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Water-related disease surveillance

INFORMAL DOCUMENT

Review of water-related disease burden and surveillance in the WHO European Region

- Draft report -

Establishing and maintaining comprehensive national and local surveillance and early warning systems for water-related disease surveillance (WRD), contingency plans and response capacities are core provisions of Article 8 of the Protocol on Water and Health.

Prevention and reduction of WRDs is a priority area under the Protocol's 2014-2016 programme of work. Undertaking a systematic review of available information on the status and surveillance of WRDs in the WHO European Region has been identified as one of the main activities at a Lead Parties' planning meeting (Bonn, 31 March 2014). This meeting also outlined the scope and the process of the review work.

The objectives of this review were to summarize the key findings and provide an overview of the available information in the European Region on the burden of water related infectious diseases and the state of water related disease surveillance and outbreak response systems. The structure, content and preliminary findings of the review were presented at the regional Member State meeting on strengthening surveillance of WRD (Bonn, 23-24 October 2014). The draft report was prepared by the WHO Regional Office for Europe jointly with the Lead Parties (Norway and Belarus) and reviewed by the Working Group on Water and Health at its seventh and eighth meetings and peer-reviewed by the technical experts. The report has been further updated reflecting the feedback and suggestions received from these reviews.

The Working Group on Water and Health is requested to review the final draft report and endorse a submission of the document to the fourth session of the Meeting of the Parties for adoption.

The draft report is for use by the Working Group on Water and Health only and not for wider distribution.

Review of water related disease burden and surveillance in the WHO European Region

Acknowledgments

Keywords

Water related diseases
Drinking water
Recreational water
Europe
Disease burden
Surveillance

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List of abbreviations

CISID – Centralized Information System for Infectious Diseases

ECDC – European Centre for Disease Prevention and Control

EEA – European Economic Area

EHEC – Enterohaemorrhagic Escherichia coli

EU – European Union

GIDEON – Global Infectious Diseases and Epidemiology Network

IBS – Indicator-based surveillance

IHR – International Health Regulations

IPC – Infection prevention and control

NRL – National reference laboratory

ProMED – Program for Monitoring of Emerging Diseases

STEC/VTEC – Shigatoxin or veratoxin producing Escherichia coli

TESSy – The European Surveillance System

UN – United Nations

UNICEF – United Nations Children's Fund

WHO – World Health Organization

WRD – water related disease

Executive summary

Introduction: Establishing and maintaining comprehensive national and local surveillance and early warning systems for water-related disease surveillance (WRD), contingency plans and response capacities are core provisions (Article 8) of the Protocol on Water and Health.

Prevention and reduction of water related diseases (WRDs) is a priority area of the work program for 2014-2016 of the Protocol on Water and Health. A lead Parties' planning meeting held on 31 March 2014 in Bonn, Germany identified a need to collect and review available information on the WRD situation in the WHO European Region. The objectives of this report are to summarize the key findings and provide an overview of the available information in the European Region on the burden of water related infectious diseases; the state of national water related disease surveillance and outbreak response systems and setting targets related to WRD under the Protocol.

Information sources: Five major sources of information were reviewed to provide an overview of the reported infectious WRDs in the WHO European Region and the major challenges with WRD surveillance and reporting. The five sources included Global Infectious Diseases and Epidemiology Network (GIDEON), Centralized Information System for Infectious Diseases (CISID), The European Surveillance System (TESSy), country reports submitted under the Protocol on Water and Health, and implementation reports of the International Health Regulations. A brief review of the literature regarding WRD surveillance was also conducted.

Results: Campylobacteriosis, giardiasis, hepatitis A and shigellosis are the most commonly reported water related diseases overall in the WHO European Region. In number of outbreaks, viral gastroenteritis, infection with pathogenic *E.coli* and legionellosis are also important diseases. Legionellosis, viral gastroenteritis, cryptosporidiosis and hepatitis A had the highest number of outbreaks specifically linked to contaminated water, most often a drinking water source. Other identified sources include lakes, springs, swimming pools, spas, water parks, heating and cooling towers and fountains. Available data indicate that surveillance systems not always able to capture the true extent of WRDs and have a limited early warning, event detection and response capacities which potentially related to a number of underlying issues, which include lack of unified way of data reporting, under-reporting, insufficient institutional capacity and lack of robust epidemiological data.

Conclusions: There are notable sub-regional differences in terms of most reported WRD, which are likely to depend on established national reporting requirements, available laboratory capacities, the endemic situation, as well as the status of water supply and sanitation services. The majority of countries have routine passive surveillance systems and outbreak alert and response mechanisms in place. However, challenges have been identified with all three components of surveillance systems: laboratory, reporting and investigation and response

capacities. Surveillance coverage tends to be less in rural areas due to the lack of laboratory, human and financial capacities. There is a general lack of linkage between drinking-water quality monitoring and WRD surveillance. Priority areas include distinguishing between cases of foodborne and waterborne origin, domestic and travel related cases, improving the identification of cases associated with recreational waters, aquatic food products and irrigated crops, and incorporation of additional important diseases that are not currently notifiable (e.g. Norovirus).There are several reporting platforms at the European level which include information on WRDs with inconsistent information among them; therefore improved coordination for harmonized reporting seems necessary. Intrinsic methodological difficulties with WRD surveillance contribute to uncertainty in relation to the true extent of reported cases and may compromise the extent of attention paid to WRDs at policy level.

1. Introduction

Prevention and reduction of water related diseases (WRDs) is a priority area of the work program for 2014-2016 of the Protocol on Water and Health (hereinafter "the Protocol"). This program area aims to assist countries in implementing the core provisions of Article 8 of the Protocol for establishing and maintaining comprehensive national surveillance and early warning systems, contingency plans and response capacities for WRDs. The program area on reduction and prevention of WRDs is jointly led by the Protocol Parties Norway and Belarus and supported by the WHO Regional Office for Europe.

A lead Parties' planning meeting held on 31 March 2014 in Bonn, Germany identified a need to collect and review available information on the WRD situation in the WHO European Region. The objectives of this report are to summarize the key findings and provide an overview of the available information in the European Region on:

- The burden of water related infectious diseases
- The state of water related disease surveillance and outbreak response systems; and
- Progress on target setting and reporting on water-related diseases under the Protocol on Water and Health.

To summarize the burden of infectious WRDs, the report presents the findings of a review of 36 water- or vector-borne diseases in 53 member countries (Figure 1) for the time period of 2000 to 2013. Additionally, the findings of limited literature review concerning WRD surveillance are included, complemented by an assessment of country-specific surveillance and reporting systems.

Figure 1: Map of WHO European member states with country abbreviations and UN-Geo classifications

SOUTH (17)	
Albania	ALB
Andorra	AND
Bosnia & Herzegovina	BIH
Croatia	CRO
Cyprus	CYP
Greece	GRE
Israel	ISR
Italy	ITA
Malta	MAT
Montenegro	MNE
Portugal	POR
San Marino	SMR
Serbia	SRB
Slovenia	SVN
Spain	SPA
Macedonia	MKD
Turkey	TUR
NORTH (10)	
Denmark	DEN
Estonia	EST
Finland	FIN
Iceland	ICE
Ireland	IRE
Latvia	LVA
Lithuania	LTU
Norway	NOR
Sweden	SWE
United Kingdom	UNK

WEST (8)	
Austria	AUT
Belgium	BEL
France	FRA
Germany	DEU
Luxembourg	LUX
Netherlands	NET
Switzerland	SWI
Monaco	MON
EAST (10)	
Belarus	BLR
Bulgaria	BUL
Czech Republic	CZH
Poland	POL
Romania	ROM
Russia	RUS
Slovakia	SVK
Hungary	HUN
Moldova	MDA
Ukraine	UKR
CENTRAL ASIA (5)	
Kazakhstan	KAZ
Kyrgyzstan	KGZ
Tajikistan	TJK
Turkmenistan	TKM
Uzbekistan	UZB
CAUCASUS (3)	
Armenia	ARM
Azerbaijan	AZE
Georgia	GEO

2. Methods

2.1 Assessing infectious water-related disease burden

Three databases (described in sections 2.1.1, 2.1.2 and 2.1.3) were used to extract information on water related diseases and assess reporting trends by diseases, countries and data sources (Table 1), supplemented with information obtained from the country reports submitted under the Protocol on Water and Health (section 2.3.1).

