Introduction to water-related infectious diseases

Module 1.1
Overview

• The Protocol on Water and Health and requirements relating to water related disease surveillance and outbreak management

• International Health Regulations (IHR) core requirements:
  • Definition of water related infectious disease (WRID)
  • Pathogens transmitted through drinking-water
  • Drinking-water systems as a source of WRID
  • Burden of WRID in the European Region
  • The need to strengthen WRID surveillance and outbreak management capacity
Protocol on Water and Health

• Article 8:
  • Establish and maintain surveillance and early warning systems
  • Develop national and local contingency plans for responding to outbreaks, incidents and risks
  • Strengthen response capacity

• Article 6.2:
  • Establish and publish targets to reduce WRD outbreaks and incidents

• Article 13:
  • Strengthen transboundary cooperation on early-warning and response systems
## IHR Core Capacity Requirements

<table>
<thead>
<tr>
<th>Core Capacity</th>
<th>Component</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveillance</td>
<td>Indicator-based surveillance</td>
<td>Early warning function for the early detection of a public health event</td>
</tr>
<tr>
<td></td>
<td>Event-based surveillance</td>
<td>Established and functioning</td>
</tr>
<tr>
<td>Response</td>
<td>Rapid response capacity</td>
<td>Public health emergency response mechanisms are established and functioning</td>
</tr>
<tr>
<td>Risk communication</td>
<td>Policy and procedures for public communication</td>
<td>Mechanisms for effective risk communication during a public health emergency are established and functioning</td>
</tr>
</tbody>
</table>

2030 Agenda for Sustainable Development

- **Ensure healthy lives and promote well-being for all at all ages**

  - **Target 3.3**: By 2030, (...) **combat** hepatitis, water-borne diseases and other communicable diseases
  - **Target 3.9**: By 2030, substantially **reduce** the number of deaths and illnesses from (...) **water** and soil pollution and contamination

- **Ensure availability and sustainable management of water and sanitation for all**

  - **Target 6.1**: By 2030, achieve universal and equitable access to **safe** and affordable **drinking-water** for all
  - **Target 6.2**: By 2030, achieve access to **adequate and equitable sanitation and hygiene** for all (...), paying special attention to the needs of women and girls (...)

Quiz

How are water-related infectious diseases transmitted?
What are water-related infectious diseases?

• Water-related disease
  • adverse effect on human health caused by the condition of water
  • Infectious or non-infectious

WRID may be transmitted via:

- the gastrointestinal tract, by ingestion of contaminated water (drinking or recreational water)
- the respiratory tract, by inhalation or aspiration of aerosols
- the skin, mucous membranes or eyes, by contact during recreational water use or bathing
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-borne</td>
<td>Ingestion of pathogens in contaminated water</td>
<td>Typhoid, legionellosis, poliomyelitis</td>
</tr>
<tr>
<td>Water-washed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Skin and eyes</td>
<td>Poor hygiene / lack of access to safe water</td>
<td>Scabies, trachoma, bacillary dysentery</td>
</tr>
<tr>
<td>b) Diarrhoeal diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water-based</td>
<td>Infection by agents that spend part of their life-cycle in water</td>
<td>Schistosomiasis</td>
</tr>
<tr>
<td>a) Skin penetration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Ingested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water-related vectors</td>
<td>Spread by vectors that breed or bite near water</td>
<td>Malaria, West Nile Fever</td>
</tr>
<tr>
<td>a) Biting near water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Breeding in water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Primary agents of infectious waterborne outbreaks

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Viruses</th>
<th>Protozoa</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Campylobacter jejuni</em></td>
<td>Hepatitis A virus</td>
<td><em>Balantidium coli</em></td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>Norovirus</td>
<td><em>Cryptosporidium spec.</em></td>
</tr>
<tr>
<td><em>Helicobacter pylori</em></td>
<td>Rotavirus</td>
<td><em>Cyclospora cayetanensis</em></td>
</tr>
<tr>
<td><em>Legionella spec.</em></td>
<td>Adenovirus</td>
<td><em>Entamoeba histolytica</em></td>
</tr>
<tr>
<td><em>Leptospira spec.</em></td>
<td>Enterovirus</td>
<td><em>Giardia spec.</em></td>
</tr>
<tr>
<td><em>Mycobacterium spec.</em></td>
<td>Astrovirus</td>
<td><em>Naegleria fowleri</em></td>
</tr>
<tr>
<td><em>Salmonella enterica</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Shigella spec.</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vibrio cholerae</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pathogens transmitted through drinking-water

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Type species/genus/group</th>
<th>Health significance</th>
<th>Persistence in water supplies</th>
<th>Resistance to chlorine</th>
<th>Relative infectivity</th>
<th>Important animal source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burkholderia</td>
<td><em>B. pseudomallei</em></td>
<td>High</td>
<td>May multiply</td>
<td>Low</td>
<td>Low</td>
<td>No</td>
</tr>
<tr>
<td>Campylobacter</td>
<td><em>C. coli</em> C. jejuni</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
<td>Yes</td>
</tr>
<tr>
<td>Escherichia coli - diarrhoeagenic</td>
<td>-</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
<td>Yes</td>
</tr>
<tr>
<td>E. coli - enterohaemorrhagic</td>
<td><em>E. coli O157</em></td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>High</td>
<td>Yes</td>
</tr>
<tr>
<td>Francisella</td>
<td><em>F. tularensis</em></td>
<td>High</td>
<td>Long</td>
<td>Moderate</td>
<td>High</td>
<td>Yes</td>
</tr>
<tr>
<td>Legionella</td>
<td><em>L. pneumophila</em></td>
<td>High</td>
<td>May multiply</td>
<td>Low</td>
<td>Moderate</td>
<td>No</td>
</tr>
</tbody>
</table>
Campylobacter spp

- Important cause of acute gastroenteritis worldwide and in the European region.
- *C. jejuni, C. coli, C. laridis* and *C. fetus*
- Incubation period: 2-4 days; illness duration 3-7 days
- Symptoms: abdominal pain, diarrhoea (sometimes bloody), vomiting, chills and fever
- Reactive arthritis, meningitis and Guillain Barre syndrome
- Reservoir: Poultry, wild birds, cattle and pets.
- Waterborne outbreaks
  - Faecal contamination of water storage reservoirs with bird faeces
  - Consumption of inadequately treated surface water
Shigella

• *S. dysenteriae*, *S. flexneri*, *S. boydii* and *S. sonnei*.

• Abdominal cramps, fever and water diarrhoea; bacillary dysentery is characterized by bloody diarrhoea.

• Incubation period: 24-72 hours

• Faecal-oral transmission through person-to-person contact, contaminated food, water and flies

• Waterborne outbreaks are occurring more frequently due to faecally contaminated drinking-water.

• Control of Shigella in drinking-water is of special public health importance

• Sensitive to disinfection
Legionella

- *L. pneumophila* is responsible for most human infections: Legionellosis
  - Legionnaires’ disease
  - Pontiac fever
- Infection through inhalation of aerosols containing the bacteria (showers, jacuzzi, sinks and cooling towers etc.)

**In rare cases transmitted by aspiration**

- Risk management strategies in high-risk settings:
  - Temperature control (in cold water systems <20°C; in hot water systems >55°C)
  - Disinfection
  - Minimise biofilm growth
Hepatitis A virus

- Highly infectious with a low infectious dose
- Average incubation period 28-30 days
- Mostly asymptomatic, disease severity increases with age
- Hepatitis A / infectious hepatitis – sudden onset, fever, malaise, nausea, anorexia, abdominal pain, jaundice and liver damage – prolonged illness
- Mortality <1%
- Source: faecally contaminated food and water
- Person to person and faecal oral transmission most common
- Strong evidence of waterborne transmission
- Highly resistant to disinfection

*E. coli or thermotolerant coliforms are not a reliable indicator of the presence/absence of HAV in drinking-water supplies.*
Hepatitis E

• Much less widespread and mostly confined to tropical and subtropical areas. It has caused large waterborne outbreaks.
  - Recent evidence indicates that HEV might also be prevalent at a low level in Europe.
• Infection can be more severe than, HAV, increased mortality in pregnant women.
Norovirus

- **90% of epidemic nonbacterial outbreaks** of gastroenteritis worldwide
- Usually self-limiting - severe illness is rare
- Transmission:
  - Faecally contaminated food or water
  - Person-to-person
  - Aerosolization of vomited virus and subsequent contamination of surfaces
- Outbreaks often occur in closed communities
  - Long-term care facilities, overnight camps, mass gatherings, hospitals, schools, prisons, dormitories and cruise ships
Cryptosporidium

- 13 species – C. hominis and C. parvum predominant in humans
- Self-limiting abdominal pain and diarrhea (1 week on average); can be prolonged and severe in immunosuppressed
- Large waterborne outbreaks, and outbreaks associated with visiting farms and contact with animals
- Oocysts shed in faeces can survive for weeks or months in fresh water
- Faecal oral and person to person transmission; consumption of contaminated food and water and transmission from animals.
- Highly infectious – 10 oocysts
- Resistant to disinfection. *E. coli* or thermotolerant coliforms are not a reliable indicator of their presence/absence.
- UV radiation inactivates oocysts.
Giardia

- Giardiasis – G. intestinalis/G. lamblia or G. duodenalis
- Diarrhoea, abdominal cramps and malabsorption deficiencies
- Self-limiting illness, but prolonged illness can occur
- Asymptomatic carriage is common
- Cysts are shed in faeces; prolonged survival of cysts in fresh water
- Infectious dose <10 cysts
- Person to person transmission, contaminated drinking-water, recreational water and food
- Well established source of waterborne outbreaks
- Resistant to disinfection

E.coli or thermotolerant coliforms are not a reliable indicator of their presence/absence.
Drinking-water systems as a source of WRID

Source water quality
Treatment, handling and storage at home
Treatment effectiveness
Residual disinfectant levels
Transport of collected water
Integrity of distribution systems
Integrity of storage reservoirs

Hazardous events at different points of the water supply system

<table>
<thead>
<tr>
<th>Point of contamination</th>
<th>Examples of hazardous events</th>
</tr>
</thead>
</table>
| Source water (surface or groundwater) | • Runoff of animal and human waste and sewage during wet weather  
• Leakage of faecal matter from on-site sanitation or damaged sewers |
| Treatment system | • Inundation of filtration beds with contaminated water during flooding  
• Failures in treatment (e.g. coagulation, filtration and/or disinfection processes) |
| Distribution system | • Ingress of contaminated water from the environment through cracked or eroded pipes, especially during pressure drops  
• Cross-contamination of drinking-water systems with wastewater, rain water etc  
• Unhygienic conditions of containers carrying water from source to home |
| Storage system | • Faecal contamination of water stored in reservoirs and storage tanks |

The water treatment and distribution process

Source: https://interestingengineering.com/dirty-clean-how-water-treatment-plant-works
Drinking-water systems as cause of WRID outbreaks

**Number of outbreaks (2000-2014)**

- Treatment deficiencies
- Raw water (groundwater)

Systematically assess and manage risks to water supply from catchment to consumer

Water safety plans

• Best way to ensure a safe drinking-water supply
• Identify hazards and events (e.g. technical defects, malpractices, accidents, natural causes) that pose a risk to the supply system or fail to remove them

• Multi-barriers to contamination
  – Preventing hazards entering to water system (catchment)
  – Removing hazards from the water (treatment)
  – Preventing re-occurrence (storage and distribution)
Burden of WRID in the European Region

• Estimated 2700 deaths due to WASH related diarrhoea in 2016 which indicates 7 people die every day (WHO, 2019)

• The diseases with the highest number of reported outbreaks are shigellosis, E. coli diarrhoea, hepatitis A and cryptosporidiosis*

• Available data do not allow to distinguish the transmission routes (water, sanitation or food)

• Under-reporting of outbreaks to insufficient surveillance and outbreak investigation capacity

*Global Infectious Disease and Epidemiology Online Network, data for 2010-2021 https://www.gideononline.com/
## Waterborne outbreaks in Europe, 2000 - 2013

<table>
<thead>
<tr>
<th>Disease</th>
<th>Outbreaks linked to water</th>
<th>Number of outbreaks</th>
<th>Proportion linked to water (%)</th>
<th>Countries</th>
<th>Most common sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legionellosis</td>
<td>37</td>
<td>100</td>
<td>37</td>
<td>15</td>
<td>Drinking-water, water heater, cooling tower, spa</td>
</tr>
<tr>
<td>Gastroenteritis – viral</td>
<td>24</td>
<td>206</td>
<td>12</td>
<td>12</td>
<td>Drinking-water, swimming area, spa</td>
</tr>
<tr>
<td>Cryptosporidiosis</td>
<td>20</td>
<td>50</td>
<td>40</td>
<td>6</td>
<td>Drinking-water, swimming pool</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>18</td>
<td>135</td>
<td>12</td>
<td>8</td>
<td>Drinking-water, sauna</td>
</tr>
<tr>
<td>Campylobacteriosis</td>
<td>14</td>
<td>45</td>
<td>31</td>
<td>11</td>
<td>Drinking-water</td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>13</td>
<td>21</td>
<td>52</td>
<td>8</td>
<td>Drinking-water, outdoor recreational area</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>10</td>
<td>37</td>
<td>27</td>
<td>7</td>
<td>Drinking-water</td>
</tr>
<tr>
<td>Shigellosis</td>
<td>9</td>
<td>64</td>
<td>14</td>
<td>8</td>
<td>Drinking-water, fountain</td>
</tr>
<tr>
<td>Typhoid and other enteric fever</td>
<td>9</td>
<td>38</td>
<td>24</td>
<td>4</td>
<td>Drinking-water</td>
</tr>
<tr>
<td>Tularemia</td>
<td>8</td>
<td>42</td>
<td>10</td>
<td>4</td>
<td>Drinking-water</td>
</tr>
<tr>
<td>E. coli diarrhea</td>
<td>5</td>
<td>109</td>
<td>5</td>
<td>4</td>
<td>Drinking-water, swimming pool</td>
</tr>
<tr>
<td>Giardiasis</td>
<td>5</td>
<td>14</td>
<td>38</td>
<td>5</td>
<td>Drinking-water</td>
</tr>
</tbody>
</table>

Global Infectious Disease and Epidemiology Online Network, [https://www.gideononline.com/](https://www.gideononline.com/)
Viral gastroenteritis

Example: Prague experienced large waterborne outbreak of norovirus infection (estimated 11,000 to 12,000 cases) caused by cross contamination resulting from breakages of water and sewage pipes (2015).

Number of people with vomit illness symptoms grows at 2018 Olympic Games

Norovirus sickens 39 in Spain with link to mussels
Burden of mortality

• Burden of disease ≠ burden of mortality
  - the burden of disease caused by pathogens transmitted by the faecal oral route is greatest, BUT
  - the burden of mortality may be caused by pathogens transmitted by other routes is greatest

• Legionella, pseudomonas and non-tuberculus mycobacteria
  - Caused 91% of WRID deaths in the USA between 2003 and 2009

• Germany: >3 deaths every day due to legionellosis

Outbreaks of legionellosis in Europe, 2010 – 2021 (published data)

<table>
<thead>
<tr>
<th>Causes</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling tower</td>
<td>29</td>
</tr>
<tr>
<td>Water supply system</td>
<td>11</td>
</tr>
<tr>
<td>Multiple</td>
<td>5</td>
</tr>
<tr>
<td>Spa, pool</td>
<td>4</td>
</tr>
<tr>
<td>Wastewater treatment plant</td>
<td>3</td>
</tr>
<tr>
<td>Fountain</td>
<td>2</td>
</tr>
<tr>
<td>Shower</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
</tr>
</tbody>
</table>
Drivers of WRID in the pan-European region

• Emergence and re-emergence of pathogens: Cryptosporidium parvum and Legionella pneumophila
• Climate change and international travel
  – Geographic dissemination of WRID pathogens to new areas – Giardia lamblia
• Small scale and community operated water and sanitation systems
  – Vulnerable to environmental contamination
  – Untreated or insufficiently treated ground or surface water
• Changes in how water is used
• Increasing age and number of immunodeficient persons
Surveillance and outbreak management capacity in the pan-European region

- Passive surveillance of a limited number of pathogens
- Wide variation in number and types of pathogens, diseases and events under surveillance
- Variable sampling, laboratory testing and reporting protocols
- Limited routine testing of enteric pathogens; less testing of viruses and parasites
- Under-ascertainment of uncommon pathogens and those not covered by surveillance
- Limited laboratory capacity for testing
- Limited human and financial resources for surveillance and outbreak response
- Limited epidemiological capacity to investigate source of infection – cases not categorised as water-related
Surveillance and outbreak management capacity cont.

- Foodborne versus waterborne
- No standard definition of an outbreak and thresholds for outbreak detection not defined
- Inadequate early-warning and response systems
- Inadequate communication and coordination between public health agencies, water providers and those responsible for monitoring water quality
The need to strengthen WRID surveillance and outbreak management capacity

- Surveillance and outbreak response procedures need to be harmonised and strengthened in order to:
  - Generate more robust data on the true burden of WRID
  - Generate data on the causes of outbreaks
  → Inform investments in water supply systems
  → Inform public health action to control WRID
Useful references for further reading

**WHO (2017):** Legionella and the prevention of legionellosis.
https://apps.who.int/iris/handle/10665/43233

Acknowledgement

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Surveillance of water-related infectious diseases

Module 1.2
Overview

• What is disease surveillance?
• WRID surveillance objectives
• Core activities and building blocks of surveillance
• The epidemic intelligence framework and different types of surveillance
• Surveillance attributes
• How to strengthen WRID surveillance?
What is disease surveillance?

