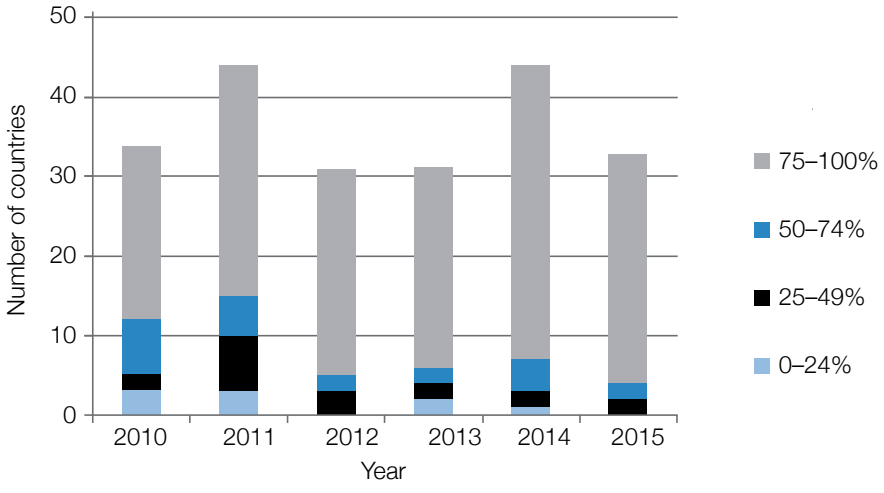
A gastrointestinal outbreak was investigated in a rural village in Austria in 2006. Microbiological testing of water samples indicated faecal contamination of the drinking-water supply. A more detailed analysis of the water sample was not performed. Stool samples from 14 affected patients underwent laboratory testing and all tested negative for *Salmonella*, *Campylobacter*, *Shigella* and *Yersinia enterocolitica*. The samples were not tested for viruses, parasites or enteropathogenic *E. coli*. The causative agent of the outbreak was not identified by this routine microbiological analysis. At least in outbreak conditions, medical practitioners must be encouraged to conduct further microbiological testing of stool samples beyond the routine analyses in order to identify the causative agent (Meusburger et al., 2007).

Box 5. Laboratory capacity case study, Denmark

A gastrointestinal outbreak was investigated in Kalundborg, Denmark in 2012. Microbiological testing of water samples indicated increased concentrations of indicator bacteria (coliforms and *E. coli*) in drinking-water. Stool samples from 23 residents of the affected area were analysed for a range of pathogens including diarrhoeagenic *E. coli*, *Campylobacter*, *Salmonella*, *Yersinia*, norovirus (GI and GII), rotavirus, sapovirus, human astrovirus and adenovirus. Five *E. coli* positive water samples from the distribution system also underwent laboratory analyses for the viruses. Norovirus GII was identified in 15 stool and all five water samples serving as a confirmed source of this waterborne outbreak (van Alphen et al., 2014).

The laboratory core capacity in the IHR monitoring framework includes two components: (i) confirmation and diagnostic capacity; and (ii) biosafety and biosecurity (described in section 2.2.2). Data on these components were not available and only the overall laboratory capacity values are presented as percentages. Of the 51 countries of the WHO European Region that reported data to IHR during the period 2010–2015, between 31 and 44 countries reported on laboratory capacity: in 2010, 65% scored this at 75% or above; in 2015, 88% of the countries reported capacity at 75% or above (Fig. 6).

Fig. 6. IHR laboratory capacity in WHO European Region, self-reported by countries (2010–2015)



Source: WHO, 2016b.

4.3 Investigation and response

During outbreak investigation, the ability to identify the vehicle of transmission remains limited in many countries and greatly contributes to the difficulties in estimating the true extent of water-related outbreaks. Waterborne outbreaks are typically of short duration and water samples from the time of exposure are rarely available. In addition, the organisms in water samples are typically of lower concentrations than those in human specimens and difficult to detect. Problems associated with microbiological examination of water make it likely that much of an investigation will rely on epidemiological evidence (Tillett, de Louvois & Wall, 1998) but the capacity or capability to conduct such an investigation may present a challenge in many countries. Outbreak detection and investigation is particularly problematic when it concerns small rural and private water supplies and bathing and swimming waters.