Table 1: Summary of data sources associated with assessing the burden of infectious WRDs

Data source	GIDEON	CISID	TESSy
All infectious diseases	351	58	59
Water related (WR)	112	22	20
WR and endemic in WHO Euro Region	36	16	13
Countries represented	52*	53	30
Time period data is available	2000-2013	2000-2010	2006 - 2013

* Serbia and Montenegro are not separated in GIDEON

2.1.1 Global Infectious Diseases and Epidemiology Network

The Global Infectious Diseases and Epidemiology Network (GIDEON) is a global internet-based infectious disease knowledge and management resource. It is intended for helping clinicians and epidemiologists to diagnose infectious diseases and stay current with the trends and developments in epidemiology and treatments. Among other functions, GIDEON contains an online database of publications related to infectious diseases. In the database, information on outbreaks and prevalence surveys can be extracted by disease (N=351) and by country (N=231) with a linked list of citations. Geographic visualization of endemic areas is also possible through the mapping tools.

The database contains 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), which may include news articles intended for the lay public. The inclusion of ProMed notifications is justified when recent information is not available from more scientifically accurate or credible sources, or when a remote area is involved. These citations are replaced when a peer-reviewed publication becomes available. GIDEON is routinely updated and the information presented in this report was obtained in August 2014. ***The use and distribution of information abstracted from GIDEON requires a formal request and a data use agreement. For all summary information provided in the report, permission was obtained.***

In the initial stages of the GIDEON database search, all diseases (N=351) were filtered by the vehicle of transmission. Transmission via the water route was possible for 57 of 351 diseases. Additionally, 37 mosquito-borne and 18 fly-borne diseases were also considered water related for a total of 112 diseases that could be water-related. The geographic distribution of these 112 diseases was reviewed identifying 36 WRDs (28 water- and 8-vector borne) as endemic in some or all of the WHO European Region countries (Table 2).

Subsequently, country summaries of outbreaks and prevalence surveys of each disease with the corresponding citation lists were reviewed and used to construct a matrix of 36 WRDs by 53 countries of the WHO European Region. For prevalence surveys (S), if any surveys in human, animal or environmental reservoirs had been conducted in the country dated 2000-2013, “Y” was indicated for yes (otherwise “N” for no). For outbreaks (O), the number of outbreaks documented between 2000 and 2013 is listed. It is important to note that this number represents only notable outbreaks, i.e. ones that were investigated and documented in the literature with a corresponding citation. For example, only 4 ***notable*** Cryptosporidium outbreaks are recorded in GIDEON in Ireland during the time period of 2000-2013. However, reviewing more detailed country notes reveals 23 outbreaks occurring between 2004 and 2006 alone. Therefore, the number of notable outbreaks presented in the report is expected to be an

under-estimate of the total number of outbreaks, especially in resource poor countries where few outbreaks are investigated and/or published. “WR” indicates the number of investigated outbreaks that were found to be water- related (i.e. associated with contaminated drinking water, indoor or outdoor swimming site, spa, Water Park, cooling tower, etc.). If a country note was not available at all, “--“ was indicated in all fields (S, O, and WR).

2.1.2 Centralized Information System for Infectious Diseases

Centralized Information System for Infectious Diseases (CISID) is a database maintained by the WHO Regional Office for Europe which presents annual counts and incidence rates of selected infectious diseases. Data reported in CISID are provided by the Member States annually via the joint WHO/UNICEF reporting form. In recent years, most advanced data collection mechanisms have moved to other reporting systems which were not accessible during the review. At the time of review, CISID contained publicly available historical data sets for WRDs up to 2010, with post-2010 data available offline.

Information on 58 diseases is available in CISID, 22 of which can be considered water-related, including 16 WRDs which are endemic in some or all of the WHO European Region according to information obtained in GIDEON (in CISID, cutaneous and visceral leishmaniasis are not distinguished). The annual counts and incidence rates for the time period of 2000 – 2010 were extracted for each of the 16 diseases in all 53 member states. Cumulative counts and annual time series were constructed and explored for trends.

2.1.3 The European Surveillance System

The European Surveillance System (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). A total of 31 countries (28 EU and 3 EEA) report their available data on 59 infectious diseases; 20 of these can be considered water-related, including 13 WRDs which are endemic in some or all of the WHO European Region according to information obtained in GIDEON.

From the TESSy system, annual aggregated counts of diseases for the period 2006-2013 were abstracted in two ways: 1) country profiles (N=31) which contain a list of all diseases reported in the country; and 2) disease profiles for the WRDs of concern which contain a list of all countries and their reported counts (N=13). The number of countries that provided data to the system on each disease varied. The primary objective for using the TESSy data was to compare the reporting trends for 13 overlapping diseases with those in the CISID database (Table 2).

Table 2: Water related diseases identified as endemic in the GIDEON database and overlap with ECDC and TESSy data sources

Disease	Vehicle	Agent	Endemicity	GIDEON	CISID	TESSy
Adenovirus infection	Water	Virus	All EURO countries	x		
Aeromonas & marine Vibrio infx.	Water	Bacterium	All EURO countries	x		
Amoebic colitis	Water	Protozoan	All EURO countries	x	x	
Blastocystis hominis infection	Water	Protozoan	All EURO countries	x		
Campylobacteriosis	Water	Bacterium	All EURO countries	x	x	x
Cercarial dermatitis	Water	Platyhelminthes, Trematoda	Some of the EURO countries	x		
Conjunctivitis - inclusion	Water	Bacterium	All EURO countries	x		
Cryptosporidiosis	Water	Protozoan	All EURO countries	x	x	x
Cyclosporiasis	Water	Protozoan	All EURO countries	x		
Escherichia coli diarrhea	Water	Bacterium	All EURO countries	x	x	x
Gastroenteritis - viral	Water	Virus	All EURO countries	x		
Giardiasis	Water	Protozoan	All EURO countries	x	x	x
Hepatitis A	Water	Virus	All EURO countries	x	x	x
Hepatitis E	Water	Virus	Many of the EURO countries	x		
Hymenolepis nana infection	Water	Platyhelminthes, Cestoda	Some of the EURO countries	x		
Legionellosis	Water	Bacterium	Many of the EURO countries	x	x	x
Leptospirosis	Water	Bacterium	Many of the EURO countries	x	x	x
Listeriosis	Water	Bacterium	Many of the EURO countries	x	x	x
Melioidosis	Water	Bacterium	Many of the EURO countries	x		
Mycobacteriosis - M. marinum	Water	Bacterium	All EURO countries	x		
Mycobacteriosis - M. scrofulaceum	Water	Bacterium	All EURO countries	x		
Mycobacteriosis - miscellaneous nontuberculous	Water	Bacterium	All EURO countries	x		
Plesiomonas infection	Water	Bacterium	All EURO countries	x		
Rotavirus infection	Water	Virus	All EURO countries	x		
Shigellosis	Water	Bacterium	All EURO countries	x	x	x
Trichostrongyliasis	Water	Nematoda	Some of the EURO countries	x		
Typhoid and enteric fever	Water	Bacterium	All EURO countries	x	x	
Yersinosis	Water	Bacterium	All EURO countries	x	x	x
Bunyaviridae infections - misc.	Vector	Virus	Some of the EURO countries	x		
Dengue	Vector	Virus	Many of the EURO countries	x	x	x
Leishmaniasis - cutaneous	Vector	Protozoan	Some of the EURO countries	x	x	
Leishmaniasis - visceral	Vector	Protozoan	Many of the EURO countries	x	x	
Old World phleboviruses	Vector	Virus	Many of the EURO countries	x		
Sindbis	Vector	Virus	Many of the EURO countries	x		
Tularemia	Vector	Bacterium	Many of the EURO countries	x	x	x
West Nile fever	Vector	Virus	Many of the EURO countries	x	x	x
Total				**36**	**16***	**13**

* In CISID, cutaneous and visceral leishmaniasis are combined resulting in 16 vs. 17 diseases

2.2 Assessing the state of water-related disease surveillance and outbreak response systems

The state of WRD surveillance and outbreak response was assessed using two relevant country reports provided by the Member States (sections 2.3.1 and 2.3.2) and supplemented through a brief literature search. The literature search was conducted in PubMed using the following search terms: “water related disease”, “waterborne disease”, “surveillance”, and “Europe”.