• Ongoing systematic collection, analysis and interpretation of health-related data
  ➢ *for use in planning, implementing and evaluating public health policies and practices*

• Right information at the right time to inform public health decision making
WRID surveillance objectives

• Monitor trends over time
• Detect outbreaks
• Identify new, emerging or re-emerging pathogens
• Estimate WRID burden
• Identify at-risk groups, populations and areas → target control and prevention measures
• Identify priorities for drinking water supply system improvement
• Assess effectiveness of control measures
• Inform water quality and WRID policies and regulations
Ideally WRID surveillance will:

• Integrate monitoring of health outcomes with monitoring of drinking water quality and environmental contamination events

• Involve strong co-ordination and collaboration between:
  • Public health surveillance agencies
  • Drinking water service providers
  • Regulators
  • Environmental agencies

→ timely sharing of information on water supply incidents and water-related outbreaks

• Operate at the national and sub-national (regional and local) level
Multilevel approach to WRID surveillance – example France

Core activities and building blocks of surveillance

- Core surveillance activities:
  - Case detection
  - Case reporting
  - Investigation and confirmation
  - Analysis and interpretation
  - Communication
  - Action - public health response, policy development and feedback to stakeholders

- Support processes enable the core activities

- Integrated disease surveillance
  - Indicator-based surveillance
  - Event-based surveillance

Epidemic intelligence framework

Kaiser et al. (2006): What is epidemic intelligence, and how is it being improved in Europe? Eurosurveillance. https://doi.org/10.2807/esw.11.05.02892-en
Indicator-based surveillance

- Notifiable disease – urgent reporting of serious diseases requiring an immediate public health response
- Syndromic – Cases that comply with a specified syndromic case definition
- Laboratory – number of isolates or positive tests for specific organisms
- Sentinel – health facilities representing high risk areas or groups
- Environmental monitoring – indicator based or event based – legally mandated monitoring of key environmental indicators at set time-periods
- Other types
  - prescriptions,
  - calls to medical helplines,
  - health insurance claims etc
Event-based surveillance

• Notifications of events related to water supply
  • water providers, municipal authorities

• Media monitoring
  • Mass media (TV, newspapers), social media reports

*EBS can be a sensitive and rapid way to detect outbreaks, but may lead to false alarms.*
Outbreak Surveillance

Event based

• Notifications of clusters of cases or suspected outbreaks
  • Health facilities, the public

Prevent and control outbreaks

Indicator based

• Number of confirmed outbreaks related to water
  • Disease burden
  • Causal agents
  • Risk factors
  • Geographical distribution

Inform on the need for investments in the water supply system and public health action
Other types of surveillance and studies

• Seroprevalence surveys
  • Public health agencies, laboratories, research institutes
  • estimate the burden of WRID

• Environmental surveys
  • Environmental agencies, research institutes
  • Detect outbreaks, risk assessment, monitoring emerging and re-emerging pathogens, estimate burden

• Case control studies using surveillance data
  • Identify water sources as risk factor for infection
  • Estimate burden of disease associated with waterborne transmission
Surveillance attributes

- Completeness
- Timeliness
- Usefulness
- Sensitivity
- Specificity
- Positive predictive value
- Representativeness
- Simplicity
- Flexibility
- Acceptability
- Stability

*Table 4 of the guidance document*
Timeliness and sensitivity

- Sensitivity – how well the system detects cases
  - % of symptomatic cases
  - % of cases seeking care
  - Sampling practices
  - Laboratory practices and capacity
  - Sensitivity and specificity of laboratory assays
  - Completeness of reporting of cases

Source: K. Nygard
Timeliness of outbreak detection varies by surveillance type.

- Event based surveillance is usually the fastest.
- Surveillance based on clinical or laboratory diagnoses are much slower and are less suitable for outbreak detection.
- Surveillance based on clinical diagnosis – risk of incorrect diagnosis → delayed or missed outbreak detection.

Proctor et al. (1998): Surveillance data for waterborne illness detection: an assessment following a massive waterborne outbreak of Cryptosporidium infection. Epidemiology and Infection, [https://doi.org/10.1017/S0950268897008327](https://doi.org/10.1017/S0950268897008327)
How to strengthen WRID surveillance?

• **Build on or expand existing surveillance systems to include WRID**
  • Include additional waterborne pathogens in the existing notifiable or laboratory based surveillance system
  • Reported using the existing surveillance procedures

• What are the surveillance objectives?

• How well will this type of surveillance meet the surveillance objectives?
  • *timeliness, sensitivity, specificity, completeness, representativeness* etc.

• Feasibility??
  • Human and laboratory capacity for collection, transportation, detection
  • Funding for surveillance
  • E-reporting and database
  • Acceptability and participation by health care workers
Questions?
Setting up, improving and maintaining national systems for WRID surveillance

Module 1.3
Overview

• Approach to WRID surveillance system strengthening
• Overview of main activities
• Enabling factors for surveillance

*We will work through a case study in parallel to this session*
Approach to WRID surveillance system strengthening

• Appoint public health specialist to lead and coordinate
• Develop overall strategy
• Support local level to develop procedures and implement
• Surveillance protocol
• Working group or advisory group
Main activities in WRID surveillance system strengthening

1. Engage key stakeholders and identify their roles
2. Characterize the public health problem through a situation analysis and agree priorities under surveillance
3. Define the overall purpose, scope and objectives of the WRID surveillance system
4. Identify the outcomes for surveillance, the core surveillance dataset and design the system
5. Develop a methodology for collecting, managing and analysing the surveillance data
6. Develop processes for monitoring and evaluating the system

- Stakeholder engagement
- Situation analysis and priority setting
- Purpose, scope and objectives
- Surveillance outcomes, scope and system design
- Methodology for data collection, management and analysis
- Monitoring and evaluation
1. Engage stakeholders and agree their roles
Establish an advisory / working group

• Establish advisory group to provide oversight and expertise
  • Do this early
  • Include decision makers, focal points and technical experts from participating organizations
  • Include those who will be responsible for running the system and acting on the results of surveillance (front line staff)
  • Include those working at the national and local level

• National advisory group
  • Overall system design and development
  • Priority setting for surveillance

• Local advisory group
  • Operationalise the system
Advisory groups could include:

At the national level:
- MoH/National public health agency
- Epidemiologist
- Water regulator
- Environment agency
- Environmental health specialists
- Laboratory specialist
- Legal and data protection expert
- IT specialist
- Data manager
- Event-based surveillance specialist

At the local level:
- Local public health specialist
- Local epidemiologist
- Local water provider
- Representative from health facilities
- Representatives from local laboratories
- Local environmental health specialists
Case study 1
2. Characterise the public health problem through a situation analysis and agree priorities for surveillance
Situation analysis

- Data sources: surveillance and laboratory reports and datasets, outbreak investigation reports, published and unpublished research studies, data from environmental studies, water providers and environment agencies
- Describe the epidemiology of WRID in the country
  - Burden of disease and trends over time
  - Economic cost, societal cost/humanistic burden
  - Outbreak potential
  - Reservoirs and sources
  - High-risk groups and areas
  - Political and social context
Situation analysis cont.

- Describe current surveillance capacity at national and subnational levels
  - Main actors and stakeholders and their roles in surveillance and disease control
  - Current data sources and potential new sources
  - Data gaps and limitations
  - International surveillance requirements

- At the local level:
  - Describe the local water supply – sources, providers, geographical distribution and population served
  - Review water quality data and condition of water system (WSP if available)
  - Review potential sources of Legionella
  - Identify local vulnerable populations and settings
Identifying priorities for surveillance

• Target surveillance at areas where WRIDs are endemic or where outbreaks occur:
  • Vulnerable water sources
  • Water supply is vulnerable to contamination – livestock
  • Areas subject to drought, drops in water pressure and intermittent supplies
  • Areas prone to flooding
  • Small-scale community supplies
  • Industrial areas

• Seasonal pathogens - enhance surveillance at certain times of year?
## Criteria for selecting candidate surveillance outcomes

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Factors to consider</th>
</tr>
</thead>
</table>
| **Disease burden – size of the problem and severity of the clinical outcomes** | - Percentage of cases attributable to waterborne transmission  
- Annual incidence rate  
- Vulnerability of exposed population groups (by sex, age, ethnicity)  
- Case-fatality ratio  
- Hospitalisation rate  
- Frequency and nature of long-term sequelae of infection |
| **Information about the hazard**                                         | Water monitoring data for microbial pathogens                                                                                                     |
| **Epidemiological features**                                            | Outbreak potential: number and size of outbreaks attributed to this pathogen  
Trends in disease incidence over time                                                                 |
| **Societal burden**                                                     | Economic cost  
Public perceptions of risk  
Political context                                                                                                                                        |
| **Feasibility**                                                         | Diagnostic capacity  
Capacity to conduct surveillance                                                                                                                     |
How to select the priority diseases

• Desktop exercise - Use the results of the situation analysis to identify priority pathogens, syndromes and diseases
• Strategy grids (next slide)
• Delphi panels
  • Form a panel of experts
  • Define criteria and score diseases against these
  • Weight and sum the results for each participant
  • Rank diseases and ask experts to assess ranking
  • Finalise results
• Decide what type of surveillance to conduct on each priority disease
Strategy Grids

• Used if resources are limited

• Focus on identifying those WRID for which surveillance will have the biggest impact.

• Use two of the five criteria listed previously to rank diseases

For instance, the grid could use:

• Disease burden + feasibility (example on next slide)
• Disease burden + epidemiological features
• Epidemiological features + availability of treatment and control
Example of a strategy grid based on disease burden and feasibility

<table>
<thead>
<tr>
<th>Disease burden, low feasibility</th>
<th>Disease burden, high feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>High disease burden, low feasibility</td>
<td>The surveillance of this WRID is a long-term project. Options for surveillance will require significant investment. Focusing on too many of these diseases can overwhelm the surveillance system and compromise its overall performance.</td>
</tr>
<tr>
<td>High disease burden, high feasibility</td>
<td>These diseases should be a high priority and sufficient resources should be assigned to their surveillance</td>
</tr>
<tr>
<td>Low disease burden, low feasibility</td>
<td>With minimal return on investment, these are the lowest priority foodborne diseases and should not be included in the surveillance system.</td>
</tr>
<tr>
<td>Low disease burden, high feasibility</td>
<td>Often politically important (as they are rare but may be high-impact diseases), these diseases may need to be considered as more resources become available. It may also be possible to gather information on these diseases using ad hoc research studies.</td>
</tr>
</tbody>
</table>
Case study 1 continued
3. Define the overall purpose, scope and objectives of surveillance
Purpose and scope

• Situation analysis and prioritization exercise → the purpose and scope of surveillance

• Purpose – the high level reason for conducting surveillance

→ “To strengthen our understanding of the burden and epidemiology of WRID in order to inform WRID prevention and control measures”

• Scope
  • What types of WRID to include in the system
  • Geographic coverage
  • Target population
  • Time period
Surveillance Objectives

• Can have multiple objectives

“The objectives are to:

  • Detect outbreaks
  • Estimate the burden and impact of WRID
  • Identify high-risk areas and populations to target with control measures”

• Design the system to meet the objectives

  • Will the system be sufficiently timely, representative, sensitive and specific to meet the objectives?
Case study 1 continued
4. Define the surveillance outcomes, the core dataset and design the system
Define outcomes for surveillance

• Informed by results of situation analysis and by purpose, scope and objectives of system
• List priority outcomes (pathogens, notifiable diseases and syndromes) to monitor
• Additional surrogate outcomes for event-based surveillance - water complaints, exceedances of water quality limits
• Link the outcomes to specific surveillance objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detect outbreaks</td>
<td>1. Physician notifications of acute gastroenteritis</td>
</tr>
<tr>
<td></td>
<td>2. Laboratory detections of cryptosporidium, giardia, campylobacter</td>
</tr>
<tr>
<td></td>
<td>3. Complaints to the water provider</td>
</tr>
<tr>
<td></td>
<td>4. Over the counter sales of anti-diarrhoeal medicines</td>
</tr>
</tbody>
</table>
Identify sources of data

• Laboratory databases → data on lab confirmed cases
• Medical insurance databases / sales databases → data on prescriptions or over-the-counter sales for anti-diarrhoeal medications
• Water providers → breech in water quality limits

What needs to be actively reported?

Can you automate the capture of data from any of these sources?
Schematic diagram of the elements of the surveillance system

Case definitions

• Define a case definition for each surveillance outcome

• Different to clinical case definitions and those used during outbreaks

• Publicly available case definitions – ECDC, CDC
Box 1. European Union surveillance case definition for cryptosporidiosis

Clinical criteria: any person with at least one of the following two:
- diarrhoea
- abdominal pain.

Laboratory criteria: at least one of the following four:
- demonstration of Cryptosporidium oocysts in stool
- demonstration of Cryptosporidium in intestinal fluid or small-bowel biopsy specimens
- detection of Cryptosporidium nucleic acid in stool
- detection of Cryptosporidium antigen in stool.

Epidemiological criteria: one of the following five epidemiological links:
- human-to-human transmission
- exposure to a common source
- animal-to-human transmission
- exposure to contaminated food/drinking water
- environmental exposure.

Case classification:
A. Possible case: not applicable
B. Probable case: any person meeting the clinical criteria with an epidemiological link
C. Confirmed case: any person meeting the clinical and the laboratory criteria.

Note: if the national surveillance system is not capturing clinical symptoms, all laboratory-confirmed individuals should be reported as confirmed cases.
Define what to collect and how often

- Usually notifiable diseases and laboratory confirmed cases are reported as case-based data. Case based data includes more detailed information on cases. For instance it may include data on age, sex, geographic location, occupation, travel history and underlying comorbidities.

  *Syndromic surveillance data may be reported as case-based data or as aggregated data. For instance physicians may report the total number of consultations for acute gastroenteritis by age-group.*

  *Only collect as much data as you need to*

  *All data collected must have a specific purpose and must contribute to the fulfilment of a specific surveillance objective.*

  *Anticipate the ethical challenges in undertaking surveillance and address them systematically and transparently. It is important to implement the relevant recommendations of the WHO guidelines on ethical issues in public health surveillance (2017). Surveillance systems should have a clear purpose and a plan for data collection, analysis, use and dissemination based on relevant public health priorities (Guideline 1). Countries have an obligation to develop appropriate, effective mechanisms to ensure ethical surveillance (and Guideline 2).*

  For instance geographic location data collected for laboratory confirmed cases can be used to monitor the geographic distribution of cases. This can help to identify areas with a higher incidence of water related disease, where an outbreak may be occurring, or where resources may need to be targeted to improve the water system.

  *If the data does not have a purpose, do not collect it.*
## Example of what to report and how often

<table>
<thead>
<tr>
<th>Surveillance outcome</th>
<th>Type of data</th>
<th>Suggested core data set</th>
<th>Example reporting frequency</th>
</tr>
</thead>
</table>
| Reporting notifiable cases of WRID | Case-based   | - Name  
- age  
- date of birth  
- sex  
- address  
- occupation  
- work address  
- date of onset of illness  
- date and place of hospitalization  
- case outcome (alive, died)  
- recent travel history | Within 24 hours |
## Example of what to report and how often

<table>
<thead>
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<th>Type of data</th>
<th>Suggested core data set</th>
<th>Example reporting frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Syndromic surveillance data (AGI, diarrhoea)</strong></td>
<td>Aggregate</td>
<td>• Total weekly cases by age group, sex and place</td>
<td>Weekly</td>
</tr>
<tr>
<td><strong>WRID outbreaks</strong></td>
<td>Case-based</td>
<td>• Location and date of outbreak, total cases, number hospitalized and died, causative agent, source of outbreak (public or private water supply, cooling tower etc.), water quality, main risks of water-supply system contamination, contributory factors</td>
<td>Quarterly</td>
</tr>
</tbody>
</table>
Strengths and limitations of the system

• Who is not covered by the system and how might that impact on WRID control measures?
• Sources of bias in the data?
• Potential to miss cases?
• Potential to misclassify cases as non-cases?
• Timeliness of the system for outbreak detection?
• Flexibility / adaptability?
• Simplicity?
• Redundancies and duplication of efforts?
Case study 1 continued
5. Develop a methodology for collecting, managing and analysing the surveillance data
Methodology

- Surveillance protocol and standard operating procedures
- Roles and responsibilities
- Case identification and investigation
- Data reporting / data flows
- What data will be collected?
- Reporting forms
- Data management
- Data analysis, interpretation and reporting
- Alert thresholds
Surveillance Thresholds

• Used to identify outbreaks and monitor seasonal epidemics
• Vary from simple calculations of historical surveillance data to complex statistical models
• Require several years of stable reliable surveillance data on a pathogen or outcome
• Can be defined in different ways:
  a) A defined number of cases that will prompt an investigation to verify existence of an outbreak
     → 5 cases of shigellosis or bloody diarrhoea
  b) An increase in the number of cases compared to the background rate for a specific disease over the same time-period and place
     → Doubling of cryptosporidium cases above the baseline surveillance rates for the previous 5 years
Monitoring and Evaluation

- Ongoing automated monitoring of surveillance data quality:
  - Data entry checks
  - Range and consistency checks
  - Cross check data between different data tables and databases

- Completeness and timeliness of data reporting

- Periodic evaluations of the system (surveillance attributes):
  - How well is the system meeting its objectives
Monitoring and Evaluation Resources

**ECDC (2014):** Data quality monitoring and surveillance system evaluation.  

**WHO (2006):** Communicable disease surveillance and response systems.  
[https://apps.who.int/iris/handle/10665/69331](https://apps.who.int/iris/handle/10665/69331)

[https://apps.who.int/iris/handle/10665/63639](https://apps.who.int/iris/handle/10665/63639)
Enabling factors I

• Set targets
  • For the prevention and reduction of WRID burden
  • For the strengthening of WRID surveillance, early warning and response systems

• Legal framework for surveillance
  • Update national legislation and guidelines
  • Establish formal requirements for WRID surveillance
  • Ethical and data protection requirements

Appropriate consideration must also be given to ensuring that surveillance procedures comply with national data management & research ethic requirements and WHO guidelines on ethical issues in public health surveillance (2017).
Enabling factors II

- Budget – local and national
- Laboratory capacity
- Transportation (specimens)
- Standard operating procedures
- Training
- Information technology
- Electronic data management system / web-based reporting system
Questions?
Case study 1 continued
Analysis, interpretation, reporting and use of data

Module 1.4
Overview

• Analysis and interpretation of data
• Surveillance bulletins
• Using surveillance data for advocacy
General approach to data analysis

• Analyse the surveillance data on a continuous basis – plan to analyse on at least a weekly basis.