A study of foodborne and waterborne outbreaks in three WHO world regions, including the European Region, found that 38% of the outbreaks had no water or food attribution specified (Dewaal et al., 2010). Another study of gastrointestinal diseases abstracted from the Italian national surveillance system identified the source of disease for 53% of the outbreaks, or 59% of the total cases; 13.3% of the diseases could be considered water-related (in this case defined as consumption of drinking-water, shellfish or agricultural products) (Blasi et al., 2008).

More emphasis should be placed on monitoring the occurrence of WRDs associated with swimming and bathing waters. Along with aquatic food products and irrigated crops, recreational waters have been cited as important potential WRD transmission vehicles that are rarely investigated (Blasi, Carere & Funari, 2011). Swimming in contaminated waters is recognized as an important transmission route for *Cryptosporidium* and *Giardia* infections (Karanis, Kourenti & Smith, 2007). Recent research suggests that viruses are commonly found in European surface waters and increased environmental monitoring is encouraged (Kern et al., 2013; Silva et al., 2010; Wyn-Jones et al., 2011). Investigation of outbreaks associated with recreational water contact is challenging because it typically relies upon questionnaires to assess exposure, sometimes with a substantial lag period between exposure and disease development. These investigations are substantially influenced by responders' recall bias that weakens the likelihood of finding associations during statistical analysis (Suppes & Reynolds, 2014). An enhanced surveillance approach in England utilizing a rolling analysis of detailed risk factor questionnaire data was able to identify eight small cryptosporidiosis outbreaks associated with swimming pool use that were missed by the national surveillance system (Briggs et al., 2014).

Limited information is available on WRD outbreak detection, investigation and response in rural small water supply areas and their contribution to the WRD burden is likely underestimated. A need for improved capacity to detect and investigate outbreaks in rural small water systems is advanced in the Protocol national reports and in the literature (Blasi, Carere & Funari, 2011). A few countries mentioned a focus on rural private or small water systems as a priority in WRD surveillance and outbreak prevention in the national reports submitted under the Protocol, as these tend to be more vulnerable to outbreaks. Research from England, United Kingdom, showed that private water supplies serve approximately 0.5% of the population but are responsible for 36% of waterborne disease outbreaks. Major risk factors include animals and agriculture in close proximity to rural small water systems; heavy rains; and inadequate treatment (Said et al., 2003). A study of microbiological water quality in private water supplies showed that at least 19%, but potentially over 30% of these, are contaminated with *E. coli* (Richardson et al., 2009).

In addition to the routine notification and reporting practices, the literature shows several approaches reported to enhance a surveillance system's ability to detect outbreaks. These include monitoring of web-based queries about symptoms of gastrointestinal illness; sales of over-the-counter

pharmaceuticals; and telephone records on patients seeking health-care advice from nurses. For example, telephone triage was useful in early detection of outbreaks in Sweden (Andersson et al., 2014). Examples of outbreak investigation techniques are provided in Boxes 6 and 7.

Box 6. Outbreak detection and investigation, United Kingdom

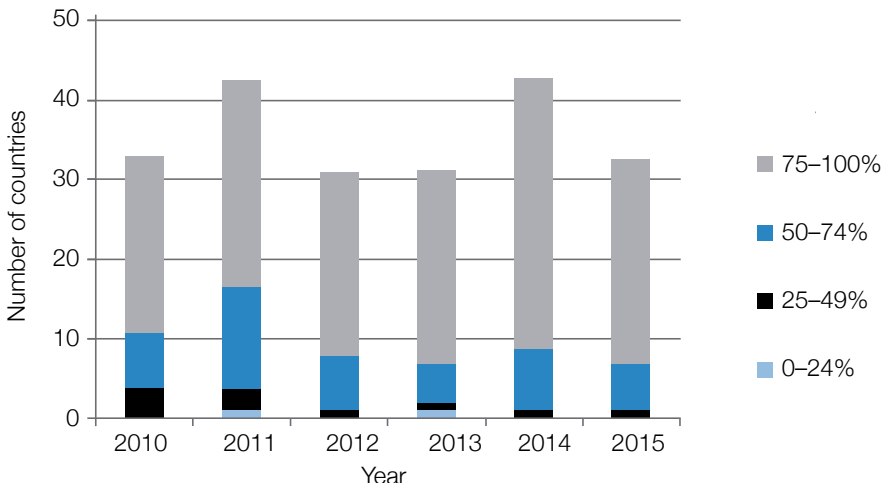
Syndromic surveillance data from a national telephone helpline and clinical diagnosis data extracted from general practitioner-based clinical information systems were used to detect and monitor a local outbreak of cryptosporidiosis in Northamptonshire, United Kingdom. In the 33 clinical cases identified, 23 individuals were confirmed to be infected with the specific outbreak strain. However, syndromic surveillance data suggested 422 excess diarrhoeal cases during the outbreak, providing an indicator of the extent of the outbreak in the population (Smith et al., 2010).