2.2.1 Reporting under the Protocol on Water and Health

The Protocol on Water and Health is a primary policy instrument for the pan-European region in the water and health domain. It is the only legally binding international agreement addressing protection of human health and well-being through linking sustainable water management with prevention, control and reduction of WRDs. .

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

(a) establish targets for a high level protection against water-related diseases within two years of becoming Party to the Protocol and to collect and evaluate data to monitor and report the progress towards meeting the targets. The Meeting of the Parties of the Protocol evaluates Protocol implementation on the basis of national summary reports. and report the progress. (Article 6 and 7),Targets are intended to be tailored to the Party’s social, economic and environmental conditions, needs, priorities and available resources.

(b) establish, improve or maintain national/local surveillance and early warning systems for WRD, contingency plans and response capacities within three years of becoming a Party (Article 8).

Currently, 36 of 53 countries (68%) are signatories and 26 countries are Parties to the Protocol on Water and Health in the pan-European region. Signing the Protocol shows the government’s interest or intention to become a Party at a later stage and its government willingness to implement the provisions set out in the Protocol. By becoming a Party countries state their consent to be bound by the provisions of the Protocol. 25 out of 26 Parties which are mandated to submit a national summary report fulfilled the requirement and submitted reports in 2013 in English, or Russian or French languages. Country reports contained information on WRD surveillance, including whether or not cases and outbreaks of cholera, shigellosis, EHEC, viral hepatitis A and typhoid fever and other diseases that have been reported in the countries, as well as targets set aiming to improve surveillance systems and reduce WRDs. The information obtained under the second reporting cycle for 2011-2013 was reviewed and summarized in this report.

2.2.2 International Health Regulations Implementation Reports

The International Health Regulations (IHR) is an international law aimed to prevent, protect against, control and respond to the international spread of diseases and other health risks. All

member states of the WHO European Region must comply with the regulations and are required to have the core capacities for detection, reporting, and managing public health risks that may be of international concern. The member states provide regular reports on their progress towards meeting the IHR targets via a self-reported annual survey.

Summary results of the 2011 and 2012 rounds of these reports were reviewed, considering the following three most relevant capacities out of eight core capacities:

- Core Capacity 3-Surveillance: early warning function for detection of public health events in routine indicator-based surveillance (IBS); event-based surveillance;
- Core Capacity 5- Response: public health emergency response mechanisms; infection prevention and control (IPC) at national and hospital levels; and
- Core Capacity 8 - Laboratory: laboratory services to test for priority health threats; laboratory biosafety and biosecurity practices;

3. REVIEW RESULTS

3.1 Burden of infectious water-related diseases in the WHO European Region

3.1.1 Findings from GIDEON data analysis: water-related disease outbreaks

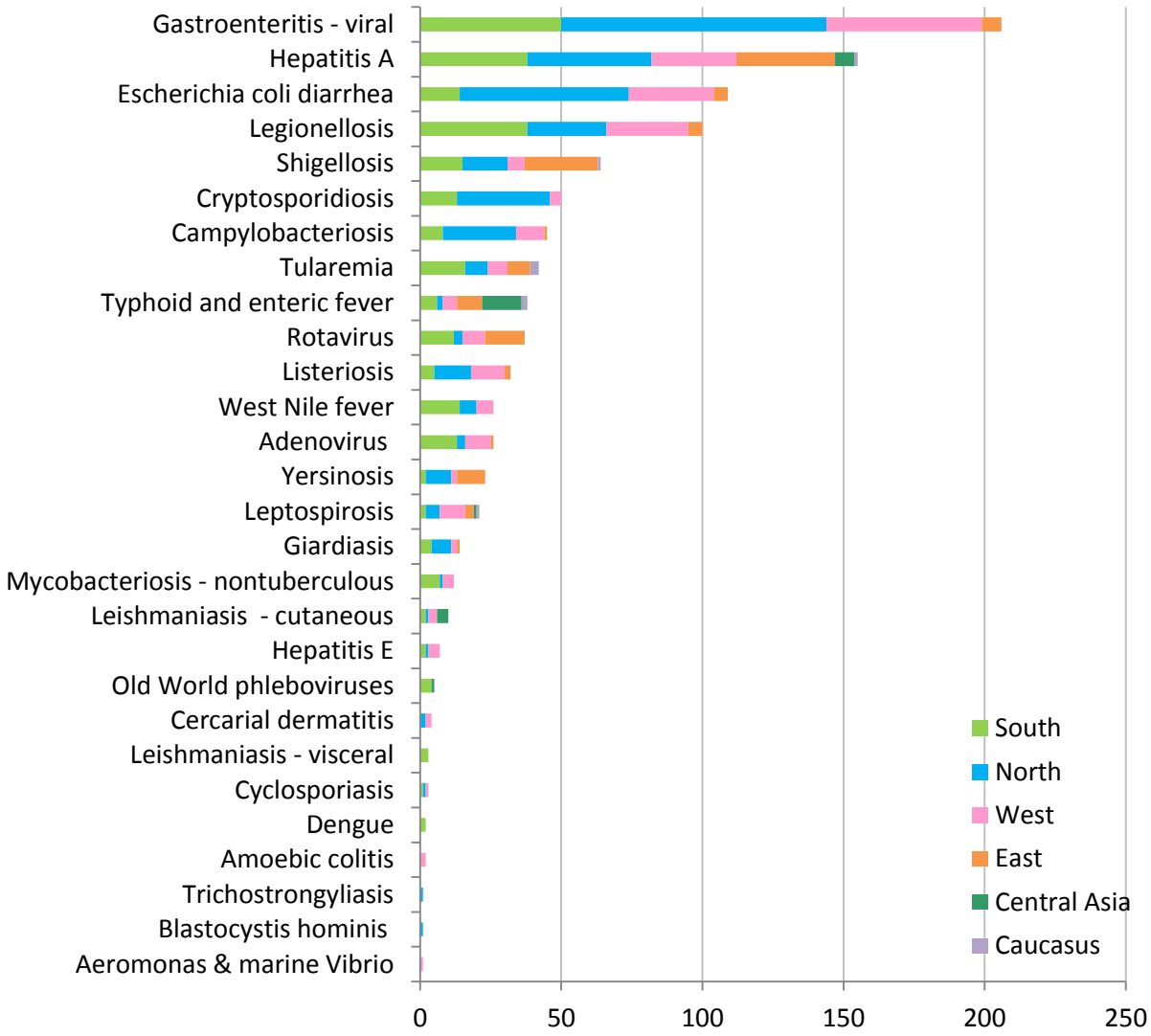
According to the GIDEON database search, the amount of published literature on WRDs varies widely among countries and diseases, which partially reflects the capacities of countries' surveillance systems to detect and investigate outbreaks. More reports of investigated outbreaks are available from Northern and Western European countries as compared to less developed regions (Table 3). An overview of available published prevalence surveys and notable outbreak reports for each disease in each country is presented in Annex A.