• Typically report:
  • Total number of cases
  • Incidence or notification rates – adjust for size of underlying population
  • Proportions

• Core descriptive analyses:
  • Time (day, week, month, year)
  • Place (district, region, country)
  • Person (age, sex, occupation, race, ethnicity)

• Present results in tables, graphs and maps
## Outputs of data analysis

### Target analyses to address surveillance objectives and questions

<table>
<thead>
<tr>
<th>Surveillance objectives</th>
<th>Analytical outputs that can address these objectives</th>
<th>Frequency of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify temporal trends and detect possible outbreaks</td>
<td>Line graph of incidence over time</td>
<td>Weekly</td>
</tr>
<tr>
<td>Identify groups who are at higher risk of WRID</td>
<td>Table of total number of cases and incidence or prevalence rate by age, sex and geographic area</td>
<td>Weekly</td>
</tr>
<tr>
<td>Detect possible outbreaks or clusters of cases; identify areas associated with higher rates of disease</td>
<td>Table or map of the number of cases or the incidence rate by geographical area</td>
<td>Weekly</td>
</tr>
<tr>
<td>Estimate disease burden</td>
<td>Table of frequency of cases</td>
<td>Quarterly or annually</td>
</tr>
<tr>
<td>Evaluate the impact of control measures, such as implementing a new water-treatment step</td>
<td>Incidence of disease before and after changes in the water treatment</td>
<td>Based on needs</td>
</tr>
</tbody>
</table>
Calculating an incidence or notification rate

Notification rate per 100,000 persons = \( \frac{\text{Number of cases (notifications)}}{\text{Total population}} \times 100,000 \)

<table>
<thead>
<tr>
<th>Surveillance week</th>
<th>Number of notifications</th>
<th>Population estimate</th>
<th>Notification rate / 100,000 persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>525</td>
<td>1,291,850</td>
<td>40.6</td>
</tr>
<tr>
<td>13</td>
<td>489</td>
<td>1,291,850</td>
<td>37.9</td>
</tr>
<tr>
<td>14</td>
<td>501</td>
<td>1,291,850</td>
<td>?</td>
</tr>
<tr>
<td>15</td>
<td>579</td>
<td>1,291,850</td>
<td>?</td>
</tr>
</tbody>
</table>

Exercise: Using the formula, calculate the notification rates for weeks 14 and 15
### Calculating an incidence or notification rate

Notification rate per 100,000 persons = \( \frac{\text{Number of cases (notifications)}}{\text{Total population}} \times 100,000 \)

<table>
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<td>501</td>
<td>1,291,850</td>
<td>38.8</td>
</tr>
<tr>
<td>15</td>
<td>579</td>
<td>1,291,850</td>
<td>44.8</td>
</tr>
</tbody>
</table>
Analysis by time – monitoring trends
Analysis by time – monitoring trends

• Different ways of presenting the data over time will illustrate different information and will convey different messages:
  • Is the rate or burden of disease increasing or decreasing?
  • How does this year compare to previous years?
  • Is there any seasonality in the incidence of disease?

• Can apply alert thresholds to detect outbreaks or identify the start of seasonal epidemics
Alert thresholds and moving averages

• Alert thresholds provide a signal that the number of cases exceeds a defined level
  • Possible outbreak or start of seasonal epidemic → sign that action may be needed
• Threshold depends on severity and epidemic potential of a pathogen and the local epidemiology
• Defined based on number of cases or by comparing number of cases in current surveillance period to historical data over previously defined time periods:
  • 5 year moving average
## Example Alert Thresholds

<table>
<thead>
<tr>
<th>Surveillance outcome</th>
<th>Alert threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bloody diarrhoea</td>
<td>5 or more cases in one place in one day</td>
</tr>
<tr>
<td></td>
<td>Double the 5-year weekly average of cases</td>
</tr>
<tr>
<td>Acute gastroenteritis</td>
<td>Increase above the five-year average for that reporting period</td>
</tr>
<tr>
<td></td>
<td>Two standard deviations above the five-year average for that reporting period</td>
</tr>
</tbody>
</table>
### Calculating a 5-year weekly moving average

5-year moving average of weekly cases =

\[
\text{Total Yr 1 + total Yr 2 + total Yr 3 + total Yr 4 + total Yr 5} \div 5
\]

<table>
<thead>
<tr>
<th>Surveillance week</th>
<th>Weekly notifications per year</th>
<th>5-year total</th>
<th>5-year average</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>10 10 10 10 10</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>13</td>
<td>53 49 61 43 57</td>
<td>263</td>
<td>53</td>
</tr>
<tr>
<td>14</td>
<td>48 37 45 54 51</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

**Exercise:** Using the formula on this slide, calculate the 5 year average for week 14
## Calculating a – 5 year weekly moving average

5-year moving average of weekly cases =

\[
\text{Total Yr 1 + total Yr 2 + total Yr 3 + total Yr 4 + total Yr 5} \div 5
\]

<table>
<thead>
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<th>Surveillance week</th>
<th>Weekly notifications per year</th>
<th>5-year total</th>
<th>5-year average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015</td>
<td>2016</td>
<td>2017</td>
</tr>
<tr>
<td><strong>12</strong></td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>13</strong></td>
<td>53</td>
<td>49</td>
<td>61</td>
</tr>
<tr>
<td><strong>14</strong></td>
<td>48</td>
<td>37</td>
<td>45</td>
</tr>
</tbody>
</table>
Number of cases and crude incidence rate (CIR) over time

Discussion: What is your interpretation of this graph?

Number of cases and crude incidence rate (CIR) over time

Interpretation: The number of notifications and the population based incidence rate have increased over the past five years; the burden of disease is increasing over time.

Weekly notifications (or incidence) compared to average notifications (or incidence) for the previous 5 years

Discussion: What is your interpretation of this graph?

Weekly notifications (or incidence) compared to average notifications (or incidence) for the previous 5 years

Interpretation: The temporal distribution of Cryptosporidium in 2017 is similar to the previous 5 years, with cases peaking at a similar time. The overall number of cases for 2017 appears to be lower than the average for the previous 5 years.

Monthly notifications compared to mean, minimum and maximum notifications for the previous 5 years

Discussion: What is your interpretation of this graph?

Interpretation: The number of monthly notifications of cryptosporidiosis are higher than the 5-year average and are at the higher limit of notifications observed over the past 5 years. There is a higher burden of cryptosporidiosis this year compared to previous years.

Monthly notifications over time

Discussion: What is your interpretation of this graph?

Monthly notifications over time

Interpretation: Cryptosporidium follows a seasonal pattern, with most notifications occurring between October and November. There has been an upward trend in notifications over the past 4 years.

Analysis by place
Spatial analyses

• Identify high-risk areas for WRID
• Simple analyses using tables and graphs.
• Use geographic information systems to map the distribution of surveillance indicators by geographical area or water supply zone
  • Number of cases
  • Incidence rates
  • Complaints to water companies
• Need a geographical marker
  • Postcode
  • Place of residence
  • Location of medical facility
Simple tables of cases and rates

Table 2: Regional distribution\(^2\) of laboratory reports of Cryptosporidium in England and Wales: 2017

<table>
<thead>
<tr>
<th>Country</th>
<th>Region</th>
<th>Number of laboratory reports</th>
<th>per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>East Midlands</td>
<td>378</td>
<td>7.9</td>
</tr>
<tr>
<td>England</td>
<td>East of England</td>
<td>539</td>
<td>8.7</td>
</tr>
<tr>
<td>England</td>
<td>London</td>
<td>250</td>
<td>2.8</td>
</tr>
<tr>
<td>England</td>
<td>North East</td>
<td>275</td>
<td>10.4</td>
</tr>
<tr>
<td>England</td>
<td>North West</td>
<td>554</td>
<td>7.6</td>
</tr>
<tr>
<td>England</td>
<td>South East</td>
<td>582</td>
<td>6.4</td>
</tr>
<tr>
<td>England</td>
<td>South West</td>
<td>590</td>
<td>10.6</td>
</tr>
<tr>
<td>England</td>
<td>Yorkshire and The Humber</td>
<td>450</td>
<td>8.3</td>
</tr>
<tr>
<td>England</td>
<td>West Midlands</td>
<td>414</td>
<td>7.1</td>
</tr>
<tr>
<td>Wales</td>
<td>Wales</td>
<td>260</td>
<td>8.3</td>
</tr>
</tbody>
</table>

• Compare number of cases and notification rates by region

• **Discussion**: What is your interpretation of this table?

**Table 2: Regional distribution of laboratory reports of Cryptosporidium in England and Wales: 2017**

<table>
<thead>
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<td>Wales</td>
<td>Wales</td>
<td>260</td>
<td>8.3</td>
</tr>
</tbody>
</table>

**Interpretation:** The highest number of cases and the highest notification rate was reported from the South West region. The burden of Cryptosporidium is highest in the South West.

---

Graph of rates by place over time

Discussion:

What is your interpretation of this graph?

What are the possible explanations for the different distribution of cryptosporidiosis by region and over time?

Interpretation: The highest notification rate was reported from the midlands. Consistently over the past 5 years, and particularly in the last two years, the burden of cryptosporidiosis has been highest in the midlands. The eastern region has the lowest burden of disease.

Over the past 5 years the incidence of cryptosporidium in Ireland has been increasing.

Maps of cases and rates


Analysis by person
Analysis by age and sex – number of notifications

Discussion:

What is your interpretation of this graph?

Analysis by age and sex – number of notifications

Interpretation: The highest number of laboratory reports of cryptosporidium occurs in children aged 0-4 years old. In this age-group, the burden is highest in males. The burden of cryptosporidium is also high among women aged between 20 and 39.

What are the possible explanations for the different distribution of cryptosporidium by age and sex?

Analysis by age and sex – number of notifications

**Young children:**
- Environmental exposure including exposure to animals
- Greater susceptibility
- More severe disease and greater care seeking

**Women aged 20-40:**
- Drink more water?
- Eat more salad and raw vegetables?
- More likely to seek care?

Analysis by age and sex

Discussion:

What is your interpretation of this graph?

What is the advantage of this type of graph compared to the previous graph?

Analysis by age and sex

Interpretation: The notification rate is highest in those aged 0-4 years old, and particularly in males aged 0 to 4 years. Higher notification rates are also observed in women aged 15 to 24 and 25 to 44.

Advantages:
Adjust for size of underlying population in each age and sex group

Analysis by person – risk factors for infection

Table 1. Number of cases (and percentage of cases where information available) where selected risk factors were reported for cryptosporidiosis cases (n=629), Ireland, 2018

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Yes</th>
<th>No</th>
<th>UNK/NS</th>
<th>% of known</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel outside of Ireland(^a)</td>
<td>43</td>
<td>435</td>
<td>151</td>
<td>9.0%</td>
</tr>
<tr>
<td>Lives/cared for on farm</td>
<td>167</td>
<td>386</td>
<td>76</td>
<td>30.2%</td>
</tr>
<tr>
<td>Visited farm</td>
<td>164</td>
<td>329</td>
<td>136</td>
<td>33.9%</td>
</tr>
<tr>
<td>Lives/works on or visited farm(^b)</td>
<td>296</td>
<td>213</td>
<td>120</td>
<td>58.1%</td>
</tr>
<tr>
<td>Swimming pool visit</td>
<td>166</td>
<td>385</td>
<td>78</td>
<td>30.1%</td>
</tr>
<tr>
<td>Other water based activities</td>
<td>45</td>
<td>397</td>
<td>187</td>
<td>10.2%</td>
</tr>
<tr>
<td>Contact with domestic pets</td>
<td>365</td>
<td>164</td>
<td>100</td>
<td>69.0%</td>
</tr>
</tbody>
</table>

Data source: CIDR

\(^a\)Based on country of infection variable

\(^b\)Composite of the two previous variables

**Discussion:** What is your interpretation of this table?

Other types of analyses
Analysis by person and time – risk factors for infection

**Discussion:**

*What is your interpretation of this graph?*

*What are the possible explanations for the varying distribution of cryptosporidiosis in this graph?*

Analysis by person and time – risk factors for infection

Interpretation:

Cryptosporidiosis notifications peak in the spring. Travel associated cases are most frequently reported between July and October. The percentage of travel associated cases peaks in October.

Explanation:

Most rain falls in spring → increase in environmental exposure (water and farm exposures) and domestic notifications

Lambing and calving in spring

Most people travel overseas in the summer – higher numbers of travel associated cases

Surveillance Bulletins

• Regularly communicate results of surveillance to stakeholders (weekly, monthly, quarterly)
  • Inform decision making for public health action
  • Demonstrate the purpose and usefulness of surveillance to those working on surveillance

• Incorporate into existing surveillance bulletins (enteric pathogens, food and waterborne illness bulletin, or communicable diseases bulletin)

• Disseminate to stakeholders (water providers, regulators etc)

• Make publicly available (public health agency website)
Outline for a surveillance bulletin

• Key messages / summary
• Introduction (brief)
• Methods (brief)
• Epidemiology
  • Time (trends in notifications or rates)
  • Person (age, sex, other risk factors (travel))
  • Place
• Outbreaks
• Discussion / conclusions
Key messages

• Summarise the main findings and take home messages of the report
  • What is the ONE message you want the audience to take away from this report?
  • What is the ONE message the reader needs to understand?

• Focus the key messages on:
  • The most important conclusions arising from the analyses
  • The most important facts you want to communicate to the reader (3 or 4 facts)
Using surveillance data for advocacy

- Inform development of policy, regulations and guidelines
- Identify priorities and where to target resources for improving the water system
- Estimate impact of WRID – disability adjusted life years, quality adjusted life years, direct costs (healthcare utilisation) and indirect costs (work absenteeism and productivity losses)
- Evaluate impact of control measures
  - impact on incidence after the introduction of the control measure
  - cost benefit analyses
Questions?
Case Study 1

Strengthening WRID Surveillance Capacity

Case Study 1
The content of this case study is adapted from the WHO manual for the surveillance of foodborne diseases.
Overview

- **Purpose:** Work through the steps of strengthening a WRID surveillance system

- **Objectives:**
  - Assess current WRID surveillance capacity
  - Identify priorities for WRID surveillance strengthening
  - Design a WRID surveillance system

- **Approach:** Work together in groups
  - Team leader
  - Rapporteur
  - Time keeper
  - Presenter

- **Outcome:** A draft surveillance protocol

  *Present protocol to group – template PowerPoint*
Materials

- Case study participant handbook
- Template PowerPoint slide for presentation of results

[Group or country name]
WRID surveillance protocol

Case Study 1: Strengthening WRID Surveillance Capacity
Scenario

You work in the national public health agency (NPHA) in the division responsible for the surveillance and control of communicable diseases. You work in the team responsible for food and waterborne diseases. You have been tasked with strengthening surveillance for WRID.
Exercise 1: Establish an advisory group and agree roles and responsibilities

You have 10 minutes to complete this exercise

1. Decide membership of advisory group to oversee development and implementation of surveillance system.

2. List types of roles (epidemiologist, laboratory specialist etc), organisations they represent, and responsibility in advisory group and in surveillance.

3. Consider whether to have separate local level advisory groups.

4. Document this information in the table (separate table for the local level group).
<table>
<thead>
<tr>
<th>Role</th>
<th>Organisation</th>
<th>Responsibility in surveillance system development and implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Exercise 2: Situation analysis and setting priorities for surveillance

You have 90 minutes to complete this exercise

• Use tools and checklists to:

1. Review the current capacity for WRID surveillance in your country
2. Review the epidemiological situation for WRID in your country
3. Identify and rank the most important WRID
4. Identify surveillance priorities and surveillance options

• Present results (1 minute/group)
Step 1: Assess the current surveillance capacity for WRID in your country

25 minutes

• Use Table 2 in participant handbook

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Yes</th>
<th>Partially</th>
<th>No</th>
<th>Description of what is in place for this indicator</th>
<th>Description of what is not in place for this indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. An indicator-based surveillance system that can monitor trends of WRID, including disease syndromes and identify outbreaks of WRID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A surveillance system for notifiable diseases that collects data from the local level, and collates the data at the national level on a regular basis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing laws and decrees governing the national notifiable disease surveillance system are up to date and include priority WRID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A list of priority WRID for surveillance selected through a formal process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Step 2: Summarise the current epidemiological situation for WRID in your country

25 minutes

• Review surveillance data (past 5 years).