Box 7. Outbreak investigation and response, Finland

A broken water distribution pipe caused a community-wide waterborne outbreak in Vuorela, Finland in 2012. The outbreak was investigated with advanced epidemiological and microbiological methods including a web-based questionnaire from 16% of the inhabitants; extensive microbiological analysis of water and stool samples; and a spatial analysis of the contaminated water distribution system. Sapovirus, enterovirus, *Campylobacter jejuni* and EHEC O157:H7 as well as virulence genes for enteropathogenic E. coli (EPEC), enteroaggregative *E. coli* (EAEC) and EHEC pathogroups were detected in the stool samples. EPEC, EAEC and EHEC virulence genes and faecal indicator bacteria were detected in water samples. Drinking untreated tap water from the outbreak area was significantly associated with illness (RR 5.6, 95% CI 1.9-16.4). The extensive investigation approach helped to define the extent and magnitude of this outbreak (Jalava et al., 2014).

In the context of the IHR, the response core capacity includes two components: (i) rapid response capacity; and (ii) infection control (described in section 2.2.2). Of the 51 countries of the WHO European Region that reported data to IHR during the period 2010–2015, between 31 and 44 countries reported on response capacity. This was scored at 75% or above by 68% of the countries in 2010 and by 79% of the countries in 2015 (Fig. 7). Strategies to improve countries' capacities to respond to WRD outbreaks include emergency stocks of drugs, vaccines and water treatment supplies, as well as communicating risks to the public more effectively (Blasi, Carere & Funari, 2011).

Fig. 7. IHR response capacity in WHO European Region, self-reported by countries (2010–2015)



Source: WHO, 2016b.

4.4 Targets set under the Protocol on Water and Health

The target setting process under article 6 of the Protocol provides a tool to identify necessary improvements of WRD surveillance and response systems aimed at meeting the requirements of article 8 of the Protocol. Table 10 provides examples of targets[7] set by Parties to the Protocol related to improving WRD surveillance and response systems.

Table 10. WRD surveillance targets set by Parties under the Protocol on Water and Health

Country	Targets
Azerbaijan*	• Improve WRD surveillance system and detection capacity of emerging diseases
Czechia	• Improve method for investigating water-related epidemics • Regularly publish an overview report
Germany	• Maintain Ministry of Health support of the Conciliary Laboratory for Legionella
Hungary	• Improve effectiveness of the surveillance system • Develop a patient registry for communicable diseases
Netherlands	• Monitor results of WRD and outbreak reporting, including diseases associated with swimming water • Publish annual overview
Norway	• Develop reliable estimation methods for determining drinking-water related endemic diseases
Serbia	• Improve surveillance of water supply systems in rural areas • Improve methodology for epidemiological investigation of waterborne outbreaks • Raise awareness of people supplied from individual wells on prevention of WRDs
Slovakia	• Map enterovirus occurrence in bathing water by 2019 • Increase surveillance of cyanobacteria in water reservoirs
Ukraine	• Upgrade 50% of laboratories for testing safety and quality of drinking-water by 2020

*Draft target – currently in the process of finalizing targets.

[7] Targets are available at: http://www.unece.org/env/water/pwh_targets_set.html, accessed 26 September 2016.