Table 3: Summary of notable outbreaks recorded in the GIDEON database (2000-2013)

Region	Number of countries	Number of notable outbreaks	Average number of outbreaks per country
South	17	271	16
North	10	359	36
West	8	241	30
East	10	133	13
Central Asia	5	27	5
Caucasus	3	8	3
Total	**53**	**1,039**	**20**

28 of the 36 diseases that were selected for review had at least one notable outbreak in the WHO European Region (Figure 2). Diseases with the highest total numbers of notable outbreaks (more than 100) that have been recorded between 2000 and 2013 are viral gastroenteritis, hepatitis A, E. Coli and legionellosis, followed by shigellosis, cryptosporidiosis, campylobacteriosis, tularemia and typhoid fever. It is important to note that these numbers do not account for the number of cases involved. For example, legionellosis outbreaks are typically small with few people affected.

Figure 2: Summary of all notable outbreaks recorded in the GIDEON database (2000-2013)



Of the 1,039 notable outbreaks, 185 were linked specifically to water, with 18 out of 36 WRDs represented (Table 4). The majority of these outbreaks were caused by contaminated drinking water supplies; other identified sources include lakes, springs, swimming pools, spas, water parks, heating and cooling towers and fountains. The highest numbers of outbreaks linked to water were recorded for the following diseases: legionellosis, viral gastroenteritis, hepatitis A, cryptosporidiosis, campylobacteriosis and leptospirosis.

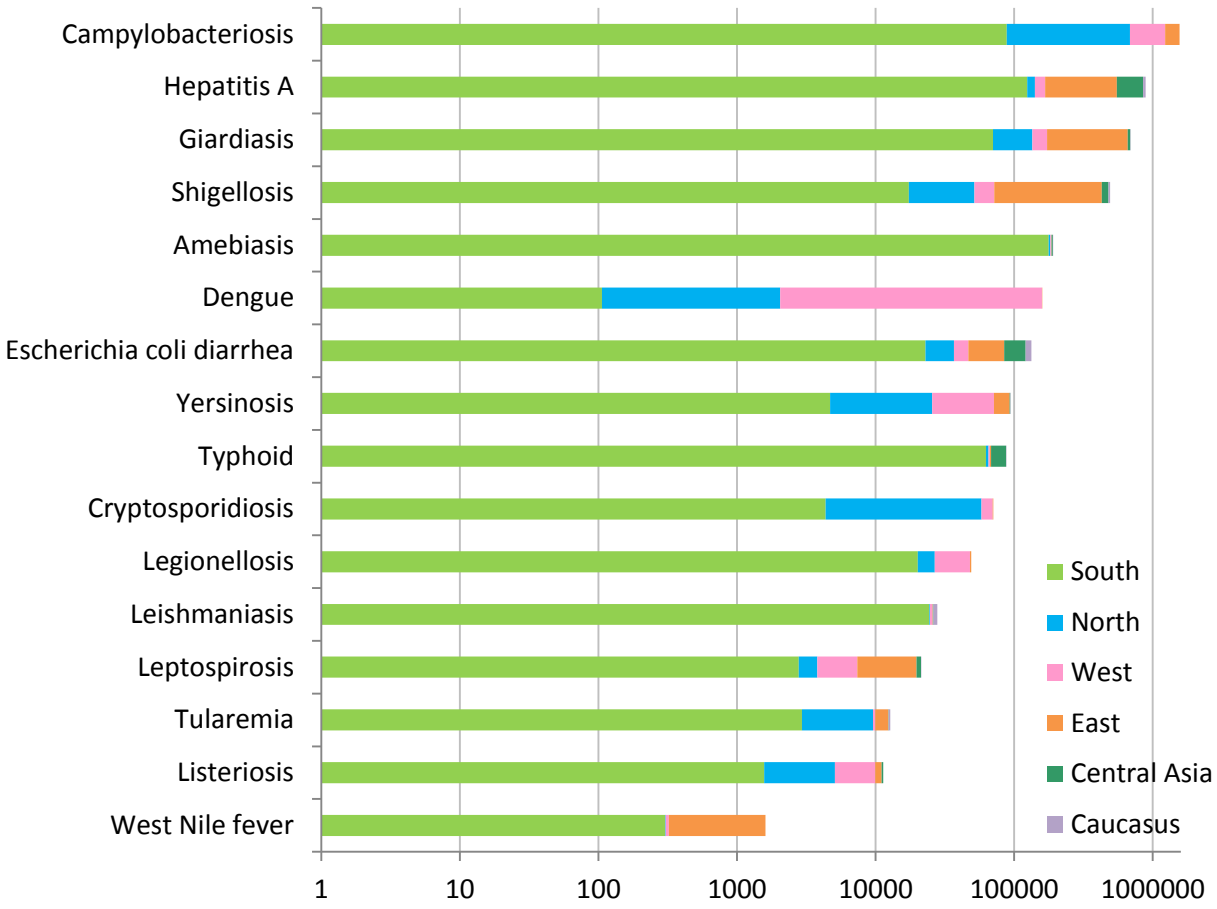
Table 2: WRD outbreaks attributed to water according to publications in GIDEON (2000 – 2013)

Disease	Outbreaks linked to water	Countries	Most common sources
Legionellosis	37	15	Drinking water, water heater, cooling tower, spa
Gastroenteritis - viral	24	12	Drinking water, swimming area, spa
Cryptosporidiosis	20	6	Drinking water, swimming pool
Hepatitis A	18	8	Drinking water, sauna
Campylobacteriosis	14	11	Drinking water
Leptospirosis	13	8	Drinking water, outdoor recreational area
Rotavirus	10	7	Drinking water
Shigellosis	9	8	Drinking water, fountain
Typhoid and enteric fever	9	4	Drinking water
Tularemia	8	4	Drinking water, spring
Escherichia coli diarrhea	5	4	Drinking water, swimming pool
Giardiasis	5	5	Drinking water
Cercarial dermatitis	4	4	Outdoor swimming and bathing areas
Adenovirus	3	3	Drinking water, swimming pool
Mycobacteriosis - nontuberculous	2	1	Swimming pool
Yersinosis	2	2	Drinking water
Aeromonas & marine Vibrio	1	1	Swimming area
Blastocystis hominis	1	1	Drinking water

3.1.2 Findings from CISID data analysis: water-related disease cases

In CISID, disease counts for 16 WRDs which overlap with the 36 diseases considered in the GIDEON review were available (Figure 3) for the time period of 2000-2010 for all 53 countries comprising the WHO European Region. Campylobacteriosis, hepatitis A, giardiasis and shigellosis are the most commonly reported diseases in the Region totaling above 400,000 cases each during the 2000 – 2010 time period. Other priority diseases with relatively high cumulative counts are amebiasis, cryptosporidiosis, dengue, E. Coli, typhoid and yersinosis.