1. What are the most frequently reported diseases and syndromes?
2. Are any of these potentially water-related?
3. Were any events or outbreaks water-related? - causal pathogens, number of cases?
4. What pathogens are detected in the water-supply system?

→ What are the most important WRID in your country?
→ What are the gaps and opportunities for strengthening surveillance?
Step 3: Summarise data on diseases and syndromes as part of the prioritisation process

20 minutes

• Use criteria in Table 3 of the participant handbook to assess what to prioritise

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Factors to consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease burden – size of the problem</td>
<td>Percentage of cases attributable to waterborne transmission</td>
</tr>
<tr>
<td></td>
<td>Annual incidence rate</td>
</tr>
</tbody>
</table>

• Summarise data in table 4 of the participant handbook

<table>
<thead>
<tr>
<th>Questions</th>
<th>Disease 1</th>
<th>Disease 2</th>
<th>Disease 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease name</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Disease burden</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of annual cases</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Step 4: Decide what diseases to include

20 minutes

1. Decide which criteria from Table 3 to use in your strategy grid.

2. Rank the diseases for inclusion in surveillance using the blank strategy grid (Figure 1).

3. Pick one pathogen and one syndrome for inclusion in the system

4. Additional surveillance outcomes?

5. List surveillance outcomes (3) to be included

6. Identify surveillance options (Table 5)
**Present results using template**

<table>
<thead>
<tr>
<th>Priority surveillance outcomes</th>
<th>Surveillance options for each outcome</th>
<th>Rationale for choosing these outcomes and options</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6 of the participant handbook
Exercise 3: Define the purpose, scope and objectives for the surveillance system

20 minutes

- Define the purpose, scope and objectives of the surveillance system
- Complete table in your template presentation (also Table 7 of participant handbook)

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td></td>
</tr>
<tr>
<td>Objectives</td>
<td></td>
</tr>
</tbody>
</table>
Exercise 4: Define the surveillance outcomes, the core dataset and design the system

30 minutes

- Link each surveillance outcome to a surveillance objective.

- **Select one surveillance outcome:**
  1. Agree the case definition
  2. Identify the sources of data for the outcome
  3. Define the core dataset and reporting frequency
  4. Consider the strengths and limitations of your system

- Use the template tables in the participant guide (Tables 8, 9, 10 and 11) and PowerPoint
Exercise 5: Develop a methodology for collecting, managing and analysing the surveillance data

30 minutes

• Develop diagram describing the system
• Plans to disseminate results in surveillance bulletin
• Present surveillance protocol to group (10 minutes)

Group presentations (1 hour)
Contents

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Organization of the case study ............................................................................................................................................... 4
Course materials available for this case study .................................................................................................................... 5

Group Work........................................................................................................................................................................ 6
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Exercise 1: Establish an advisory group / working group and agree roles and responsibilities ......................................................... 6
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Advance preparation

To ensure successful work on the case study during the training, participants are requested to familiarise themselves with the instructions provided in this handbook and in particular to collate, in advance of the training workshop, information on the following:

1. A description of their public health system overall and the existing system for WRID surveillance and outbreak management – how is this organised (national, subnational etc)
2. Recent surveillance data on any WRID currently monitored in the country (ideally data from the past 5 years)
3. Background data on WRID outbreaks

This information is needed to undertake steps 1 to 3 of Exercise 2 and so participants are requested to bring this information with them for use during the case study.

Introduction

This case study will take participants through a series of exercises that will mirror the main steps involved in strengthening WRID surveillance. The objectives of the case study are to:

1. Assess current WRID surveillance capacity
2. Identify priorities for WRID surveillance strengthening
3. Design a WRID surveillance system

Organization of the case study

The case study consists of group work on a series of five exercises (taking around 3 hours), followed by a 1-hour plenary debrief. The case study is structured as follows:

<table>
<thead>
<tr>
<th>GROUP WORK</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise 1: Establish an advisory group and agree roles and responsibilities</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Exercise 2: Situation analysis and setting priorities for surveillance</td>
<td>90 minutes</td>
</tr>
<tr>
<td>Step 1:</td>
<td>25 minutes</td>
</tr>
<tr>
<td>Step 2:</td>
<td>25 minutes</td>
</tr>
<tr>
<td>Step 3:</td>
<td>20 minutes</td>
</tr>
<tr>
<td>Step 4:</td>
<td>20 minutes</td>
</tr>
<tr>
<td>Exercise 3: Define the purpose, scope and objectives for the surveillance system</td>
<td>20 minutes</td>
</tr>
<tr>
<td>Exercise 4: Define the surveillance outcomes, the core dataset and design the system</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Exercise 5: Develop a methodology for collecting, managing and analysing the surveillance data</td>
<td>30 minutes</td>
</tr>
<tr>
<td>PLENARY Session (Group Presentations)</td>
<td>60 minutes</td>
</tr>
<tr>
<td>Total time</td>
<td>240 minutes</td>
</tr>
</tbody>
</table>
Participants will work together in groups of five to six people to complete the case study. We suggest that each group should appoint:

- A team leader and time-keeper who will moderate the group activities, and ensure the group keeps to the allocated time for each exercise
- A rapporteur / note-taker who will be responsible for documenting the work of the group
- A presenter, who will present the group’s work during plenary discussions.

**Course materials available for this case study**

- A case study participant handbook, which takes you through all the exercises in the case study, and which includes tools, checklists and tables for you to work through
- A blank template PowerPoint presentation for you to document the results of your work on the case study. You should complete the PowerPoint as you work through the case study. At the end of the case study, your group will present an overview of your WRID surveillance system using the template presentation.

**Outcomes**

By the end of this case study each group will have designed and developed a draft outline of a protocol for WRID surveillance. Groups are asked to document the outcomes of the exercises on the provided PowerPoint template for presentation and discussion with the groups at the end of the case study.

**Scenario**

You work in the national public health agency (NPHA) in the division responsible for the surveillance and control of communicable diseases. You work in the team responsible for food and waterborne diseases. You have been tasked with strengthening surveillance for WRID.
Exercise 1: Establish an advisory group / working group and agree roles and responsibilities

You have 10 minutes to complete this exercise

1. As a group, discuss and agree who to include in the advisory group who will oversee the development and implementation of the surveillance system.

2. Instead of naming individuals, list the types of roles that will be represented in the group (for instance epidemiologist, laboratory specialist etc), name the organisations they represent, and their responsibility in the advisory group and in surveillance.

3. Document this information in the table.

4. Consider whether to have separate local level advisory groups.

5. If you decide to have both national and local level groups, create a separate table for the local level group.

6. Add extra rows to the table as necessary

Table 1: Membership of the national advisory group for WRID surveillance

<table>
<thead>
<tr>
<th>Role</th>
<th>Organisation</th>
<th>Responsibility in surveillance system development and implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Exercise 2: Situation analysis and setting priorities for surveillance

You have 90 minutes to complete this exercise

This exercise covers four steps and you will use tools and checklists to:

1. Review the current capacity for WRID surveillance in your country
2. Review the epidemiological situation for WRID in your country
3. Identify and rank the most important WRID
4. Identify surveillance priorities and surveillance options

Step 1: Use the following table to assess the current surveillance capacity for WRID in your country (25 minutes)

Table 2: Tool for the assessment of current WRID surveillance capacity

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Yes</th>
<th>Partially</th>
<th>No</th>
<th>Description of what is in place for this indicator</th>
<th>Description of what is not in place for this indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. An indicator-based surveillance system that can monitor trends of WRID, including disease syndromes and identify outbreaks of WRID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A surveillance system for notifiable diseases that collects data from the local level, and collates the data at the national level on a regular basis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing laws and decrees governing the national notifiable disease surveillance system are up to date and include priority WRID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A list of priority WRID for surveillance selected through a formal process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory-based surveillance for priority WRID, in which cases detected through the surveillance system are confirmed and further characterized in the laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inclusion in the surveillance system diseases and syndromes that may indicate WRID (e.g. diarrhoea)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are case definitions for each of the WRID under surveillance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Protocols for testing clinical specimens for all priority WRID that includes:

- a description of how laboratory testing is organized e.g. identifying what samples from which reporting sites go to which laboratories,
- instructions for the further characterization of priority pathogens.

Data reporting forms and a data reporting system (e.g. fax number, telephone notification, web-based system)

Laboratory and healthcare workers who know and are trained in the surveillance procedures

A database to store the surveillance data, with a data dictionary

A protocol that documents the functioning of the surveillance system and which describes:

- who will send/enter the data to the surveillance system,
- what data will be sent,
- how often the data will be sent,
- what actions will be taken on the basis of the information sent to the surveillance system

Capacity to analyse surveillance data on a regular basis (e.g. every week or every two weeks) to monitor trends and detect outbreaks

Regular publication and dissemination of surveillance bulletins, showing the trends in syndromic data that may indicate WRID

**2. An event-based surveillance (EBS) system capable of detecting WRID events**

A national focal point to receive reports about events

An event report forms to capture information about an event
Step 2: Summarise the current epidemiological situation for WRID in your country (25 minutes)

- Review data from the existing event based and indicator-based surveillance systems in your country. Focus on data from the past 5 years.
- What are the diseases and syndromes most frequently reported through indicator-based surveillance?
- Are any of the most frequently reported diseases and syndromes potentially water-related?
- For events and outbreaks detected through event-based surveillance and indicator-based surveillance, were any of these potentially water-related? If yes, what were the causal pathogens and how many people were affected?
- Review any available data on pathogens detected in the water-supply system in your country, including data on the frequency of detection.
- Based on the previous questions, what do you consider to be the most important WRID in your country?
- Considering the existing surveillance capacity in your country, are there any gaps or opportunities for strengthening WRID surveillance?
Step 3: Summarise data on diseases and syndromes as part of the prioritisation process (20 minutes)

- Use the following criteria to assess what diseases and syndromes to prioritise for surveillance

Table 3: Criteria for the priority assessment

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Factors to consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease burden – size of the problem and severity of the clinical outcomes</td>
<td>Percentage of cases attributable to waterborne transmission</td>
</tr>
<tr>
<td></td>
<td>Annual incidence rate</td>
</tr>
<tr>
<td></td>
<td>Vulnerability of exposed population groups (by sex, age, ethnicity)</td>
</tr>
<tr>
<td></td>
<td>Case-fatality ratio</td>
</tr>
<tr>
<td></td>
<td>Hospitalisation rate</td>
</tr>
<tr>
<td></td>
<td>Frequency and nature of long-term sequelae of infection</td>
</tr>
<tr>
<td>Information about the hazard</td>
<td>Water monitoring data for microbial pathogens</td>
</tr>
<tr>
<td>Epidemiological features</td>
<td>Outbreak potential: number and size of outbreaks attributed to this pathogen</td>
</tr>
<tr>
<td></td>
<td>Trends in disease incidence over time</td>
</tr>
<tr>
<td>Societal burden</td>
<td>Economic cost</td>
</tr>
<tr>
<td></td>
<td>Public perceptions of risk</td>
</tr>
<tr>
<td></td>
<td>Political context</td>
</tr>
<tr>
<td>Feasibility</td>
<td>Diagnostic capacity</td>
</tr>
<tr>
<td></td>
<td>Capacity to conduct surveillance</td>
</tr>
</tbody>
</table>

- Based on the review in step 2, and in particular focusing on gaps in existing surveillance capacity identified in steps 1 and 2, **select 3 pathogens or syndromes** that are potentially water-related for priority assessment. Summarise the available data on these pathogens and syndromes using the following table.
Table 4: Overview of the epidemiological situation for the WRID included in the priority assessment

<table>
<thead>
<tr>
<th>Questions</th>
<th>Disease 1</th>
<th>Disease 2</th>
<th>Disease 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Disease burden</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disease name</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of annual cases attributable to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>waterborne transmission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual number of cases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual incidence rate per 100 000 population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At-risk populations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male:female ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age groups most affected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other high-risk groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of cases hospitalised or hospitalisation rate/100 000 population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case fatality rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature and frequency of long-term disabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Information about hazards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water-monitoring data for microbial pathogens</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>C. Epidemiological features</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outbreak potential:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of WRID outbreaks associated with pathogen in past 5 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cases in each outbreak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the disease incidence increasing or decreasing over the past 5 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Availability of treatment and control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific prevention or control measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E. Societal burden</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated economic cost per year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public perception of risk (high/medium/low)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Is the pathogen a political priority? Y/N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E. Feasibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are reliable diagnostic tests readily available?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current diagnostic capacity in country?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to conduct surveillance for the disease in country?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Step 4: Decide what diseases to include (20 minutes)

We will use strategy grids for this exercise.

1. Decide which criteria from Table 3 to use in your strategy grid.

2. Use the blank strategy grid (Figure 1) to rank the diseases under consideration for inclusion in surveillance.

3. Pick one pathogen and one syndrome for inclusion in the system

4. Are there any additional surveillance outcomes that you would like to prioritise for surveillance?

Figure 1: Blank strategy grid for ranking diseases for inclusion in surveillance

<table>
<thead>
<tr>
<th>Criteria 1</th>
<th>Criteria 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>High _____, low _______</td>
<td>High ________, high ________</td>
</tr>
<tr>
<td>Low _______, low ________</td>
<td>High ________, high ________</td>
</tr>
</tbody>
</table>

5. List the surveillance outcomes that you will include in surveillance.
   - Surveillance outcome 1:
   - Surveillance outcome 2:
   - Surveillance outcome 3:

6. Translate priorities into surveillance options (5 minutes)

Using the following table, for each surveillance outcome, identify what types of surveillance you will conduct for that surveillance outcome, including the rationale for choosing that surveillance option.
Table 5: Selection of surveillance options

<table>
<thead>
<tr>
<th>Surveillance outcome</th>
<th>Surveillance options</th>
<th>Rationale for selecting these surveillance options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notifiable disease</td>
<td>Syndromic</td>
<td>Laboratory</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Present the results of the priority setting exercise in the following table

Table 6: Results of the priority setting exercise

<table>
<thead>
<tr>
<th>Priority surveillance outcomes</th>
<th>Surveillance options for each outcome</th>
<th>Rationale for choosing these outcomes and options</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Exercise 3: Define the purpose, scope and objectives for the surveillance system

You have 20 minutes to complete this exercise

1. As a group, discuss and agree the purpose, scope and objectives of the surveillance system, and document these in the following table. We suggest defining 3 objectives for the system.

Table 7: Purpose, scope and objectives of the system

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td></td>
</tr>
<tr>
<td>Objectives</td>
<td></td>
</tr>
</tbody>
</table>
Exercise 4: Define the surveillance outcomes, the core dataset and design the system

You have 30 minutes to complete this exercise

In this exercise you will link each surveillance outcome to a surveillance objective. You will select one of the surveillance outcomes, and for this outcome you will:

- Agree the case definition
- Identify the sources of data for the outcome
- Define the core dataset and reporting frequency
- Consider the strengths and limitations of your system

1. Using the following table, link each surveillance objective defined in exercise 3 to the outcomes selected in exercise 2 (outcomes can be linked to more than one objective)

Table 8: Linkage between the surveillance objectives and the outcomes

<table>
<thead>
<tr>
<th>Surveillance objective</th>
<th>Surveillance outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

2. Pick one of the surveillance outcomes and specify the case definition for that outcome. You can include confirmed, probable and possible case definitions.
Table 9: Case definitions for the surveillance outcomes

<table>
<thead>
<tr>
<th>Surveillance outcome</th>
<th>Case definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Identify and list the sources of data for this surveillance outcome

Table 10: Data sources for the surveillance outcome

<table>
<thead>
<tr>
<th>Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

4. Define the core dataset and reporting frequency for this outcome using the following table (NB: you might collect more than one type of data on a surveillance outcome)
Table 11: Data to be collected on the surveillance outcome

<table>
<thead>
<tr>
<th>Surveillance outcome</th>
<th>Type of data</th>
<th>Core dataset</th>
<th>Reporting frequency</th>
</tr>
</thead>
</table>

5. List two strengths and two limitations of your surveillance system

Strengths:
1. 
2. 

Limitations:
1. 
2.
Exercise 5: Develop a methodology for collecting, managing and analysing the surveillance data

You have 30 minutes to complete this exercise

During this exercise you will:

1. Develop a schematic diagram for the surveillance of the outcome selected in the previous exercise
   
   This diagram should detail:
   
   a. The data flows for the system, including who will collect and report the data
   b. How water providers, water regulators and other multisectoral stakeholders will be included in the system
   c. The plan for analysing the data, including who will do this and how often
   d. How the data will be used

2. Describe the plans for disseminating the results of surveillance in a surveillance bulletin.

You can use a whiteboard to develop the schematic diagram, or you can do this electronically using the PowerPoint template or another application like Word.