5. Conclusions

This review makes an initial attempt to bring together information from different sources to assess the state of surveillance of WRDs at the regional scale. Presented data in this report indicate the complexity of this issue and lack of systematic information on the situation and surveillance of WRDs in the pan-European region. The main conclusions of the report are summarized below.

- Campylobacteriosis, giardiasis, hepatitis A and shigellosis are the most commonly reported gastrointestinal infectious diseases in the WHO European Region. While these are the most commonly reported diseases that can be water-related, the data present all exposure pathways and so the proportion of cases linked to water is unknown.
- Diseases with the highest number of reported outbreaks are viral gastroenteritis, hepatitis A, *E. coli* diarrhoea and legionellosis. Limited published data in GIDEON indicate that approximately 18% of investigated outbreaks in the WHO European Region are linked to water. The percentage of attribution to water may vary between countries according to their capability to investigate outbreaks. The majority of outbreaks linked to water are caused by contaminated public drinking-water supplies. Other identified sources include recreational exposure (lakes, swimming pools, spas, water parks) as well as heating and cooling towers, as in the case of legionellosis.
- Available WRD data likely represent only a small fraction of the total number of disease cases occurring in the population. Causes include poor detection of cases and outbreaks by routine surveillance systems in some countries and failure to attribute causal pathogens and transmission sources. Specifically, emerging diseases (including cryptosporidiosis, giardiasis, legionellosis and tropical vector-borne diseases) and diseases associated with swimming and bathing waters are not well captured by surveillance systems. Compared to other diseases, under-representation of WRDs within countries may compromise attention to prevent and control WRDs at policy level.
- The notable subregional differences between most reported WRDs likely arise from variations in established national reporting requirements, case and outbreak definitions, available laboratory and investigation capacities, endemicity and the condition of water supply and sanitation services. This limits ability to compare data across countries.
- The majority of countries have in place both routine passive surveillance systems and outbreak alert and response mechanisms. Progress has been made but challenges have been identified in the implementation of surveillance and response core capacity requirements, including all three components of surveillance systems (surveillance, laboratory services and response). This indicates a need to prioritize and undertake systematic actions to strengthen and maintain the national surveillance capacities necessary to meet the requirements of the IHR, and to ensure effective WRD surveillance and outbreak response systems as required in article 8 of the Protocol on Water and Health.
- WRD surveillance may be inhibited by insufficient early-warning and event detection functions, and low response capacities. Limitations include insufficient laboratory, human and financial capacities; lack of robust epidemiological data; and lack of a unified method for data reporting. Priority areas for improvement of WRD surveillance include strengthening epidemiological investigation capacities for identifying the causal pathogens and transmission vehicles; improving identification

of cases associated with recreational waters, aquatic food products and irrigated crops; and strengthening capacity to detect cases originating in small water systems in rural areas.

- Several reporting platforms for WRDs exist at the regional level, including CISID, TESSy and the reporting mechanism under the Protocol. However, heterogeneity of information among the platforms inhibits not only comparisons across countries, subregions and reporting systems, but also development of accurate understanding of the extent of WRDs in the region. Improved coordination for harmonized reporting appears necessary.
- Reports for both the IHR and the Protocol require countries to provide information on capacities to detect and respond to emergencies, including WRD outbreaks. It is important to explore options for linking the reporting of surveillance capacities and target-setting under the Protocol with the core capacity requirements of the IHR.
- Progress has been made in setting specific targets for prevention and reduction of WRDs and strengthening surveillance and early-warning systems in accordance with article 6 of the Protocol. It is important to translate these targets into tangible action.

References

Andersson T, Bjelkmar P, Hulth A, Lindh J, Stenmark S, Widerström M (2014). Syndromic surveillance for local outbreak detection and awareness: evaluating outbreak signals of acute gastroenteritis in telephone triage, web-based queries and over-the-counter pharmacy sales. Epidemiol Infect. 142(2):303–13. doi:10.1017/S0950268813001088.