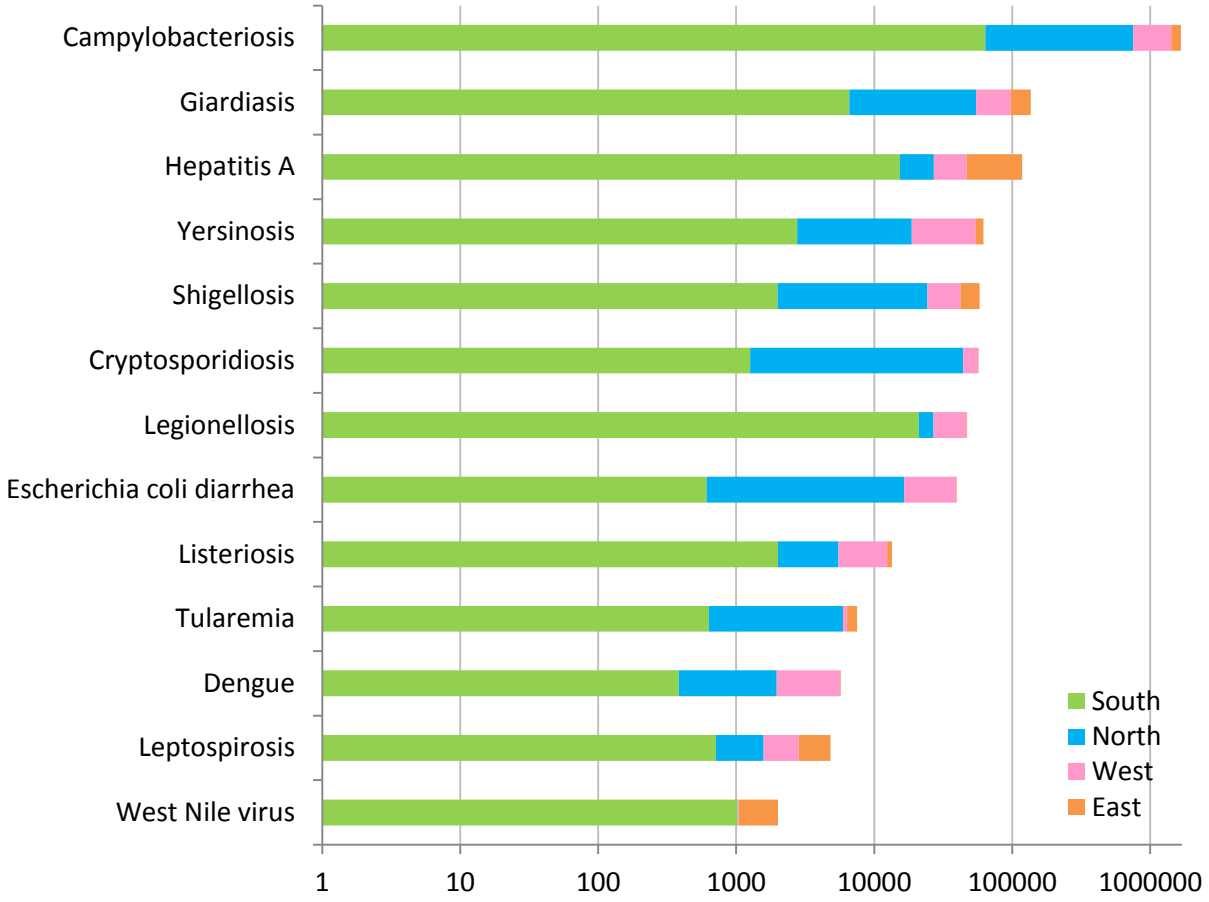
Figure 3: Disease counts ($\log_{10}$) in the WHO European Region reported to CISID by the Member States disaggregated by sub-regions (2000-2010)



3.1.3 Findings from TESSy data

In TESSy, disease counts for 13 WRDs which overlap with the 36 diseases considered in the GIDEON review were available (Figure 4) for the time period of 2006-2013 with only about half of the countries reporting on any one particular disease. Campylobacteriosis, giardiasis and hepatitis A are the most commonly reported diseases to totaling above 100,000 cases each during the 2006 – 2013 time period. Other priority diseases with relatively high cumulative counts are yersinosis, shigellosis, cryptosporidiosis, legionellosis, and E. coli infection It should be noted that Central Asia and Caucasus regions are not part of TESSy and the number of countries belonging to the other regions is not necessarily the same as in Figure 3.

Figure 4: Disease counts ($\log_{10}$) reported in TESSy (2006-2013)



3.1.4 Synthesis of information from multiple data sources

Overall, campylobacteriosis, giardiasis, hepatitis A and shigellosis are the most reported diseases that could be potentially related to water in the WHO European Region. It should be noted that the route of disease transmission or percentage attributable to water is unknown, potentially due to a number of underlying issues, including no mandatory reporting requirements of water-related diseases, lack of laboratory testing and epidemiological investigation capacities. Table 5provides a summary of diseases with the highest counts by geographic sub-regions in the various data sources.

Table 5: Four WRDs with the highest reported counts in CISID and TESSy and most notable outbreaks in GIDEON by each geographic region

Region	CISID	TESSy	GIDEON
South	amebiasis hepatitis A campylobacteriosis giardiasis	campylobacteriosis legionellosis hepatitis A giardiasis	gastroenteritis – viral legionellosis hepatitis A

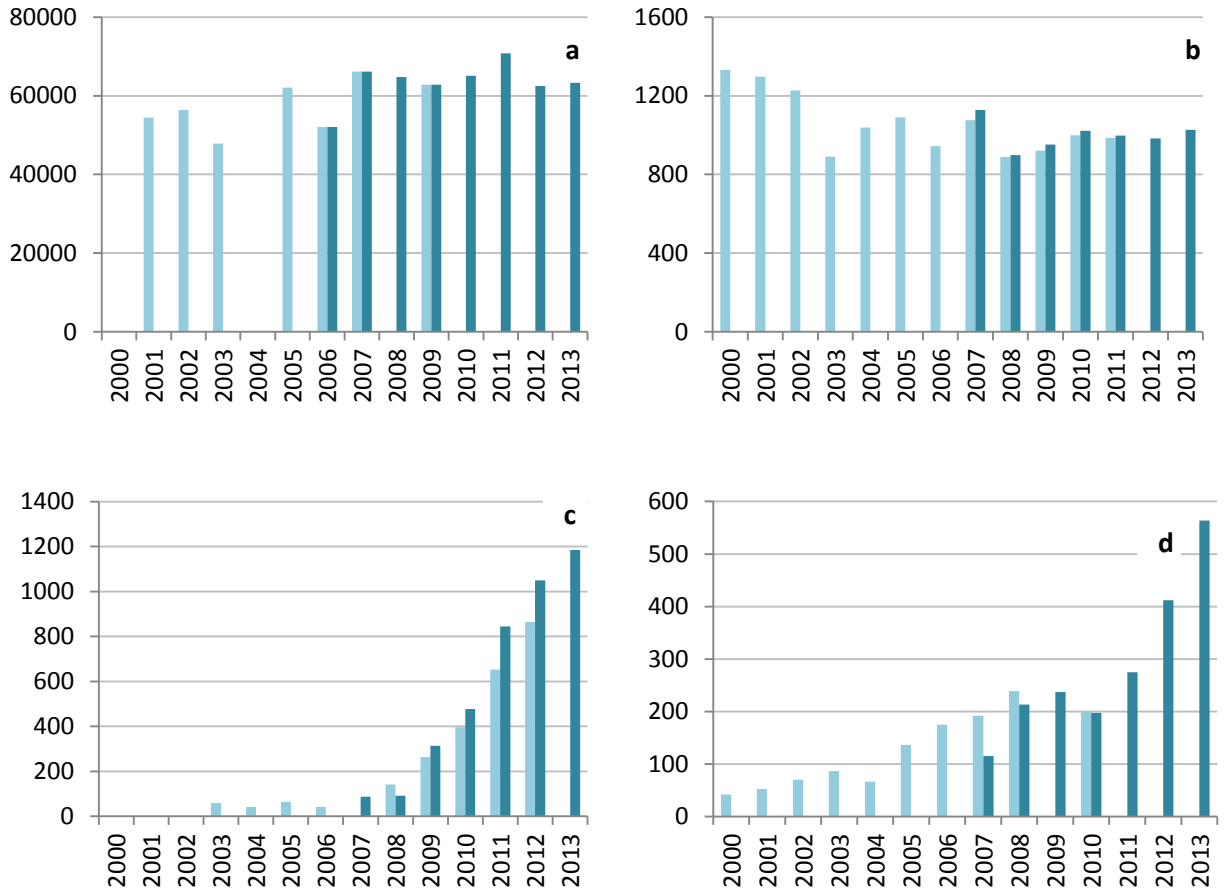
North	campylobacteriosis giardiasis cryptosporidiosis shigellosis	campylobacteriosis giardiasis cryptosporidiosis shigellosis	gastroenteritis – viral E.coli hepatitis A cryptosporidiosis
West	campylobacteriosis dengue yersinosis giardiasis	campylobacteriosis giardia yersinosis E.coli	gastroenteritis – viral E.coli hepatitis A legionellosis
East	giardiasis hepatitis A shigellosis campylobacteriosis	campylobacteriosis hepatitis A giardiasis shigellosis	hepatitis A shigellosis rotavirus yersinosis
Central Asia	shigellosis hepatitis A giardiasis	N/A	typhoid fever hepatitis A
Caucasus	hepatitis A shigellosis E.coli giardiasis	N/A	tularemia typhoid fever