Throughout the case study you have documented the results of your work in both this handbook and in the PowerPoint template provided. This template now essentially gives an overview of your WRID surveillance protocol. At the end of this exercise you will be given 10 minutes to present this PowerPoint to the group.
## Contents

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- Exercise 1: Establish an advisory group / working group and agree roles and responsibilities..................................................................................................................6
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Water-related Infectious Disease Surveillance Case Study 1

Objectives

The objective of this exercise is to give participants hands on experience of developing a protocol for the surveillance of water-related infectious disease.

Advance preparation

To ensure successful work on the case study during the training, participants are requested to familiarise themselves with the instructions provided in this handbook and in particular to collate, in advance of the training workshop, information on the following:

1. A description of their public health system overall and the existing system for WRID surveillance and outbreak management – how is this organised (national, subnational etc)
2. Recent surveillance data on any WRID currently monitored in the country (ideally data from the past 5 years)
3. Background data on WRID outbreaks

This information is needed to undertake steps 1 to 3 of Exercise 2 and so participants are requested to bring this information with them for use during the case study.

Structure of the exercise

During this case study you will take participants through a series of exercises that will mirror the main steps involved in strengthening WRID surveillance. The objectives of the case study are to:

1. Assess current WRID surveillance capacity
2. Identify priorities for WRID surveillance strengthening
3. Design a WRID surveillance system

You can use the accompanying PowerPoint presentation to walk participants through the presentation. The presentation includes prompts and instructions for each exercise.
Organization of the case study

The case study consists of group work on a series of five exercises (taking around 3 hours), followed by a 1-hour plenary debrief. The case study is structured as follows:

<table>
<thead>
<tr>
<th>GROUP WORK</th>
<th>180 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise 1: Establish an advisory group and agree roles and responsibilities 10 minutes</td>
<td></td>
</tr>
<tr>
<td>Exercise 2: Situation analysis and setting priorities for surveillance 90 minutes</td>
<td></td>
</tr>
<tr>
<td>Step 1 25 minutes</td>
<td></td>
</tr>
<tr>
<td>Step 2 25 minutes</td>
<td></td>
</tr>
<tr>
<td>Step 3 20 minutes</td>
<td></td>
</tr>
<tr>
<td>Step 4 20 minutes</td>
<td></td>
</tr>
<tr>
<td>Exercise 3: Define the purpose, scope and objectives for the surveillance system 20 minutes</td>
<td></td>
</tr>
<tr>
<td>Exercise 4: Define the surveillance outcomes, the core dataset and design the system 30 minutes</td>
<td></td>
</tr>
<tr>
<td>Exercise 5: Develop a methodology for collecting, managing and analysing the surveillance data 30 minutes</td>
<td></td>
</tr>
<tr>
<td>PLENARY Session (Group Presentations) 60 minutes</td>
<td></td>
</tr>
<tr>
<td>Total time 240 minutes</td>
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</tr>
</tbody>
</table>

Ask participants to work together in groups of five to six people to complete the case study. We suggest that each group should appoint:

- A team leader and time-keeper who will moderate the group activities, and ensure the group keeps to the allocated time for each exercise
- A rapporteur / note-taker who will be responsible for documenting the work of the group
- A presenter, who will present the group’s work during plenary discussions.

By the end of this case study each group will have designed and developed a draft outline of a protocol for WRID surveillance, which they will present at the plenary session.

Ask groups to document the outcomes of the exercises on the provided PowerPoint template for presentation and discussion with the groups during a plenary session at the end of the case study.

**The entire case study should take about 3 hours, with an additional hour for groups to present their protocols**
Course materials available for this case study

- Case study facilitator handbook: including facilitator probes to guide the discussion
- Facilitator PowerPoint presentation: a set of slides are available to be used and edited as needed by the workshop facilitators. They include the case study structure and probes for the delivery of the case study.
- A case study participant handbook, which takes participants through all the exercises in the case study, and which includes tools, checklists and tables for them to work through
- A blank template PowerPoint presentation for participants to document the results of their work on the case study. Participants should complete the PowerPoint as they work through the case study. At the end of the case study, ask each group to present an overview of their WRID surveillance system using the template presentation.
Group Work

Scenario

Present the following scenario to the participants:

You work in the national public health agency (NPHA) in the division responsible for the surveillance and control of communicable diseases. You work in the team responsible for food and waterborne diseases. You have been tasked with strengthening surveillance for WRID.

Exercise 1: Establish an advisory group / working group and agree roles and responsibilities

Participants have 10 minutes to complete this exercise.

Walk participants through the following instructions:

1. As a group, discuss and agree who to include in the advisory group who will oversee the development and implementation of the surveillance system.

2. Instead of naming individuals, list the types of roles that will be represented in the group (for instance epidemiologist, laboratory specialist etc), name the organisations they represent, and their responsibility in the advisory group and in surveillance.

3. Document this information in the table provided in either or both of the participant handbook and the template presentation.

4. Consider whether to have separate local level advisory groups.

5. If you decide to have both national and local level groups, create a separate table for the local level group.

6. Add extra rows to the table as necessary

Table 1: Membership of the national advisory group for WRID surveillance

<table>
<thead>
<tr>
<th>Role</th>
<th>Organisation</th>
<th>Responsibility in surveillance system development and implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Exercise 2: Situation analysis and setting priorities for surveillance

This exercise comprises four steps. The exercise is presented in slides 7 to 12 of the facilitator presentation. Walk the groups through these slides before they start the exercise. Participants have 90 minutes to complete this exercise.

Ask the participants to use the provided tools and checklists to:

Step 1: Review the current capacity for WRID surveillance in their country
Step 2: Review the epidemiological situation for WRID in their country
Step 3: Identify and rank the most important WRID
Step 4: Identify surveillance priorities and surveillance options

Step 1: Review the current capacity for WRID surveillance in their country

In Step 1 of this exercise, ask participants to use table 2 on page 3 of the participant handbook (and on the next page of this handbook) to assess the current surveillance capacity for WRID in their country. Ask them to go through each question in the table and assess whether there is complete, partial or no capacity for each indicator in their country. Ask them to note what is in place for each indicator, and what is missing for each indicator. Participants have 25 minutes to complete this step, so advise them to keep their responses short.

Table 2: Tool for the assessment of current WRID surveillance capacity

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Yes</th>
<th>Partially</th>
<th>No</th>
<th>Description of what is in place for this indicator</th>
<th>Description of what is not in place for this indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. An indicator-based surveillance system that can monitor trends of WRID, including disease syndromes and identify outbreaks of WRID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A surveillance system for notifiable diseases that collects data from the local level, and collates the data at the national level on a regular basis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing laws and decrees governing the national notifiable disease surveillance system are up to date and include priority WRID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A list of priority WRID for surveillance selected through a formal process</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Laboratory-based surveillance for priority WRID, in which cases detected through the surveillance system are confirmed and further characterized in the laboratory

Inclusion in the surveillance system diseases and syndromes that may indicate WRID (e.g. diarrhoea)

There are case definitions for each of the WRID under surveillance

Protocols for testing clinical specimens for all priority WRID that includes:

- a description of how laboratory testing is organized e.g. identifying what samples from which reporting sites go to which laboratories,
- instructions for the further characterization of priority pathogens.

Data reporting forms and a data reporting system (e.g. fax number, telephone notification, web-based system)

Laboratory and healthcare workers who know and are trained in the surveillance procedures

A database to store the surveillance data, with a data dictionary

A protocol that documents the functioning of the surveillance system and which describes:

- who will send/ enter the data to the surveillance system,
- what data will be sent,
- how often the data will be sent,
- what actions will be taken on the basis of the information sent to the surveillance system

Capacity to analyse surveillance data on a regular basis (e.g. every week or every two weeks) to monitor trends and detect outbreaks
Regular publication and dissemination of surveillance bulletins, showing the trends in syndromic data that may indicate WRID

2. An event-based surveillance (EBS) system capable of detecting WRID events

   A national focal point to receive reports about events

   An event report forms to capture information about an event

   An event database to store information about reported events

   Health care workers, sanitary inspectors, environmental and waterworks staff have been trained on reporting WRID events to EBS

3. Monitoring and evaluating the WRID surveillance system

   Monitoring indicators for each component of the system

   A process for measuring the monitoring indicators (e.g. define when system will be monitored, how it will be monitored and by whom)

   A log of system performance

   Regular evaluation of the WRID surveillance system

**Step 2: Summarise the current epidemiological situation for WRID in their country**

**Participants have 25 minutes to complete this exercise**

Ask participants to:

- Review data from the existing event based and indicator-based surveillance systems in their country. Focus on data from the past 5 years.
- Identify the diseases and syndromes most frequently reported through indicator-based surveillance
- Identify whether any of the most frequently reported diseases and syndromes are potentially water-related
- For events and outbreaks detected through event-based surveillance and indicator-based surveillance, identify whether any of these potentially were water-related? If yes, what were the causal pathogens and how many people were affected?
• Review any available data on pathogens detected in the water-supply system in their country, including data on the frequency of detection

• Based on the previous questions, identify what they consider to be the most important WRID in their country?

• Considering the existing surveillance capacity in their country, identify any gaps or opportunities for strengthening WRID surveillance?

**Step 3: Summarise data on diseases and syndromes as part of the prioritisation process**

**Participants have 20 minutes to complete this exercise**

• Ask participants to use the criteria in Table 3 on page 6 of the participant handbook to assess what diseases and syndromes to prioritise for surveillance

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Factors to consider</th>
</tr>
</thead>
</table>
| Disease burden – size of the problem and severity of the clinical outcomes | Percentage of cases attributable to waterborne transmission  
Annual incidence rate  
Vulnerability of exposed population groups (by sex, age, ethnicity)  
Case-fatality ratio  
Hospitalisation rate  
Frequency and nature of long-term sequelae of infection |
| Information about the hazard | Water monitoring data for microbial pathogens |
| Epidemiological features | Outbreak potential: number and size of outbreaks attributed to this pathogen  
Trends in disease incidence over time |
| Societal burden | Economic cost  
Public perceptions of risk  
Political context |
| Feasibility | Diagnostic capacity  
Capacity to conduct surveillance |

• Based on the review in step 2, and in particular focusing on gaps in existing surveillance capacity identified in steps 1 and 2, ask participants to select 3 pathogens or syndromes that are potentially water-related for priority assessment.
- Ask participants to summarise the available data on these pathogens and syndromes using Table 4, on page 7 of the participant handbook.

Table 4: Overview of the epidemiological situation for the WRID included in the priority assessment

<table>
<thead>
<tr>
<th>Questions</th>
<th>Disease 1</th>
<th>Disease 2</th>
<th>Disease 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Disease burden</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disease name</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of annual cases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>attributable to waterborne</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>transmission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual number of cases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual incidence rate per</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 000 population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At-risk populations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male:female ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age groups most affected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other high-risk groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of cases hospitalised or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hospitalisation rate/100 000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case fatality rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature and frequency of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>long-term disabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Information about hazards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water-monitoring data for</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>microbial pathogens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. Epidemiological features</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outbreak potential:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of WRID outbreaks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>associated with pathogen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in past 5 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cases in each outbreak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the disease incidence increasing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or decreasing over the past 5 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Availability of treatment and control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific prevention or control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E. Societal burden</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Estimated economic cost per year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public perception of risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(high/medium/low)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the pathogen a political priority? Y/N</td>
<td></td>
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<tr>
<td><strong>E. Feasibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are reliable diagnostic tests</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>readily available?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current diagnostic capacity in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>country?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to conduct surveillance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for the disease in country?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Step 4: Decide what diseases to include**

*Participants have 20 minutes to complete this exercise*

Participants are provided with a blank strategy grid (Figure 1) on page 8 of the participant handbook.

Ask participants to use the strategy grid to help them to identify the priority diseases to include in surveillance. Ask participants to

1. Decide which criteria from **Table 3** to use in the strategy grid.
2. Use the blank strategy grid (**Figure 1**) to rank the diseases under consideration for inclusion in surveillance.
3. Pick one pathogen and one syndrome for inclusion in the system.
4. Identify whether there are any additional surveillance outcomes that they would like to prioritise for surveillance?
5. List the surveillance outcomes to include in surveillance.
6. Translate the priorities into surveillance options using **Table 5** on page 9 of the participant handbook. In particular, for each surveillance outcome, they should identify what types of surveillance they will conduct for that surveillance outcome, including the rationale for choosing that surveillance option.
7. Ask participants to summarise the results of the priority setting exercise using **Table 6** on page 10 of the participant handbook (and also in the participant template presentation, as well as on page 11 of this handbook).

---

Figure 1: Blank strategy grid for ranking diseases for inclusion in surveillance

<table>
<thead>
<tr>
<th>Criteria 1</th>
<th>Criteria 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>High ______, low _________</td>
<td>High ________, high ________</td>
</tr>
<tr>
<td>Low ______, low _________</td>
<td>High ________, high ________</td>
</tr>
</tbody>
</table>

---
**Table 5: Selection of surveillance options**

<table>
<thead>
<tr>
<th>Surveillance outcome</th>
<th>Notifiable disease</th>
<th>Syndromic</th>
<th>Laboratory</th>
<th>Sentinel</th>
<th>Other indicator-based</th>
<th>Event-based</th>
<th>Rationale for selecting these surveillance options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 6: Results of the priority setting exercise**

<table>
<thead>
<tr>
<th>Priority surveillance outcomes</th>
<th>Surveillance options for each outcome</th>
<th>Rationale for choosing these outcomes and options</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Exercise 3: Define the purpose, scope and objectives for the surveillance system**

*Participants have 20 minutes to complete this exercise*

Ask participants as a group, to discuss and agree the purpose, scope and objectives of the surveillance system, and to document these in the Table 7, on page 10 of the participant hand book (and in the participant template presentation). Suggest that they define 3 objectives for the system.

**Table 7: Purpose, scope and objectives of the system**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
</tr>
<tr>
<td>Objectives</td>
</tr>
</tbody>
</table>
Exercise 4: Define the surveillance outcomes, the core dataset and design the system

**Participants have 30 minutes to complete this exercise**

In this exercise ask participants to link each surveillance outcome to a surveillance objective. Advise the participants to select a single surveillance outcome. For that outcome they should:

- Agree the case definition
- Identify the sources of data for the outcome
- Define the core dataset and reporting frequency
- Consider the strengths and limitations of your system

Remind the participants that surveillance outcomes can address more than one surveillance objective. Participants can draw the schematic diagram on a whiteboard or using word or excel. Remind participants that they can collect more than one type of data on a surveillance outcome (for instance both they can collect both case based and aggregate data for an outcome).

Participants can use Table 8 on page 11 of the participant handbook (and in the template participant presentation) to link each surveillance objective defined in exercise 3 to the outcomes selected in exercise 2 (outcomes can be linked to more than one objective).

Participants should pick one of the surveillance outcomes and specify the case definition for that outcome. They can specify confirmed, probable and possible case definitions. Ask participants to document the case definition in Table 9 on page 11 of the participant handbook (the table can also be found in the template participant presentation).

Table 8: Linkage between the surveillance objectives and the outcomes

<table>
<thead>
<tr>
<th>Surveillance objective</th>
<th>Surveillance outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
Table 9: Case definitions for the surveillance outcomes

<table>
<thead>
<tr>
<th>Surveillance outcome</th>
<th>Case definitions</th>
</tr>
</thead>
</table>

Ask the participants to identify the sources of data for this surveillance outcome and to list the sources of these data in Table 10 on page 12 of the participant handbook (and in the template participant presentation).

Table 10: Data sources for the surveillance outcome

<table>
<thead>
<tr>
<th>Data Sources</th>
</tr>
</thead>
</table>

Ask participants to define the core dataset and reporting frequency for this outcome and to document these in Table 11 on page 12 of the participant handbook (and in the template participant presentation). Remind them that they can collect more than one type of data on a surveillance outcome.
Table 11: Data to be collected on the surveillance outcome

<table>
<thead>
<tr>
<th>Surveillance outcome</th>
<th>Type of data</th>
<th>Core dataset</th>
<th>Reporting frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ask participants to identify and list two strengths and two limitations of their surveillance system and to detail these in the participant handbook and/or the template participant presentation.
Exercise 5: Develop a methodology for collecting, managing and analysing the surveillance data

Participants have 30 minutes to complete this exercise

In this final exercise ask participants to:

1. Develop a schematic diagram for the surveillance of the outcome selected in the previous exercise

   This diagram should detail:

   a. The data flows for the system, including who will collect and report the data

   b. How water providers, water regulators and other multisectoral stakeholders will be included in the system

   c. The plan for analysing the data, including who will do this and how often

   d. How the data will be used

2. Describe the plans for disseminating the results of surveillance in a surveillance bulletin.

Participants can use a whiteboard to develop the schematic diagram, or they can do this electronically using the PowerPoint template or another application like Word.

Plenary session: Group presentations

Throughout the case study participants have documented the results of their work in both the participant handbook and in the PowerPoint template provided. This template now essentially gives an overview of their WRID surveillance protocol. At the end of this exercise ask participants to present their protocol to the group.

Each group has 10 minutes to present their surveillance protocol

Monitor the time they spend on the presentation

Ring the bell after 8 minutes to ensure they keep to time.