Arce A, Estirado A, Ordobas M, Sevilla S, García N, Moratilla L et al. (2013). Re-emergence of leishmaniasis in Spain: community outbreak in Madrid, Spain, 2009 to 2012. Euro Surveill. 18(30):20546. doi:10.2807/1560-7917.ES2013.18.30.20546.

Baranton G, Postic D (2006). Trends in leptospirosis epidemiology in France. Sixty-six years of passive serological surveillance from 1920 to 2003. Int J Infect Dis. 10(2):162–70. doi:10.1016/j.ijid.2005.02.010.

Blasi M, Carere M, Funari E (2011). National surveillance capacity of water-related diseases in the WHO European region. J Water Health. 9(4):752–62. doi:10.2166/wh.2011.039.

Blasi MF, Carere M, Pompa MG, Rizzuto E, Funari E (2008). Water-related disease outbreaks reported in Italy. J Water Health. 6(3):423–32. doi:10.2166/wh.2008.063.

Briggs AD, Boxall NS, Van Santen D, Chalmers RM, McCarthy ND (2014). Approaches to the detection of very small, common, and easily missed outbreaks that together contribute substantially to human Cryptosporidium infection. Epidemiol Infect. 142(9):1869–76. doi:10.1017/S0950268814000673.

CISID (2016) [online database]. Copenhagen: Centralized Information System for Infectious Diseases (http://data.euro.who.int/CISID/, accessed September 26 September 2016).

Cristino S, Legnani PP, Leoni E (2012). Plan for the control of legionella infections in long-term care facilities: role of environmental monitoring. Int J Hyg Environ Health. 215(3): 279–85. doi:10.1016/j.ijheh.2011.08.007.

Dewaal CS, Robert N, Witmer J, Tian XA (2010). A comparison of the burden of foodborne and waterborne diseases in three world regions, 2008. Food Prot Trends. 30(8): 483–90.

ECDC (2012). Survey of National Reference Laboratory (NRL) capacity for six food- and waterborne diseases in EU/EEA countries. Stockholm: European Centre for Disease Prevention and Control (Technical Report; http://ecdc.europa.eu/en/publications/publications/survey-nrl-capacity-for-food-waterborne-agents.pdf, accessed 26 September 2016).

ECDC (2013). Annual epidemiological report: reporting on 2011 surveillance data and 2012 epidemic intelligence data, 2013. Stockholm: European Centre for Disease Prevention and Control (Surveillance Report; http://ecdc.europa.eu/en/publications/Publications/annual-epidemiological-report-2013.pdf, accessed 26 September 2016).

ECDC (2016). Indicator-based surveillance. In: European Centre for Disease Prevention and Control [website]. Stockholm (http://ecdc.europa.eu/en/activities/surveillance/Pages/ index.aspx, accessed 26 September 2016).

GIDEON (2016). Web application. In: Global Infectious Diseases and Epidemiology Online Network [website]. Los Angeles (http://www.gideononline.com/about/gideon/, accessed 26 September 2016).

Guzman-Herrador B, Vold L, Berg T, Berglund TM, Heier B, Kapperud G et al. (2016). The national web-based outbreak rapid alert system in Norway: eight years of experience, 2006–2013. Epidemiol Infect. 144(1): 215–24. doi:10.1017/S095026881500093X.

Hardiman MC, WHO Department of Global Capacities, Alert and Response (2012). World Health Organization perspective on implementation of International Health Regulations. Emerg Infect Dis. [serial on the Internet] (http://dx.doi.org/10.3201/eid1807.120395, accessed 26 September 2016).

Hartemann P, Hautemaniere A (2011). Legionellosis prevention in France. Bundesgesundheitsblatt – Gesundheitsforschung – Gesundheitsschutz. 54(6):724–7. doi:10.1007/s00103-011-1290-5.

Hrudey SE, Hrudey EJ (2007). Published case studies of waterborne disease outbreaks – evidence of a recurrent threat. Water Environ Res. 79(3):233–45. doi: 10.2175/ 106143006X95483.

Jalava K, Rintala H, Ollgren J, Maunula L, Gomez-Alvarez V, Revez J et al. (2014). Novel microbiological and spatial statistical methods to improve strength of epidemiological evidence in a community-wide waterborne outbreak. PloS One. 9(8):e104713. doi:10.1371/journal.pone.0104713.