Although counts of vector-transmitted diseases more common in tropical climates, such as dengue and West Nile virus, are still low and the majority of the cases in the WHO European Region member countries are likely travel related, local outbreaks of both diseases have been reported. West Nile virus fever is now found in Southeast Europe and dengue is found in France and in Madeira, Portugal, (Semenza, Sudre, Oni, Suk, & Giesecke, 2013), and cases are expected to increase as temperatures rise due to climate change.

For the majority of country/disease/year combinations, there is an agreement between CISID and TESSy in the numbers of cases reported allowing for combining the data sources for a longer time series to examine trends in the disease reporting patterns (Figure 5). For some, there are disparities, which might be related to that countries are using different definitions of cases to report to the two databases, different departments are tasked with reporting of data, or they are extracting the counts from different in-country sources. In such cases, synchronization within the country and between CISID and TESSy reporting mechanisms would be beneficial to obtain the best understanding of the disease reporting patterns. With a time series of 14 years of data (2000-2013) constructed using data from both CISID (2000-2010) and TESSy (2006-2013) with some overlap where data from both sources were available, visual analysis of the temporal pattern of diseases within countries was possible (Annex B). Upward trends were observed in several countries for most diseases, which in many cases is indicative of increased capability of the surveillance systems to detect cases over time, not only increases

in case numbers. For hepatitis A, leptospirosis, shigellosis and yersinosis, downward trends in several countries were also observed.

Figure 5: Results of time series analysis of disease cases reported to CISID (light blue) and TESSy (dark blue) are presented in Figure 5 on the example of Campylobacteriosis in Germany (a) and Slovenia (b) and E.coli in Netherlands (c) and Spain (d). The data show a temporal pattern and indicate consistency between two data sources.



The Protocol on Water and Health country reports were also used to supplement trends found in disease counts. The report provided by France focused specifically on legionellosis as a priority WRD. Research activities into geographical disparities of legionellosis cases were mentioned as well as better regulations and monitoring of cooling towers and hot water systems in public buildings, bath houses, and elderly homes. Germany and Hungary also mentioned the need for specific improvements in addressing the disease. By looking at case counts in CISID and TESSy, the numbers of cases of legionellosis are low compared to some of the other WRDs. However, in GIDEON, Legionella is one of the most common causes of outbreaks. The report from Netherlands noted there are no regulatory limits or registration

system in place for cyanobacteria in swimming waters which causes closures of swimming areas. There was no other mention of surveillance for diseases associated with swimming or bathing in the reports. It is likely that diseases associated with swimming or bathing waters are either unreported altogether or under-reported in CISID and TESSy and deserve attention in the review of surveillance systems.

3.2 Surveillance of water-related diseases

3.2.1 Laboratory capacity

Laboratory services are a core capacity required by the IHR. In the IHR surveys, many countries reported not meeting either one or both components of the laboratory core capacity which includes having adequate laboratory services to test for priority health threats and adequate laboratory biosafety and biosecurity practices (Annex C). 10 countries reported not meeting the laboratory services requirement and 14 the laboratory safety requirement. The same 10 countries, lack both components (BIH, CYP, SRB, SVN, MKD, IRE, MON, MDA, KAZ, KGZ, TJK, UZB, ARM, AZB), including nearly all countries of the Central Asia and Caucasus regions.

In the Protocol on Water and Health reports, of the countries that do not report occurrences of EHEC, three have specifically stated that EHEC is not typed, not diagnosed at all, or reported together with other gastrointestinal illnesses. In terms of laboratory improvements, HUN reported having insufficient capacity to test for protozoan agents and MDA for agents of viral origin. GEO reported that *Campylobacter* infections and cryptosporidiosis are not diagnosed in the country. In SPA, a decline in outbreaks of WRDs caused by bacteria and increase in those caused by viruses is noted, potentially due to improvements in laboratory diagnosis and notification process as well as resistance of some viruses to chemical disinfection.

Literature review revealed similar findings that laboratory capacity is a significant limitation for countries' surveillance systems. In 2009, a survey was conducted by the ECDC on the capacity of the National Reference Labs (NRLs) for the following pathogens: Campylobacter, Listeria, *Salmonella, Shigella*, Shiga toxin/verotoxin producing *E. Coli* (STEC/VTEC) and *Yersenia* (ECDC, 2012). The survey found that the designated NRL services are comparably most complete for Salmonella. Campylobacter, while being the most common bacterial cause of diarrhea and the most commonly reported disease (ECDC, 2013), lacks a designated NRL in many countries as well as limited capacity to characterize the pathogen in the existing clinical laboratories. STEC/VTEC, Listeria, Shigella and Yersenia detection and characterization services were found to be very diverse. It was concluded by the survey 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. While lab capabilities related to protozoa

were not assessed in the survey, it is believed that many protozoan outbreaks (primarily caused by Cryptosporidium and Giardia lamblia) are unrecognized and unreported (ECDC, 2013) while these two pathogens are believed to be common waterborne pathogens (Baldursson & Karanis, 2011).

Another extensive set of surveys of laboratory capacity was conducted in response to the multi-country E.coli outbreak which affected more than 4,000 individuals in Europe (Rosin, Niskanen, Palm, Struelens, & Takkinen, 2013). In the first survey, it was found that only in 9 countries (NOR, SWE, FIN, NET, DEU, AUT, SVN, CYP, LUX), Shigatoxin diagnostic testing was available and routinely used in 15-90% of the clinical laboratories. Another 3 countries (SPA, EST, SVK) had it available only in some laboratories for use in outbreaks. In the remaining 12 countries which responded to the survey, it was not available (UCE, UNK, IRE, POR, BEL, CZH, BUL, ROM, HUN, POL, LVA, LTU). Results of this assessment have shown that during the outbreak, several countries lacked the capacity at the national level to detect and characterize cases; even greater detection gaps existed at the primary diagnostic level. Diagnostic and characterization capacity at the national level may compensate in part for the lack of routine Shiga toxin testing at the primary level. The survey demonstrated the need to strengthen the microbiology lab capacity for timely communicable disease alert and response (Rosin et al., 2013).

Another problem with lab-based surveillance even when the technical capability is present is that often times, when a sample is requested from a patient, the GP will not provide clear instructions to the laboratory of what pathogens to look for but will write a generic statement such as “stool culture”. The lab in turn may not record what tests are performed causing an inconsistency of records from various facilities. It is more typical to culture for bacteria in stool samples than parasites and viruses. More often than not, 1 or 2 standard pathogens are tested for, salmonella and shigella for example, and the rest are optional and not done because of cost. Another laboratory-related issue is that the conventional methods often fail to identify a large percentage of infections, but the full set of molecular methods is costly and time consuming to perform. If WRD surveillance is to be standardized among countries, a standard lab protocol that all countries have the technological and financial capability to follow is necessary.