For each presentation make sure to ask the group to describe:

1. How the data will be collected and reported, including by whom and to whom

2. How the system will link to multisectoral stakeholders, such as the water providers and water regulators

3. What the plans are for analysing the data and disseminating the results in a surveillance bulletin

Invite other participating groups to ask questions and to give feedback on the surveillance system of the presenting group.
Principles and steps of an outbreak investigation

Module 2.1
What is an outbreak?

- Unexpected increase in cases in a specific place and time
- Exceedance of a predefined alert threshold
- Two or more cases of disease linked to the same source
What is an waterborne outbreak? - WHO definition

At least two people experience a similar illness after exposure to water and the evidence suggests a probable water source.
(Large water supply) waterborne outbreaks

- Associated with watershed events:
  - Defects in the water-treatment process or distribution system
  - Exceedance of water-quality parameters
- Sudden, rapid and widespread occurrence of gastrointestinal consultations
- Clustering of cases in a particular water-supply zone
When to investigate a waterborne outbreak?

- The outbreak is likely to continue if no intervention
- Unknown source
- Unknown cause
- Severe and/or unusual disease
- Large number of cases
When to investigate a waterborne outbreak?

- The outbreak is likely to continue if no intervention is made.
- Unknown source
- Unknown cause
- Severe and/or unusual disease
- Large number of cases

A full investigation may not be required if the agent and source can be identified without the need for further investigations and the outbreak has already been controlled. However, it will still be important to identify the cause and contributing factors in order to prevent new outbreaks.
Outbreak investigation objectives

• Confirm the outbreak
• Identify the source and contributing factors
• Implement control measures

➔ In order prevent further cases
Outbreak investigation steps

• Differ from outbreak to outbreak
• Simultaneous and in parallel
• Control measures as early as possible
• Communication on an ongoing basis
10 step approach

1. Detect and confirm the outbreak and agent
2. Rapid Response Team (RRT)
3. Define cases
4. Identify cases and obtain information
5. Descriptive epidemiological investigation (time, place, person)
6. Additional studies (environmental, risk assessments, laboratory)
7. Interview cases and generate hypotheses
8. Evaluate the hypotheses
9. Inform risk managers and implement control measures
10. Communicate findings, make recommendations and evaluate the outbreak response
Step 1. Detect and confirm the outbreak and agent

**Health-care systems**
- Detection by surveillance systems
  - Indicator and event based surveillance
  - Epidemiological
  - Microbiological
- Health-care facilities reports

**Other signals**
- Absenteeism from work, schools
- Increased sales of certain medications
- Media reports

**Water quality**
- Routine samples with faecal bacteria
- Water treatment or distribution failures
- User complaints
Step 1. Detect and confirm the outbreak and agent

Is the outbreak real? → More cases than expected?

- Seasonal variations?
- Notification artefacts?
- New surveillance system?
- Diagnostic bias?
Step 1. Detect and confirm the outbreak and agent

- Outbreak confirmed
- Rapid Risk assessment
  - Contact drinking water provider
  - Immediate precautionary control measures
  - Contact all relevant stakeholders
  - Environmental specimen collection strategy
Step 1. Detect and confirm the outbreak and agent

Identifying the microorganism helps to:
• develop a hypothesis about the source (previous events)
• identify time of exposure (incubation period)
• choose control measures

- Do not wait for lab results to start the investigation
- Confirm a proportion of cases
Step 1. Detect and confirm the outbreak and agent

• Time between the contamination event and the outbreak detection
  • Long incubation periods
  • Few cases go to the doctor ("peak of the iceberg")
• Longer delay → lower probability of detecting the agent in water
• Relevant water samples may no longer be available
Large waterborne *Campylobacter* outbreak in Norway in 2019

*Hyllestad et al. (2020), Eurosurveillance*

Available from:
https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011
Step 1. Detect and confirm the existence of the outbreak and confirm the causative agent

6 June 2019, Askøy, Norway.

- In 24 h, 10 people **hospitalized** with fever, abdominal pain and diarrhea, and 30 **consultations** from out-of-hours primary healthcare services.

- Many patients presenting with gastroenteritis **had home addresses near each other**

  → drinking-water?

- One person tested positive for **Campylobacter**

- Medical Officer in Askøy **reports the outbreak** to the Norwegian Institute of Public Health.

**Hyllestad et al. (2020):** Large waterborne Campylobacter outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway, June 2019. Eurosurveillance, https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011
Outbreak context

• Island municipality Askøy, Norway
• 29,500 inhabitants

Three different water supply systems in Askøy: A, B, C

Water Supply System A (WSS-A) from the 1950s, serves ca. 12,000 people in the south of the island.

WSS-A has 9 reservoirs, including 3 built as unlined mountain caverns.

One of these reservoirs was reservoir X
Step 1. Detect and confirm the existence of the outbreak and confirm the causative agent

Immediate precautionary control measures taken once outbreak detected

• 6 June: Boil Water Advice issued
• 7 June: Reservoir X taken out of service

Step 2. Form the Rapid Response Team (RRT)

1. Outbreak confirmed
2. Investigation needed
3. Form the Rapid Response team
Step 2. Form the Rapid Response Team (RRT)

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local/regional public Health agency</td>
<td>Overall coordination</td>
</tr>
<tr>
<td>Food/water authority</td>
<td>Environmental investigation</td>
</tr>
<tr>
<td>Water supplier</td>
<td>Control measures implementation</td>
</tr>
<tr>
<td>Health-care providers</td>
<td>Case management</td>
</tr>
<tr>
<td>Laboratory</td>
<td>Microbiological investigation</td>
</tr>
</tbody>
</table>

Communication experts!!
Step 2. Form the Rapid Response Team (RRT)

Coordinating activities across agencies can be difficult

- Clear roles and responsibilities
- Teams before an outbreak occurs
- Contact meetings and exercises between crisis
Step 2. Form the Rapid Response Team (RRT)

- Complete investigation planned
  - Epidemiological
  - Microbiological
  - Environmental

- Municipal services
- Norwegian Food Safety Authority
- Norwegian Institute of Public Health

Step 3: Define cases

**Case definition components**
- Time
- Place
- Person

**Case Classification**
- Possible
- Probable
- Confirmed
Step 3: Define cases

“A person **(who?)** living in town XXXX **(where?)**, with diarrhoea (≥ 3 loose stools in 24 hours) and any one of the following symptoms – abdominal pain, nausea and vomiting **(who?)** – and date of onset of symptoms from 1 August 2020 **(when?)** and not travel history **(who?, where?)**.”
Step 4: Identify cases and obtain information

In order to:

- Estimate the size of the outbreak and its distribution
- Determine the population at risk
- Enroll patients
  - hypothesis-generating pilot interviews
  - descriptive and analytical epidemiology
- Identify patients who need treatment
Step 4: Identify cases and obtain information

How?

• Passive case finding → Existing surveillance system.

• Active case finding
  • Additional laboratories not part of national surveillance systems
  • Public and private hospitals or primary healthcare centers
  • People at risk: school children, nursing homes, mass gatherings
  • Invitation lists, reservation lists, guest lists
Step 4: Identify cases and obtain information

Line List

• Basic information on each case
  • ID, age, type of case, sex, phone number, residence, clinical information….

• One line per case

• Spreadsheet

• Updated as the investigation develops

• Facilitates systematization of the information
• Provides an overall picture
Step 4: Identify cases and obtain information

<table>
<thead>
<tr>
<th></th>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>District</th>
<th>Address</th>
<th>Phone</th>
<th>Hospital admission</th>
<th>Interviewed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>M</td>
<td>17</td>
<td>A</td>
<td>Water Street</td>
<td>99999</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>M</td>
<td>27</td>
<td>A</td>
<td>Water Street</td>
<td>88888</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>F</td>
<td>53</td>
<td>A</td>
<td>Water Street</td>
<td>77777</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>F</td>
<td>81</td>
<td>A</td>
<td>Water Street</td>
<td>66666</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>F</td>
<td>23</td>
<td>B</td>
<td>Water Street</td>
<td>55555</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>M</td>
<td>44</td>
<td>B</td>
<td>Lake Street</td>
<td>44444</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>F</td>
<td>38</td>
<td>B</td>
<td>Pound Square</td>
<td>33333</td>
<td>?</td>
<td>N</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Step 4: Identify cases and obtain information

Pilot interviews

- Standardized questionnaire:
  - clinical information, risk factors and demographics
- Comprehensive: all relevant exposures
- Few interviewers
- Sample of cases

- Obvious common exposures?
- Exclude exposures?
Step 4: Identify cases and obtain information

9. What kind of water supply do you have in your household?

<table>
<thead>
<tr>
<th>Water work for at least 20 households</th>
<th>Yes</th>
<th>No</th>
<th>Unsure</th>
<th>Details (if instance name of the water work):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water work for fewer than 20 households</td>
<td>Yes</td>
<td>No</td>
<td>Unsure</td>
<td>Details (if instance name of the water work):</td>
</tr>
<tr>
<td>Private water supply for just your household</td>
<td>Yes</td>
<td>No</td>
<td>Unsure</td>
<td>Details (if instance name of the water work):</td>
</tr>
</tbody>
</table>

11. Did you drink tap water, either at home or elsewhere, during the week before you got ill?

Also include water used to make juice, lemonade, or ice cubes.

At home: Yes [ ] No [ ] Unsure [ ] If yes, how many glasses per day? [1-2]

Elsewhere: Yes [ ] No [ ] Unsure [ ] If yes, how many glasses per day? [1-2]

Where? [ ] What kind of water? [ ]

12. Did you drink water directly from a lake, pond, river or brook? (for instance while hiking, swimming or fishing)

Yes [ ] No [ ] Unsure [ ] If yes, where?

13. Did you drink any water from a well or cistern? (for instance at a holiday cabin or tourist cabin)

Yes [ ] No [ ] Unsure [ ] If yes, where?

14. Did you drink bottled water or water from a container?

Yes [ ] No [ ] Unsure [ ] If yes, what kind of water?

Step 4: Identify cases and obtain information

Questionnaires distribution

- Email
- Web questionnaires
- Telephone interviews
- Paper questionnaires by mail
- Social media
Step 5: Descriptive epidemiological investigation

What do cases have in common? → Generate hypothesis

- **Time**: When were they infected?
- **Place**: Where were they infected? Where do they live?
- **Person**: What are the symptoms and etiology? Who was infected?
Step 3: Define cases
Step 4: Identify cases and obtain information
Step 5: Descriptive epidemiological investigation

- **Outbreak monitoring** → Determine the extend of the outbreak
  - **Case finding**: gastroenteritis consultations
  - **Map** gastroenteritis consultations
  - **Trawling questionnaires** to first campylobacteriosis cases

- **Survey childcare centres** → Ascertain start and distribution of the outbreak and document absence for illness

---

Outbreak monitoring → Determine the extend of the outbreak

- **Case finding:** Gastroenteritis consultations *(who?)* at primary care in Askøy *(where?)* between 3 June and 15 June *(when?)*
- **Map** consultations by household address and water supply
- **Trawling questionnaires** to first campylobacteriosis cases
  - Food consumption
  - Animal contact
  - Environmental exposures
  - Clinical and demographical information

**Step 3: Define cases**  
**Step 4: Identify cases and obtain information**  
**Step 5: Descriptive epidemiological investigation**

Step 3: Define cases
Step 4: Identify cases and obtain information
Step 5: Descriptive epidemiological investigation

Number of gastroenteritis consultations at general practitioner and out-of-hours primary healthcare services

Hyllestad et al. (2020): Large waterborne *Campylobacter* outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway, June 2019. Eurosurveillance, [https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011](https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011)
Outbreak monitoring

• Sharp increase in **gastroenteritis consultations** (from 12 to 182 consultations) on Thursday 6 June

• Consultations evenly distributed among all age groups, although in-person consultations were primarily for children

---

**Step 3: Define cases**

**Step 4: Identify cases and obtain information**

**Step 5: Descriptive epidemiological investigation**

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**Hyllestad et al. (2020):** Large waterborne *Campylobacter* outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway, June 2019. Eurosurveillance, [https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011](https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011)
Step 3: Define cases
Step 4: Identify cases and obtain information
Step 5: Descriptive epidemiological investigation

Water supply zones of water supply system WSS-A defined by different reservoirs Zones 6, 7 and 8 were served by Reservoir X.

Estimated incidence rates for gastroenteritis consultations linked to reservoir supply zones

Outbreak monitoring

Gastroenteritis patients’ residences were coincided with three water supply zones served by Reservoir X.

The three zones with Incidence Rate > 1 are the ones served by Reservoir X.

Outbreak monitoring

• Trawling questionnaires to five campylobacteriosis cases.
  • Diarrhoea, stomach pain and fever (onset 4-5 June)
  • Tap water at home in the week before symptom onset
  • Attendance to events, food items, contact with animals or recreational water not common to all five cases

Survey of childcare centres

• **Case definition**: any person absent from the childcare centre (child or employee) because of diarrhoea or vomiting *(who?, where?)* between 28 May and 7 June *(when?)*

• Comparison of **attack rates** in childcare centres served/not served by Reservoir X

**Step 3: Define cases**
**Step 4: Identify cases and obtain information**
**Step 5: Descriptive epidemiological investigation**

**Hyllestad et al. (2020)**: Large waterborne *Campylobacter* outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway, June 2019. Eurosurveillance, [https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011](https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011)
Survey of childcare centres

• All childcare centres (n=27) in the municipality participated in the study. Eight (769 children and employees) in areas supplied by Reservoir X and 19 (1,761 children and employees) in areas supplied by other reservoirs.
  • Childcare centres in affected areas: Attack rate: 20%
  • Childcare centres in unaffected areas: Attack rate 2%

• Absences started to increase at the childcare centres in affected areas on 3 June (n=26) and peaked on 7 June with 81 absences

Step 6: Additional studies (environmental, laboratory)

→ Environmental investigation
→ Laboratory investigation of the water supply system
Step 6: Additional studies
Environmental investigation

1) Description of the water supply system

- Water source
- Abstraction points and distribution network
- Treatment processes
- Storage tanks
- Distribution network
- Location of potential contamination sources
2) Rapid system assessment → Hazardous events? Control measures in place?

- Interview water-supply system personnel
- Review outcomes of sanitary surveys
- Assess water quality information and weather records
- Operational records and procedures: any problems compromising control measures?
- Customer complaint reports
- Non-piped systems: Review water collection, transport and handling
- Map potential exposures of interest
Step 6: Additional studies

Laboratory investigation of the water-supply system

- Provides strong evidence on the link between the source and cases
- Still possible to demonstrate that water is the source of an outbreak even if the agent is not isolated from the water-supply system
Step 6: Additional studies
Laboratory investigation of the water-supply system

- Increase frequency of sampling
- Increase the number of sampling sites
  - Suspected sources of pollution
  - Critical points in the treatment plant
  - Water and sediment from storage reservoirs and the distribution system
  - Stored water
Step 6: Additional studies
Laboratory investigation of the water-supply system

Microorganisms may not be detected in the water-supply system due to:

- Time between the contamination event, exposure and sampling.
- Transient contamination
- Disinfection of the system as a preliminary measure
- Special sampling needed to isolate enteric viruses or protozoa
Environmental investigation – Description of the water supply network

Under normal conditions, Reservoir X supplies Zone 6 (1,350 residents)

Before the outbreak, a valve opened from Reservoir X to ensure replacement of water in response to customer complaints about the water quality.

This led to a connection between zone 6 and zones 7 and 8 (3,558 residents) with drinking water from both Reservoir X and others.

Consultations indicated a higher IR in these zones.

The valve was closed on 6 June.

Environmental investigation – Visual inspection of Reservoir X

- Basin constructed as an unlined rock cavern. Its entrance sealed by a locked door
- 400 m³ of water, located above a residential area in mountainous terrain
- Natural cracks located in the back of the reservoir, leaks in the concrete construction and water running from inside the roof.
- Large antenna with power lines above the reservoir, were birds could gather
  - Risk of bird faeces contaminating the area below
- No animals observed
- No unusual malfunctions reported before the outbreak

**Step 6: Additional studies (environmental, laboratory)**

*Hyllestad et al. (2020):* Large waterborne *Campylobacter* outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway, June 2019. Eurosurveillance, https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011
Environmental investigation – Weather records.

Weather data from a nearby weather station indicated heavy rainfall. This coincided with registered consultations of gastroenteritis in the Norwegian Syndromic Surveillance System.

Analysis of water in WSS-A or in Reservoir X.

- Routine samples prior to the outbreak did not detect any faecal indicator bacteria after the outbreak, extra sampling in WSS-A was conducted.
- Routine samples for WSS-A on 3 June were also negative.
- On 6 June, samples collected from Reservoir X and areas supplied by Reservoir X were contaminated.
- Several samples positive for Campylobacter (7 June).

Step 7: Generate hypotheses

**Descripive epidemiology**
- Age
- Sex
- Residence
- Work place
- Routines

**Microbiology**
- Incubation period
- Mode of transmission
- Previous outbreaks

**Environment**
- Risk assessments
- Inspections
Step 8:
Evaluate the hypotheses
Analytical studies
Assessing the strength of evidence

• **Analytical studies** may generate stronger evidence to support the hypothesis and to quantify the strength of the association.

• Compare exposure between cases and non-cases and identify risk factors.

Cohort studies
Case-control studies
Step 8: Analytical studies - Considerations

Challenges when collecting water usage exposure:

• Time elapsed between the exposure and the investigation
• Respondents may have changed water use as part of control measures
• Exposure to different water sources: home, workplace, sport center...
• Household members may be exposed to different water sources.
Step 8: Analytical studies - Considerations

Everyone is exposed to the same water source?