Karanis P, Kourenti C, Smith H (2007). Waterborne transmission of protozoan parasites: a worldwide review of outbreaks and lessons learnt. J Water Health. 5(1):1–38. doi:10.2166/wh.2006.002.

Kern A, Kadar M, Szomor K, Berencsi G, Kapusinszky B, Vargha M (2013). Detection of enteric viruses in Hungarian surface waters: first steps towards environmental surveillance. J Water Health. 11(4):772–82. doi:10.2166/wh.2013.242.

Lourenço J, Recker M (2014). The 2012 Madeira dengue outbreak: epidemiological determinants and future epidemic potential. PLoS Negl Trop Dis. 8(8):e3083. doi: 10.1371/journal.pntd.0003083.

Meusburger S, Reichart S, Kapfer S, Schableger K, Fretz R, Allerberger F (2007). Outbreak of acute gastroenteritis of unknown etiology caused by contaminated drinking water in a rural village in Austria, August 2006. Wiener klinische Wochenschrift [The Central European Journal of Medicine]. 119(23):717–21. doi:10.1007/s00508-007-0916-y.

Montagna MT, 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–/s10654-006-0009-731. doi:10.1007.

Napoli C, Fasano F, Iatta R, Barbuti G, Cuna T, Montagna MT (2010). Legionella spp. and legionellosis in southeastern Italy: disease epidemiology and environmental surveillance in community and health care facilities. BMC Public Health. 10:660. doi:10.1186/1471-2458-10-660.

Picardeau M (2013). Diagnosis and epidemiology of leptospirosis. Med Mal Infect. 43(1):1–9. doi:10.1016/j.medmal.2012.11.005.

Richardson HY, Nichols G, Lane C, Lake IR, Hunter PR (2009). Microbiological surveillance of private water supplies in England: the impact of environmental and climate factors on water quality. Water Res. 43(8):2159–68. doi:10.1016/j.watres.2009.02.035.

Risebro HL, Hunter PR (2007). Surveillance of waterborne disease in European member states: a qualitative study. J Water Health. 5(Suppl 1):19–38. doi:10.2166/wh.2007.135.

Rosin P, Niskanen T, Palm D, Struelens M, Takkinen J (2013). Laboratory preparedness for detection and monitoring of Shiga toxin 2-producing Escherichia coli O104:H4 in Europe and response to the 2011 outbreak. Euro Surveill. 18(25):1–9. doi: 10.2807/1560-7917. ES2013.18.25.20508.

Said B, Wright F, Nichols GL, Reacher M, Rutter M (2003). Outbreaks of infectious disease associated with private drinking water supplies in England and Wales 1970–2000. Epidemiol Infect. 130:469–79. doi:10.1017/S0950268803008495.

Semenza JC, Sudre B, Oni T, Suk JE, Giesecke J (2013). Linking environmental drivers to infectious diseases: the European Environment and Epidemiology Network. PLoS Negl Trop Dis. 7(7):e2323. doi: 10.1371/journal.pntd.0002323.

Silva AM, Vieira H, Martins N, Granja AT, Vale MJ, Vale FF (2010). Viral and bacterial contamination in recreational waters: a case study in the Lisbon bay area. J Appl Microbiol. 108(3):1023–31. doi:10.1111/j.1365-2672.2009.04503.x.

Smith S, Elliot AJ, Mallaghan C, Modha D, Hippisley-Cox J, Large S et al. (2010). Value of syndromic surveillance in monitoring a focal waterborne outbreak due to an unusual Cryptosporidium genotype in Northamptonshire, United Kingdom, June – July 2008. Euro Surveill. 15(33):14–22. pii:19643.

Suppes LM, Reynolds KA (2014). Swimmer recall on a recreational waterborne illness outbreak questionnaire. Microchem J. 112:150–152. doi:10.1016/j.microc.2013.10.004.

Tillett HE, de Louvois J, Wall PG (1998). Surveillance of outbreaks of waterborne infectious disease: categorizing levels of evidence. Epidemiol Infect. 120(1):37–42. PMCID: PMC2809347.