Case study: *A gastrointestinal outbreak was investigated in a rural village in Austria in 2006. Microbiological testing of water samples indicated fecal contamination of untreated drinking water. Stool samples from 14 patients were sent for a microbiological analysis: all tested negative for Salmonella, Campylobacter, Shigella and Yersinia enterocolitica. Specimens were not tested for viruses, parasites or enteropathogenic E. coli. No identification was made of pathogenic microorganisms in stool samples by the limited routine microbiological analysis. Public health officers must be made aware that the spectrum of routine laboratory tests on stool specimens does not cover the wide array of pathogens capable of causing waterborne outbreaks and medical practitioners should be encouraged to conduct further microbiological testing, at the very least in outbreak conditions (Meusburger et al., 2007).*

3.2.2 Reporting

On the reporting end, there is a large disparity among countries in the number of notifiable diseases (e.g. Finland has 79 and France only 26). There is some debate on whether an extensive list of notifiable diseases actually discourages the clinicians to report the cases because it is too burdensome. Electronic notification has greatly simplified this process, however it is not available everywhere and even in countries where an electronic notification system is set up and functioning, it is not available in all facilities and paper reports are still in use. Notification directly to the national level without the intermediate regional level reporting was considered desirable as a way to reduce delays in receipt of surveillance data (Risebro & Hunter, 2007).

Within the notification system, it would be very valuable to have demographic information about the patient; however patient information is only available if the case is reported by the physician, but not the laboratory. In the Nordic countries, a unique identifier is used which is linked to a number of personal characteristics of the patient, including the current place of residence, which is extremely valuable to have in any surveillance system (Risebro & Hunter, 2007).

The information about WRD surveillance provided in the Protocol on Water and Health country reports varied in quality and in focus depending on which department provided the information (Annex D). Some reports lacked any information on disease surveillance and focused on water quality monitoring aspects due to the report being submitted by a department that most likely does not conduct disease surveillance (e.g. Norway). When numbers of diseases and outbreaks were provided, they were reported inconsistently with some countries reporting incidence, some counts and some percentages. When reporting incidence, the denominator was not always clear. When a baseline and current year statistics were provided, the baseline year was

inconsistent, making it difficult to summarize the data; in some cases the year of reporting was missing altogether. Another inconsistency that was observed in disease reporting is that some member states perceived it to be all cases of waterborne or foodborne origin, some reported only those known to be of waterborne origin and some reported a combination of both.

Considering IHR reporting compliance, from the 53 member states, 4 have not submitted the survey in 2011 or 2012 or requested an extension (ALB, GRE, ISR, UKR) (Annex C). Of the remaining 49 countries which provided information, 11 countries have insufficient or missing capacity to meet the indicator-based surveillance requirement, or the early warning function for detection of public health events in indicator-based (routine) surveillance and 14 the event-based surveillance requirement. Nine countries reported lacking both the indicator-based and event-based surveillance requirements (BIH, CYP, MAT, SRB, MDA, KAZ, KGZ, TJK, UZB).

After a comparison between the CISID and TESSy reporting systems to obtain data about WRDs in the WHO European Region, the following advantages and disadvantages were identified:

Advantages of using the TESSy system as compared to CISID:

- Data available in TESSy are much more detailed than in CISID, which includes information on the number of lab confirmed cases, giving some indication of the lab capabilities of the countries to diagnose various diseases.
- Recent data (post 2010) are available as opposed to CISID data generally lagging by 2-4 years in the reporting.

Disadvantages of using the TESSy system as compared to CISID:

- Data are confidential and are not available for analysis by external organizations; it would be beneficial to allow for extraction of annual counts and incidence rates for each disease by country as this data is already available in regularly released annual summary reports but in an inconvenient PDF format.
- Reporting of incidence rates is inconsistent as opposed to CISID where the numbers are always reported per 100,000.
- Data in CISID date back further allowing for more data available for a trend analysis.
- CISID contains data for all WHO European Region countries, whereas TESSy contains data for EU/EEA countries.

Case study: *In 2005, the Norwegian Institute of Public Health established a web-based outbreak reporting system called Vesuv. The system is used for mandatory outbreak reporting by municipal medical officers, healthcare institutions, and food safety authorities. As of 2013, 1,426 outbreaks have been notified, involving 32,901 cases. A total of 474 outbreaks (33.2%) were associated with food or drinking water. Vesuv has proved to be a helpful tool by enhancing reporting and enabling rapid and efficient information sharing between different authorities at both the local and national levels. It is also an important tool for event-based reporting, as required by the IHR 2005. Having a national database with information on all reported outbreaks is also useful for analyzing trends and contributing factors in order to identify common problems where more general preventive measures are needed (Guzman-Herrador et al., 2016).*

3.2.3 Investigation and response

Based on laboratory and reporting challenges discussed, quantification of sporadic cases of WRDs is particularly difficult. Outbreaks typically get more attention, however the definition of "outbreak" may differ depending on the country and the threshold for the number of cases required for outbreak investigation varies. Not having a mandated outbreak definition across countries and a threshold for requiring an investigation of outbreaks is a deficiency of many surveillance systems. In the Protocol on Water and Health, only one country stated a threshold of 5 cases occurring at the local level before the next level of reporting is notified. No information was provided by any of the member states on the minimum number of cases before an outbreak is investigated.

Generally, the capacity of countries to investigate outbreaks is low. Even if an outbreak is detected and reported into a surveillance system, the number of cases or the attributed sources are not often available. For example, in the Dewaal study, 38% of the outbreaks had no water or food attribution specified (Dewaal, Robert, Witmer, & Tian, 2010). The ability to identify the vehicle of transmission or the pathogen remains limited in many countries. Additional capacity to detect and investigate outbreaks in rural small water systems is called for in the Protocol on Water and Health Reports as well as in the literature (M. Blasi, Carere, & Funari, 2011). In the Protocol on Water and Health, four countries reported a specific focus on rural areas supplied by private wells or small water systems serving 500 people or less as these tend to be more vulnerable to outbreaks which are also more difficult to detect.

Improvements are also needed in the capacity to respond to WRD outbreaks, including but not limited to emergency stock of drugs, vaccines and water treatment supplies, as well as in the communication of risks to the public (M. Blasi et al., 2011). In the IHR reports, 15 countries reported not meeting the emergency response requirement and 8 the infection prevention and

control requirement at national and hospital levels. Eight countries lacked both components of the response core capacity (BIH, CYP, SRB, BUL, CZH, MDA, KGZ, UZB).

Case study: *A water distribution pipe breakage caused a community-wide waterborne outbreak in Vuorela, Finland, July 2012. We investigated this outbreak with advanced epidemiological and microbiological methods. A total of 473/2931 inhabitants (16%) responded to a web-based questionnaire. Water and patient samples were subjected to analysis of multiple microbial targets, molecular typing and microbial community analysis. Spatial analysis on the water distribution network was done and we applied a spatial logistic regression model. The course of the illness was mild. Drinking untreated tap water from the defined outbreak area was significantly associated with illness (RR 5.6, 95% CI 1.9-16.4) increasing in a dose response manner. The closer a person lived to the water distribution breakage point, the higher the risk of becoming ill. The polyphasic approach improved the understanding of the source of the infections, and aided to define the extent and magnitude of this outbreak. (Rintala et al., 2016).*

3.2.4 Setting targets on water-related diseases

Protocol on Water and Health reports from 25 countries were reviewed for targets the countries have set to improve their surveillance capabilities (Annex D). 8 of the 25 countries did not list targets for improving WRD surveillance (BLR, BIH, CRO, LVA, LTU, NET, RUS, SPA) and 3 more reported that targets are currently under development (ALB, SRB, NOR). Furthermore, EST, ROM, and SVK reported generic targets such as “reduce the occurrence of WRDs” or “strengthen the surveillance system for WRD detection” progress towards which is not measureable. More specific targets included numeric reductions in WRDs, uses of modern technologies to improve the timeliness of reporting, improving the ability to detect outbreaks due to drinking water specifically and improving laboratory diagnostics. Some examples are provided below:

- **EST:** Reduce the risk of WRD by improving and adequately monitoring drinking water quality.
- **FIN:** Reduce the number of persons falling ill in WRD epidemics to an annual level of 0.01% of the population by 31.12.2015.
- **GEO:** Reduce the occurrence of shigellosis and hepatitis A by 10% by 2015; maintain absence of cholera and typhoid; improve small water systems to reduce the risk of WRD infections from drinking water; increase rotavirus vaccinations.
- **MDA:** Maintain at zero level the cholera and typhoid incidence in the population until 2020; reduce viral hepatitis A and dysentery incidence by 20% by 2020.
- **SWI:** Develop a reporting system for outbreaks caused by water.