Measure Dose response
Risk increases with increasing amounts of water
## Step 8: Evaluate the hypotheses
Assessing the strength of evidence

| A. Pathogen identified in clinical cases also found in water | B. Water quality failure and/or water-treatment problem of relevance, but outbreak pathogen is not detected in water |
| C. Evidence from an analytical (case-control or cohort) study demonstrates an association between water and illness | D. Descriptive epidemiology suggests that the outbreak is water-related and excludes obvious alternative explanations |

*Strongly associated if (A+C) or (A+D) or (B+C); probably associated if (B+D) or C only or A only; possibly associated if B only or D only.*

*Source: Tillet et al*
Cohort study of households

All residents who received water from WSS-A were included

Exposed: people in households receiving water from Reservoir X

Case definition: person with gastroenteritis with symptom onset between 01 and 19 June 2019

Step 8: Evaluate the hypotheses
Analytical studies
Assessing the strength of evidence

Step 8: Evaluate the hypotheses
Analytical studies
Assessing the strength of evidence

Cohort study of households

SMS with link to a questionnaire sent to all households served by WSSA
One person should respond on behalf of all household members.
The questionnaire included items on illness and tap water consumption

Step 8: Evaluate the hypotheses
Analytical studies
Assessing the strength of evidence

Cohort study of households

- Information available from 2,526 persons who responded on behalf of 6,108 household members
- Coverage of 51% (6,108/11,995) of the residents supplied by WSSA

Step 8: Evaluate the hypotheses
Analytical studies
Assessing the strength of evidence

Cohort study of households

- Mean age: 34 years (0-93)
- 50% were female
- 1,573 respondents met the case definition
- Attack rate: 26%.
- Number of cases peaked on 6 June and decreased gradually thereafter

**Hyllestad et al. (2020):** Large waterborne *Campylobacter* outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway, June 2019. Eurosurveillance, https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011
Step 8: Evaluate the hypotheses
Analytical studies
Assessing the strength of evidence

Cohort study of households
Attack rates and risk ratio for areas supplied by Reservoir X and other areas

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Households</th>
<th>Individuals</th>
<th>Cases</th>
<th>Attack rate</th>
<th>Risk ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other reservoirs in WSS-A (zones 1–5)</td>
<td>1,653</td>
<td>4,098</td>
<td>481</td>
<td>12%</td>
<td>Reference</td>
</tr>
<tr>
<td>Reservoir X (zones 6–8)</td>
<td>873</td>
<td>2,010</td>
<td>1,092</td>
<td>54%</td>
<td>4.6 (4.2–5.0)</td>
</tr>
</tbody>
</table>

**Country example**

Hyllestad et al. (2020): Large waterborne *Campylobacter* outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway, June 2019. Eurosurveillance,
https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011
Step 8: Evaluate the hypotheses
Analytical studies
Assessing the strength of evidence

Cohort study of households
Risk of gastrointestinal illness by consumption of tap water

<table>
<thead>
<tr>
<th>Daily tap water consumption</th>
<th>Individuals</th>
<th>Cases</th>
<th>Attack rate</th>
<th>Risk ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 glasses</td>
<td>381</td>
<td>27</td>
<td>7%</td>
<td>Reference</td>
</tr>
<tr>
<td>1–3 glasses</td>
<td>2,562</td>
<td>586</td>
<td>23%</td>
<td>3.2 (2.2–4.7)</td>
</tr>
<tr>
<td>4–6 glasses</td>
<td>2,255</td>
<td>654</td>
<td>29%</td>
<td>4.1 (2.8–5.9)</td>
</tr>
<tr>
<td>≥7 glasses</td>
<td>910</td>
<td>306</td>
<td>34%</td>
<td>4.7 (3.3–6.9)</td>
</tr>
</tbody>
</table>

Step 9:
Implement control measures

• Implemented immediately
  • Boil water advisory

• Evaluated and adjusted continuously throughout the outbreak

• Control measures should also target the underlying causes of the outbreak
  • Insufficient policy or tools?
  • Inadequate training of waterworks personnel?
  • Inadequate maintenance of the water distribution system?

• The outbreak may prompt policy changes
Step 9: Implement control measures

Immediate precautionary control measures

- Boil water advice issued
- Reservoir X taken out of service
- Emergency water supply distribution from water tanks located in public areas
- Infection control measures in public services were strengthened

Important considerations

- The triangulation of epidemiological, genomic, geographical and water systems data was essential for confirming the role of Reservoir X.
- Rationale for the early decisions was based on local knowledge and mapping of cases rather than epidemiological studies.
- The use of mixed methods allowed to identify contributing factors, such as inclement weather conditions.

_Hyllestad et al. (2020):_ Large waterborne _Campylobacter_ outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway, June 2019. Eurosurveillance, [https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011](https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011)
Important considerations

- Water contamination through cracks in a mountain reservoir, because of heavy rainfall
- Water supply systems, in particular ageing infrastructure, are generally vulnerable to contamination especially as external risks such as climate factors are changing.
- Importance of conducting water safety planning, updating the infrastructure and performing risk-based surveillance to mitigate risks.

Step 10
Communicate findings, make recommendations and evaluate the outbreak response

• Communication should begin early
  • What is already known?
  • What is being done?

• Control measures should be communicated continuously to relevant stakeholders

• The public should receive regular updates

• Detailed outbreak report
After-action review:

• Outbreak detection and alert
• Suitability and speed of implementation of control measures
• Outbreak reporting and communication
• What worked well
• What could be improved
This module is based on the document: Surveillance and outbreak management of water-related infectious diseases associated with water-supply system. Copenhagen: WHO Regional Office for Europe; 2019. Licence: CC BY-NC-SA 3.0 IGO.


Additional references are:

- Additional references were materials used in pilot national training workshops on water-related disease surveillance previously run by the World Health Organization Regional Office for Europe under the framework of the Protocol of Water and Health and training materials from the the European Programme for Intervention Epidemiology Training (EPIET)
Acknowledgement

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Epidemiological studies

Module 2.2
## Steps in outbreak management

1. Detect and confirm the outbreak and agent
2. Rapid Response Team (RRT)
3. Define cases
4. Identify cases and obtain information
5. **Descriptive epidemiological investigation (time, place, person)**
6. Additional studies (environmental, risk assessments, laboratory)
7. Interview cases and generate hypotheses
8. **Evaluate the hypotheses**
9. Inform risk managers and implement control measures
10. Communicate findings, make recommendations and evaluate the outbreak response
Epidemiological studies

- Descriptive
- Ecological
- Analytical
  - Cohort studies
  - Case-control studies
Descriptive analysis

They answer the question "What’s going on?"

<table>
<thead>
<tr>
<th>Person</th>
<th>Place</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Who?</td>
<td>• Where?</td>
<td>• When?</td>
</tr>
</tbody>
</table>
Descriptive analysis

- Generate hypotheses on the possible source, etiology and modes of transmission
- Identify the population at risk
- Estimate when the initial exposure to the causative pathogen occurred
- Identify opportunities for control
Descriptive analysis

• Results visualized in tables and maps or curves
• Not possible to identify causality or risk factors
Time- when?

The epidemic curve indicates

1) Type of source: point source, continuous, intermittent

2) Mode of transmission
Reported campylobacteriosis in Hawke’s Bay from July to September 2016 graphed according to onset of symptoms.

Confirmed, probable and unlinked reported campylobacteriosis cases

**Gilpin et al. (2020):** A large scale waterborne Campylobacteriosis outbreak. Havelock North, New Zealand. Journal of Infection. [https://doi.org/10.1016/j.jinf.2020.06.065](https://doi.org/10.1016/j.jinf.2020.06.065)
Cases of gastroenteritis in a sample of Røros (Grey) and Holtalen (Plum) household members by date of illness onset (n = 105), from April 30 to May 14, 2007 and the timeline of events, which may be relevant to the water contamination.

Jakopanec et al. (2008): A large waterborne outbreak of campylobacteriosis in Norway: The need to focus on distribution system safety. BMC Infectious Disease, https://doi.org/10.1186/1471-2334-8-128
Place- where?

• Cases mapped to assess the geographical extent of the outbreak
• Visualize and explore the spatial distribution of cases
• A cluster of cases might suggest exposure to a particular source
• Attack rates by exposure to particular water sources and by place
• Visualize and explore the spatial distribution of cases
Geographic distribution of outbreak cases, and unlinked infections with onset of illness of 7–24 August 2016. Also shown is the Havelock North contaminated reticulation area (red box), and locations of the reticulated network sampling points, bores and sheep paddocks.

Place- where?

Person- who?

• Age
• Sex
• Number of cases
• Attack rate
• Symptoms

• Hospital admission
• Deaths
• Case fatality rate
• Other?: Occupation....
Demographic characteristics and clinical outcomes of confirmed and probable campylobacteriosis cases.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Cases</th>
<th>Rates per 100,000 with 95% confidence intervals</th>
<th>p-value by group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>497</td>
<td>595.2 (544.1, 649.7)</td>
<td>0.795</td>
</tr>
<tr>
<td>Male</td>
<td>456</td>
<td>584.7 (532.4, 640.8)</td>
<td></td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>61</td>
<td>553.3 (423.5, 710.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>5–19</td>
<td>184</td>
<td>532.4 (458.4, 614.9)</td>
<td></td>
</tr>
<tr>
<td>20–59</td>
<td>326</td>
<td>425.5 (380.6, 474.1)</td>
<td></td>
</tr>
<tr>
<td>≥60</td>
<td>382</td>
<td>972.4 (877.7, 1074.4)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>100</td>
<td>296.4 (241.2, 360.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pacific</td>
<td>17</td>
<td>284.0 (165.6, 454.4)</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>29</td>
<td>580.2 (388.9, 832.3)</td>
<td></td>
</tr>
<tr>
<td>European</td>
<td>802</td>
<td>716.8 (668.2, 768.0)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>146.1 (47.5, 340.6)</td>
<td></td>
</tr>
<tr>
<td>Age group amongst hospitalized</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>1</td>
<td>9.1 (0.2, 50.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>5–19</td>
<td>1</td>
<td>2.9 (0.1, 16.1)</td>
<td></td>
</tr>
<tr>
<td>20–59</td>
<td>7</td>
<td>9.1 (3.7, 18.8)</td>
<td></td>
</tr>
<tr>
<td>≥60</td>
<td>31</td>
<td>78.9 (53.6, 112.0)</td>
<td></td>
</tr>
<tr>
<td>Serious outcomes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deceased</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guillain–Barré syndrome</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Rate in European ethnicity and hospitalized ≥60 years is significantly higher than other sub populations.

**Gilpin et al. (2020):** A large scale waterborne Campylobacteriosis outbreak, Havelock North, New Zealand. Journal of Infection, [https://doi.org/10.1016/j.jinf.2020.06.065](https://doi.org/10.1016/j.jinf.2020.06.065)
Person - who?

Male  Female
>91
81-90
71-80
61-70
51-60
41-50
31-40
21-30
11-20
0-10

Male  Female
The W's of descriptive epidemiology:

- **What** → health issue of concern
- **Who** → person
- **Where** → place
- **When** → time

Descriptive analysis, in conclusion
Descriptive analysis, in conclusion

• **Analyse by person:**
  • calculate attack rates by exposure to particular water sources

• **Analyse by place:**
  • calculate attack rates by place
  • map cases distribution to assess the geographical extent of the outbreak
  • Undertake spatial analyses to visualize the spatial distribution of cases in relation to suspect sources.

• **Analyse by time:**
  • if the causative agent is known, use the epidemic curve to estimate the likely time period of exposure
  • Assess if the epidemic curve correlates with events in the water-supply system and implementation of control measures
Water supply zones of water supply system WSS-A defined by different reservoirs Zones 6, 7 and 8 were served by Reservoir X.


Estimated incidence rates for gastroenteritis consultations linked to reservoir supply zones.
### Watersupply Outbreak Table

<table>
<thead>
<tr>
<th>Watersupply</th>
<th>Cases</th>
<th>Number of recipients</th>
<th>Attack-rate (per 10,000)</th>
<th>Risk ratio</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>637</td>
<td>42,774</td>
<td>148.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>9,685</td>
<td>15.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>89</td>
<td>105,440</td>
<td>8.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>33</td>
<td>34,406</td>
<td>9.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>14,266</td>
<td>2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>13</td>
<td>23,848</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B+C+D+E+F</td>
<td>158</td>
<td>194,519</td>
<td>8.1</td>
<td>Ref.</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>637</td>
<td>42,774</td>
<td>148.9</td>
<td>18.3</td>
<td>15.4 – 21.8</td>
</tr>
</tbody>
</table>

John Snow and Cholera outbreak in London

Source: Field epidemiology manual wiki

Source: CDC
Ecological studies

- Quite useful for outbreaks associated with public water supplies
- They relate to population level, not individual level
- Rates of disease and their association with exposures are compared among defined populations.
Analytical studies

“Are there any differences between what sick and not sick people did?”

• They help to identify exposures associated with disease
• Generate evidence to support the hypothesis under investigation
• Estimate the strength of the association between an exposure and an outcome.
• In outbreak investigations: retrospective cohort studies, case-control studies
Analytical studies

(retrospective) cohort studies

case-control studies
Analytical studies - Cohort studies

• Comparison of risk of disease over a defined time period among those exposed to factor X, versus those not exposed
  • Two cohorts: exposed and not exposed

• If those exposed have a higher rate of disease, this provides evidence that the factor is the cause of the disease.

• This assumes that both groups are the same, except in terms of their exposure to the factor.
Analytical studies - Cohort studies

Cohort

Exposed

Disease
No Disease

Not exposed

Disease
No Disease
Analytical studies - **Retrospective** Cohort studies

- **Cohort**
  - Exposed
    - Disease
    - No Disease
  - Not exposed
    - Disease
    - No Disease

**Study starts here**

**Time**
Analytical studies- Cohort studies

<table>
<thead>
<tr>
<th></th>
<th>Disease</th>
<th>No disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>a+b</td>
<td></td>
</tr>
<tr>
<td>Not Exposed</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td></td>
<td>c+d</td>
<td></td>
</tr>
</tbody>
</table>

- Attack rate (incidence) in exposed: $\frac{a}{a+b}$
- Attack rate (incidence) in not exposed: $\frac{c}{c+d}$

$\rightarrow$ Relative Risk (RR): Incidence in exposed/incidence in not exposed
Relative Risk - Interpretation

- $\text{RR} = 1$; no association
- $\text{RR} > 1$; the exposure is a **risk** factor
- $\text{RR} < 1$; the exposure is a “protective” factor
Cohort study - example

**Boccia et al. (2002):** Waterborne Outbreak of Norwalk-Like Virus Gastroenteritis at a Tourist Resort, Italy. Emerging Infectious Diseases, https://wwwnc.cdc.gov/eid/article/8/6/01-0371_article
Cohort study - example

Outbreak context

• July 2000, outbreak of gastroenteritis at a tourist resort in southern Italy.
• Illness in 344 people, 69 staff members
• Norwalk-like virus was found in stool specimens
• The source was likely contaminated drinking water
  • Breakdown in the water system
  • Tap water samples with fecal bacteria

Boccia et al. (2002): Waterborne Outbreak of Norwalk-Like Virus Gastroenteritis at a Tourist Resort, Italy. Emerging Infectious Diseases, https://wwwnc.cdc.gov/eid/article/8/6/01-0371_article
Cohort study- example

Epidemiological investigation

Case definition: Guest/employee at the resort during July 1–31 and who had diarrhea (≥3 loose stools in 24-hour period) or vomiting (at least 1 episode) or both, in the same period.

Retrospective Cohort study: Because of the high number of cases in staff members, performed to assess risk factors in this group.

• Inclusion criteria: staff members employed from July 1 to 31.
• Questionnaires sent to all 224 staff members in the first week of August.
• A month had elapsed between onset of symptoms and distribution of the questionnaires.

Boccia et al. (2002): Waterborne Outbreak of Norwalk-Like Virus Gastroenteritis at a Tourist Resort, Italy. Emerging Infectious Diseases, https://wwwnc.cdc.gov/eid/article/8/6/01-0371_article
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- Inclusion criteria: staff members employed from July 1 to 31.
- Questionnaires sent to all 224 staff members in the first week of August.
- A month had elapsed between onset of symptoms and distribution of the questionnaires.