United Nations (2015). Transforming our world: the 2030 agenda for sustainable development. New York (https://sustainabledevelopment.un.org/post2015/transformingourworld, accessed 26 September 2016).

UNECE/WHO Regional Office for Europe (1999). Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes. Geneva: United Nations Economic Commission for Europe/World Health Organization Regional Office for Europe (http://www.euro.who.int/__data/assets/pdf_file/0007/88603/E89602.pdf?ua=1, accessed 26 September 2016).

van Alphen LB, Dorléans F, Schultz AC, Fonager J, Ethelberg S, Dalgaard C et al. (2014). The application of new molecular methods in the investigation of a waterborne outbreak of norovirus in Denmark, 2012. PloS One. 9(9):e105053. doi:10.1371/journal.pone.0105053.

Vein J, Perrin A, Berny PJ, Benoit E, Leblond A, Kodjo A (2012). Adaptation of a real-time PCR method for the detection and quantification of pathogenic leptospires in environmental water. Can J Microbiol. 58(7):828–35. doi:10.1139/w2012-060.

World Health Assembly (2011). Resolution WHA64.24. Drinking-water, sanitation and health. In: Sixty-fourth World Health Assembly, Geneva, 16–24 May 2011. Resolutions and decisions, annexes. Geneva: World Health Organization; 2011:46 (WHA64/2011/REC/1; http://apps.who.int/gb/ebwha/pdf_files/WHA64-REC1/A64_REC1-en.pdf#page=66, accessed 26 September 2016).

WHO Regional Office for Europe (2010). Parma Declaration on Environment and Health. Fifth Ministerial Conference on Environment and Health: protecting children's health in a changing environment. Parma, Italy, 10–12 March 2010. Copenhagen (http://www.euro. who.int/__data/assets/pdf_file/0011/78608/E93618.pdf, accessed 26 September 2016).

WHO (2016a). International Health Regulations (2005), third edition. Geneva: World Health Organization (http://www.who.int/ihr/publications/9789241580496/en/, accessed 26 September 2016).

WHO (2016b). Global Health Observatory Data Repository (European Region) [online database]. Geneva: World Health Organization (http://apps.who.int/gho/data/view.main-euro.IHRCTRYALLv?lang=en, accessed 26 September 2016).

WHO (2016c). International Health Regulations (2005). IHR core capacity monitoring framework: questionnaire for monitoring progress in the implementation of IHR core capacities in States Parties: 2016 questionnaire. Geneva: World Health Organization (http://apps.who.int/iris/bitstream/10665/246237/1/WHO-HSE-GCR-201616-eng.pdf?ua=1, accessed 12 September 2016).

Wyn-Jones AP, Carducci A, Cook N, D'Agostino M, Divizia M, Fleischer J et al. (2011). Surveillance of adenoviruses and noroviruses in European recreational waters. Water Res. 45(3):1025–38. doi:10.1016/j.watres.2010.10.015.

The Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes aims at protecting human health and well-being through sustainable water management and the prevention, control and reduction of water-related diseases. It supports the realization of the 2030 Agenda for Sustainable Development, in particular Goal 3 and Goal 6 targets related to combating waterborne diseases and to the provision of safe water, sanitation and hygiene for all.

The Protocol requires the establishment of national and/or local targets on the reduction of the scale of outbreaks and incidents of water-related disease. Other core provisions include the establishment, improvement and maintenance of comprehensive national and/or local surveillance and early warning systems to identify and respond to outbreaks or incidents of water-related disease.

This report provides an overview of the situation of water-related infectious diseases and surveillance systems in the pan-European region, and progress on target setting and reporting on water-related diseases under the provisions of the Protocol. It aims to inspire public health professionals and policy-makers concerned with strengthening national and local surveillance systems and with formulating and implementing targets for the reduction and prevention of water-related diseases.

ISBN 9789289052023

World Health Organization
Regional Office for Europe
UN City, Marmorvej 51, DK-2100 Copenhagen Ø, Denmark
Tel.: +45 45 33 70 00, Fax: +45 45 33 70 01
Email: euwhocontact@who.int
Website: www.euro.who.int