- **UKR:** Decrease the morbidity rate of cholera, shigellosis, acute enteric infection caused by EHEC, viral hepatitis, typhoid fever, aqueous nitrate methemoglobinemia by 2020; upgrade at least 50% of laboratories with modern equipment necessary for testing safety and quality of drinking water by 2020.

Three countries mentioned specific activities related to reducing the incidence of Legionellosis (FRA, DEU, HUN). Four countries discussed the need to focus WRD surveillance efforts on rural areas and small water systems (CRO, FIN, SVK, TJK). FIN and NET mentioned the need to improve monitoring of swimming and bathing waters and surveillance of associated diseases.

Additional deficiencies and areas where WHO support is needed were identified during a meeting discussing the IHR core capacities (Table 6).

Table 6: Summary of the gaps in surveillance capabilities and areas of potential WHO support identified in an IHR meeting between WHO Regional Stakeholders held in 2013.

Main gaps	Potential WHO support

• Insufficient guidance on implementation of event-based surveillance and early warning
• Inadequacy of electronic tools for collections, analysis, transmission and reporting of epidemiological data
• Insufficient use of surveillance networks existing in the region
• Insufficient coordination between the different coexisting systems and with potential surveillance data providers
	• Development of global and regional guidance on event-based surveillance and early warning systems
	• Coordination with international surveillance networks
	• Technical assistance to:
	  ○ Evaluate surveillance systems
	  ○ Adapt global and regional guidance at country level
	  ○ Implement/strengthen event based surveillance and early warning functions
	  ○ Develop training materials adapted to all levels of the health system
	  ○ Advocate and mobilize resources for deployment of electronic tools supporting surveillance

3.2.5 Synthesis of information on water-related disease surveillance

Most countries have limited ability to estimate sporadic and background water related disease burden due to the inherent difficulties with gastrointestinal disease surveillance (Risebro & Hunter, 2007). In the clinical setting, patients don't always seek care if their condition is not severe enough (Dewaal, Robert, Witmer, & Tian, 2010). The general practitioner does not always ask for a stool sample for analysis if the result is not expected to affect the course of treatment, the patient will not always want to provide a sample for analysis due to cost

(Risebro & Hunter, 2007), and a stool sample is not always analyzed for a sufficient number of pathogens.

When local surveillance is able to identify individual cases, detecting an association with drinking water is extremely difficult even in outbreak conditions. For example, a study of gastrointestinal diseases abstracted from the Italian national surveillance system for 1998 – 2005 found that the source of disease was identified for 53% of the outbreaks, corresponding to 59% of the total cases. 13.3% of the diseases could be considered water related (defined in this case as consumption of drinking water, shell-fish or agricultural products). However, due to the lack of a standardized definition of a WRD, definitions among surveillance systems can vary widely (M. F. Blasi, Carere, Funari, Pompa, & Rizzuto, 2008).

Problems exist with laboratory capacity, reporting and investigation and response components of surveillance systems. Many countries lack sufficient laboratory capacity to detect certain pathogens even at the national level. Particular weaknesses were identified with parasites and viruses, as compared to pathogens of bacterial origin. Reporting systems vary in their definitions of cases, outbreaks, timeliness of reporting, and the level of detail available about the cases to enable efficient investigation and response. At higher levels of data analysis, this heterogeneity often inhibits comparisons across countries, regions and reporting systems. Particular deficiencies in WRD outbreak detection, investigation and response exist in rural small water systems and their contribution to the WRD burden is likely largely under-estimated.

More emphasis should be placed on monitoring the occurrence of WRDs associated with swimming and bathing waters. Recreational waters, along with aquatic food products and irrigated crops, have been cited as important potential WRD transmission vehicles but are rarely investigated (M. Blasi et al., 2011). Swimming in contaminated waters is now recognized as an important transmission route for Cryptosporidium and Giardia (Kourenti, Karanis, & Smith, 2007). Investigation of outbreaks associated with recreational water contact is challenging because questionnaires are typically relied on to assess exposure with sometimes a substantial lag period between exposure and disease development. These investigations are substantially influenced by recall bias of the responders weakening 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 8 small Cryptosporidiosis outbreaks that were missed by the national surveillance system. These outbreaks were primarily associated with swimming pool use (Briggs, Boxall, Van Santen, Chalmers, & McCarthy, 2014).

Furthermore, Europe is having an upsurge in tropical diseases more commonly found in tropical climates. While the majority of cases currently are travel related, domestic incidence of these

diseases in some areas of Europe is expected to increase due to changes in the environmental conditions. To monitor and forecast the increasing trends in these diseases, the ECDC has developed the European Environment and Epidemiology (E3) Network. While the surveillance capacity in many countries is still under-developed, further difficulties are expected due to effects of climate change (Semenza, Suk, Estevez, Ebi, & Lindgren, 2012).

4. CONCLUSIONS

1) Campylobacteriosis, giardiasis, hepatitis A infection and shigellosis are the most commonly reported water related diseases overall in the WHO European Region.
2) In the number of outbreaks, viral gastroenteritis, infection with pathogenic *E.coli* and legionellosis are also important diseases.
3) There are notable sub-regional differences in terms of most reported WRD, which are likely to depend on established national reporting requirements, available laboratory capacities, the endemic situation, as well as the status of water supply and sanitation services.
4) There are several reporting platforms at the European level which include information on WRDs, such as CISID, TESSy, and the reporting mechanism under the Protocol. However, there is a lack of consistent information on the WRD situation for the WHO European Region across these mechanisms, and therefore improved coordination for harmonized reporting seems necessary.
5) The majority of countries have routine passive surveillance systems and outbreak alert and response mechanisms in place. However, challenges have been identified with all three components of surveillance systems: laboratory, reporting and investigation and response.
6) Surveillance coverage tends to be less in rural areas due to the lack of laboratory, human and financial capacities. There is a general lack of linkage between drinking-water quality monitoring and WRD surveillance.
7) Emerging pathogens (including legionella and tropical vector-borne diseases), diseases associated with swimming and bathing waters, and non-communicable health outcomes from chemical constituents in drinking-water are not well covered by many surveillance systems.
8) Health burden due to nitrate, fluoride, arsenic and lead in drinking water is difficult to quantify. Arsenic in groundwater is localized, with high concentrations found in some areas in Poland, Hungary and Turkey. Lead exposure through the water distribution network is thought to be relatively common across Europe in old urban neighborhoods.
9) Priority areas include distinguishing between cases of foodborne and waterborne origin, domestic and travel related cases, improving the identification of cases associated with

recreational waters, aquatic food products and irrigated crops, and incorporation of additional important diseases that are not currently notifiable (e.g. Norovirus).

10) Due to intrinsic methodological difficulties, there are a number of challenges related to reporting of WRDs, including under-reporting and lack of epidemiological evidence on the source of the case or outbreak. This uncertainty in relation to the true extent of reported cases may compromise attention to WRDs at policy level.

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WHO Protocol on Water and Health: http://www.euro.who.int/en/health-topics/environment-and-health/water-and-sanitation/protocol-on-water-and-health

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