- 181 questionnaires from 224 staff members were analyzed.
- Attack rate = 38.1% (69/181)

*Boccia et al. (2002):* Waterborne Outbreak of Norwalk-Like Virus Gastroenteritis at a Tourist Resort, Italy. Emerging Infectious Diseases, [https://wwwnc.cdc.gov/eid/article/8/6/01-0371_article](https://wwwnc.cdc.gov/eid/article/8/6/01-0371_article)
Cohort study - example

<table>
<thead>
<tr>
<th>Exposure</th>
<th>No. (n=69)</th>
<th>No. exposed</th>
<th>Attack rate (%)</th>
<th>Relative risk</th>
<th>95% CI a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shower on the beach</td>
<td>22</td>
<td>14</td>
<td>63.6</td>
<td>1.8</td>
<td>1.2-2.6</td>
</tr>
<tr>
<td>Swimming in the pool</td>
<td>45</td>
<td>22</td>
<td>48.9</td>
<td>1.4</td>
<td>0.9-2.0</td>
</tr>
<tr>
<td>Drinking tap water</td>
<td>104</td>
<td>47</td>
<td>45.2</td>
<td>1.4</td>
<td>0.9-2.2</td>
</tr>
<tr>
<td>Drinks with ice</td>
<td>128</td>
<td>55</td>
<td>43.0</td>
<td>1.8</td>
<td>1.0-3.2</td>
</tr>
<tr>
<td>Swimming in the sea</td>
<td>72</td>
<td>31</td>
<td>43.0</td>
<td>1.2</td>
<td>0.8-1.7</td>
</tr>
<tr>
<td>Eating at resort restaurant</td>
<td>159</td>
<td>64</td>
<td>40.2</td>
<td>1.5</td>
<td>0.5-3.9</td>
</tr>
<tr>
<td>Eating ice cream</td>
<td>140</td>
<td>56</td>
<td>40.0</td>
<td>1.1</td>
<td>0.6-1.9</td>
</tr>
<tr>
<td>Eating meat</td>
<td>151</td>
<td>60</td>
<td>39.7</td>
<td>1.2</td>
<td>0.6-2.4</td>
</tr>
<tr>
<td>Eating salad</td>
<td>123</td>
<td>48</td>
<td>39.0</td>
<td>1.0</td>
<td>0.6-1.6</td>
</tr>
<tr>
<td>Eating fruit</td>
<td>139</td>
<td>54</td>
<td>38.8</td>
<td>1.0</td>
<td>0.6-1.8</td>
</tr>
<tr>
<td>Eating pasta</td>
<td>142</td>
<td>55</td>
<td>38.7</td>
<td>1.2</td>
<td>0.6-2.1</td>
</tr>
<tr>
<td>Consuming drinks on draught</td>
<td>91</td>
<td>35</td>
<td>38.5</td>
<td>1.0</td>
<td>0.7-1.4</td>
</tr>
<tr>
<td>Eating fish</td>
<td>112</td>
<td>40</td>
<td>35.7</td>
<td>0.7</td>
<td>0.5-1.1</td>
</tr>
<tr>
<td>Eating seafood</td>
<td>85</td>
<td>28</td>
<td>32.9</td>
<td>0.7</td>
<td>0.5-1.1</td>
</tr>
</tbody>
</table>

*CI, confidence interval.

**Boccia et al. (2002):** Waterborne Outbreak of Norwalk-Like Virus Gastroenteritis at a Tourist Resort, Italy. Emerging Infectious Diseases, [https://wwwnc.cdc.gov/eid/article/8/6/01-0371_article](https://wwwnc.cdc.gov/eid/article/8/6/01-0371_article)
Analytical studies

(retrospective) cohort studies

case-control studies
Analytical studies - Case-control studies

• Most frequent analytical approach in waterborne outbreaks
• Cases are compared to individuals unaffected by the disease in question to find out whether there is a difference in their exposures
• These unaffected individuals are called “controls”
Analytical studies - Case-control studies

• Who are right controls? That is crucial for success
• Controls must represent the population at risk of disease and must not have the disease under investigation at the time of their recruitment.
• Prevent and address the confounding and selection bias in sampling controls
• Controls represent the background level of exposure in the population.
• If the level of exposure is greater among cases than controls, this provides evidence that the exposure is associated with disease.
135 cases of *Cryptosporidium hominis*

- **Where?** City XX (population 350,000)
- **When?** Second week September 2020-first week October 2020
- **Who?** 47% Women; mean age 37 years old. Range: 19-91
Example of control selection

135 cases of *Cryptosporidium* hominis:

- **Where?** City XX (population 350,000)
- **When?** Second week September 2020 - first week October 2020
- **Who?** 47% Women; mean age 37 years old. Range: 19-91

Who are the right controls for a case-control study?
Example of control selection

135 cases of *Cryptosporidium* hominis:

- **Where?** City XX (population 350,000)
- **When?** Second week September 2020 – first week October 2020
- **Who?** 47% Women; mean age 37 years old. Range: 19-91

Who are the right controls for a case-control study?

They have to be representative of the population where cases belong.
Example of control selection

135 cases of *Cryptosporidium hominis*

- **Where?** City XX (population 350,000)
- **When?** Second week of September–first week of October 2020
- **Who?** 47% Women; mean age 37 years old. Range: 19-91

Source population:

People living at City XX > 19 years
Not travelled outside the city in the relevant period
How to select controls

• Random sample for population registry or list
  • Complete
  • Accessible
  • Feasible to stratify (sex, age, district....)
How to select controls

- Telephone / mobile register
- Challenges:
  - Who has a mobile?
  - Who will answer?
How to select controls

• Friends, family, neighbours
  • Can be efficient
  • Similar to cases
  • Low cooperation
How to select controls- Challenges

• Disease with high rate of asymptomatic
• Immune people
• 100% exposure
How to select controls

• Never perfect
• Balance strengths and weaknesses
• Balance urgency, resources
• Defend your choices
• Take into account how limitations may affect results
Analytical studies- Case-control studies
Calculation of OR

- The odds ratio (OR) is the ratio between the probability that someone with disease has experience of the potential factor and the probability that someone without the disease has experience of the same factor.
- Relative risk (RR) is used in cohort study and odds ratio (OR) is used in a case-control study.
Odds ratio- Interpretation

• An OR = 1; no association

• An OR > 1; the study factor is a risk factor

• An OR < 1; the study factor is a “protective” factor
Case-Control study example

Outbreak context

• October 2004: Municipal medical officer in Bergen (Norway) alerted by the university hospital to an increase of patients with giardiasis
• During two weeks: 27 cases with unknown or no travel history
• Mainly young adults from the central part of the city
• 1–2 domestic cases of giardiasis are normally reported annually in Bergen

The epidemiological investigation included:

• **Active case-finding, descriptive and ecological analysis**
  - Cases identified through the laboratory conducting giardia diagnostics in the area.
  - All laboratory-confirmed cases mapped based on address of residence
  - Attack rates and relative risks were calculated for each water supply zone.

• **Case control study**
  - Among people living in the central area of Bergen
  - Age- and sex matched controls randomly selected from the population register.

**Nygård et al. (2006):** A large community outbreak of waterborne giardiasis- delayed detection in a non-endemic urban area. BMC Public Health, https://doi.org/10.1186/1471-2458-6-141
Case-Control study example

Selection of controls and information collection

- Potential controls contacted by telephone (two controls per case)
- Cases and controls were asked about exposures two weeks before symptom onset for the case.
- Cases and controls that had travelled to a highly endemic country for giardiasis were excluded.
- Information was collected by telephone interviews
  - Structured questionnaire: food and drinks consumed different activities, clinical illness, use of health services
- Additional analysis to assess risk associated with quantity of water consumed
  - Group matched analysis including interviewed cases for whom we did not interview individually matched controls.
  - Group matching was based on gender and 10-year age groups.

Case-Control study example

Matched univariate conditional logistic regression analysis of selected dichotomous risk factors among cases of giardiasis and matched controls, water-supply zone A, Bergen municipality 1/9 – 15/11 2004.

Case-Control study example

**Case-control study** - Risk of giardiasis associated with quantity of water consumed among residents in water supply zone A, Bergen municipality 1/9 – 15/11 2004. Group matched analysis by sex and 10-year age groups (83 cases, 54 controls).

<table>
<thead>
<tr>
<th>Water intake</th>
<th>Cases</th>
<th>%</th>
<th>Controls</th>
<th>%</th>
<th>OR*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 glass</td>
<td>1</td>
<td>1 %</td>
<td>4</td>
<td>7 %</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>1 – 2 glasses</td>
<td>8</td>
<td>10 %</td>
<td>11</td>
<td>20 %</td>
<td>3.2</td>
<td>0.2 – 69.5</td>
</tr>
<tr>
<td>3 – 5 glasses</td>
<td>23</td>
<td>28 %</td>
<td>27</td>
<td>50 %</td>
<td>4.8</td>
<td>0.4 – 64.7</td>
</tr>
<tr>
<td>more than 5 glasses</td>
<td>51</td>
<td>61 %</td>
<td>12</td>
<td>22 %</td>
<td>7.4</td>
<td>1.2 – 44.5</td>
</tr>
</tbody>
</table>

* chi-square test for linear trend: 19.7; p < 0.001.

**Nygård et al. (2006):** A large community outbreak of waterborne giardiasis- delayed detection in a non-endemic urban area. BMC Public Health, https://doi.org/10.1186/1471-2458-6-141
In summary....

Descriptive epidemiology
What is happening?

Ecological epidemiology
Explore associations

Analytical epidemiology
Test hypothesis
Analytical studies

- Small defined populations
  - Meetings, courses, restaurants, parties, weddings
  - Retrospective cohort study
  - Relative risk

- Large open populations
  - Cities, countries
  - Case control study
  - Odds ratio
This module is based on the document: *Surveillance and outbreak management of water-related infectious diseases associated with water-supply system*. Copenhagen: WHO Regional Office for Europe; 2019. Licence: CC BY-NC-SA 3.0 IGO.

Additional used references are


- Additional references were materials used in pilot national training workshops on water-related disease surveillance previously run by the World Health Organization Regional Office for Europe under the framework of the Protocol of Water and Health and training materials from the the European Programme for Intervention Epidemiology Training (EPIET)

- References used for the country examples are embedded in the presentation
Risk communication

Module 2.3
10 step approach

1. Detect and confirm the outbreak and agent
2. Rapid Response Team (RRT)
3. Define cases
4. Identify cases and obtain information
5. Descriptive epidemiological investigation (time, place, person)
6. Additional studies (environmental, risk assessments, laboratory)
7. Interview cases and generate hypotheses
8. Evaluate the hypotheses
9. Inform risk managers and implement control measures
10. Communicate findings, make recommendations and evaluate the outbreak response
Key points

• Crucial component of risk management
• Should be guided by risk communication planning
• Used to guide public participation to support outbreak’s control
• Communication opportunities exist throughout the investigation → skilled communication is critical
Risk communication under the Protocol and IHR

• Article 8 of the **Protocol of Water and Health** stipulates that Parties give prompt and clear notification about outbreaks, incidents or threats in the event of any imminent threat to public health from water-related disease.

> Parties shall “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”.

• Core requirement for countries within the framework of the **International Health Regulations (IHR)**.
Effective risk communication and planning can mitigate complications during outbreaks

• Outbreaks are unpredictable and alarming to the public and attract media attention
• Public health authorities communicate through the media
• Official information has to be rapid to meet the increasingly rapid media cycle, mitigating rumors
• Communication failures can impede outbreak control measures, undermine public trust and engagement and prolong social, economic and political turmoil
Key elements of risk communication

• Trust
• Announce early
• Transparency
• Understand the public
• Integration in contingency planning
Key elements- Trust

- Communicate in ways that build, maintain or restore trust
- Acknowledge uncertainty
- Trust is hard to win and easy to lose
- No trust $\rightarrow$ fear and lack of compliance
- Build trust between those leading on communication
- Trust public's ability to tolerate incomplete or alarming information
- Ensure accountability and transparency
- Listen to and be aware of public concerns
Key elements- Announce early

It helps to build public trust and prevent rumors and misinformation spreading

• Those responsible for risk communication should:
  • avoid withholding information to “protect” the public
  • acknowledge that the announcement is based on preliminary information, so the situation may change as further information emerges
  • ensure clear communication channels between key stakeholders so they are aware in advance of the announcement
  • The way the initial announcement is done may impact on the reception to all subsequent communication
Key elements - Transparency

It leads to greater trust

• Communication should be frank, easily understood, complete and accurate

• Those responsible for risk communication should:
  • keep the public informed about the activities of the investigation, including the information-gathering, risk assessment and decision-making process of outbreak management
  • focus on what is being done and the next steps
  • explain the unknowns
  • be aware that pride, embarrassment, fear of revealing weaknesses and fear of being blamed can lead to a lack of trust
Key elements - Understand the public

• Knowing who the public is, and what they think, is essential in developing effective public health messages

• Those responsible for risk communication should:
  • understand the public’s beliefs, opinions and knowledge about specific risks
  • involve representatives of the public in the decision-making process
  • respect the public’s concern, regardless of its validity
  • address the concern in any policies developed
  • publicly acknowledge and correct mistaken concerns
  • include information in risk-communication messages on how the public can protect themselves
Key elements- Integration in contingency planning

- Risk communication should be integrated into contingency planning for major events and outbreak response.

- Those responsible for risk communication should:
  - develop the risk-communication plan as part of the outbreak-management plan from the start of the outbreak
  - ensure media training for relevant members of the response team
  - develop partnerships with the media
  - organize press conferences to answer multiple media enquiries in an organized way
  - prepare pre-approved public health messages that can be adapted for the outbreak
Preparing public Health messages

Important to provide clear information and advice to the public during the outbreak

Best done through prepared communication messages with clear public health advice

Who is the target audience for the message?
What is their relationship to the event?
What is their level of education and the nature of their interest in the event?
Example messaging: “boil water advisory”

- Explain current risk: e.g. potential microbial contamination in specific area
- Stipulate under what circumstances: e.g. water for drinking and food preparation
- Describe action to be taken: e.g. bring the water to a rolling boil and allow to cool naturally
Preparing public health messages

The target audience can absorb only a limited amount of information, so the **single overarching communication outcome** and the key message that needs to be understood by the audience should be determined:

- simple, accurate, credible, relevant, consistent and timely
- should not contain technical language
- should describe clearly what needs to be done, by whom, when it needs to be done, how it needs to be done and for how long
- should be capable of being understood by, and be accessible to, different groups
Communication channels

• Institutional website

• Social media
  • important tool for directly and immediately communicating with the public.
  • enables those who use it to become involved in the response to the outbreak through commentary
  • useful for monitoring response and public concerns including community resistance, and can be used to monitor and counter rumors about the outbreak.

• Traditional media
  • Television, radio, printed press
  • Press releases

• Partners and stakeholders (internal & external)
References

- *This module is based on the document: Surveillance and outbreak management of water-related infectious diseases associated with water-supply system*. Copenhagen: WHO Regional Office for Europe; 2019. Licence: CC BY-NC-SA 3.0 IGO.

- Additional references were materials used in pilot national training workshops on water-related disease surveillance previously run by the World Health Organization Regional Office for Europe under the framework of the Protocol of Water and Health.
Case study on waterborne outbreak of Cryptosporidiosis
Scope and objectives

• Purpose: Work through the steps of outbreak management
• Fictional event
• Participants will respond to questions focused on the investigation of a waterborne outbreak as if they were part of the outbreak team
• In some questions, participants will be asked to elaborate an answer as if the outbreak was occurring in their country of origin.
Materials and exercise structure

• Case study participant handbook
• Template PowerPoint slide for presentation of results
• The exercise consists of group work and plenary debrief
Group work

• 240 minutes (4 hours) divided in two parts
  – Part 1: 150 minutes (2.5 hours): Steps I-V
  – Part 2: 90 minutes (1.5 hours): Steps VI-X

• Participants divided in groups (5-6 persons)

• At least two computers per group

• All groups will work through and discuss the entire scenario

• Each group will be responsible for presenting one specific question during the plenary debrief
Group work

• Each group should appoint:
  – A moderator-time keeper
  – A note taker-spokesman

• The workshop facilitator will be available to solve doubts during the entire session
Debrief in plenary

• 60 minutes
• Each group’s spokesman will briefly present (no more than 5 minutes each) and discuss the solution to their question.
• Free format for the presentation
## Exercise structure

<table>
<thead>
<tr>
<th>GROUP WORK TOPIC</th>
<th>Question for discussion</th>
<th>Allocated time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PART ONE</strong></td>
<td></td>
<td>240 minutes</td>
</tr>
<tr>
<td>Step I. Outbreak alert and detection. First hypotheses</td>
<td>Question 1</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 2</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step II: The outbreak team. Member roles, responsibilities and first actions</td>
<td>Question 3</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Step III. Define cases</td>
<td>Question 4</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Step IV. Identify cases and obtain information. Microbiological information</td>
<td>Question 5</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step V. Conduct a descriptive epidemiological investigation (time, place, person)</td>
<td>Question 6</td>
<td>25 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 7</td>
<td>25 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 8</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 9</td>
<td>10 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 10</td>
<td>25 minutes</td>
</tr>
<tr>
<td><strong>PART TWO</strong></td>
<td></td>
<td>90 minutes</td>
</tr>
<tr>
<td>Step VI. Conduct additional studies and collect additional information (environmental, laboratory)</td>
<td>Question 11</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step VII. Generate hypotheses</td>
<td>Question 12</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step VIII. Evaluate hypotheses</td>
<td>Question 13</td>
<td>10 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 14</td>
<td>10 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 15</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Step IX. Implement control measures and risk communication</td>
<td>Question 16</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Step X. Communication and evaluation of the outbreak response</td>
<td>Question 17</td>
<td>30 minutes</td>
</tr>
<tr>
<td><strong>PLENARY DISCUSSION</strong></td>
<td></td>
<td>60 minutes</td>
</tr>
</tbody>
</table>
CASE STUDY
PART ONE. STEPS I-V
QUESTION 1

Would this chain of events be likely to happen at the municipality/district level of your country? What would be similar? What would be different?

Please, discuss with your group.

(10 minutes)
I. Outbreak alert and detection. First hypotheses

**QUESTION 2**

Any hypothesis so far about what is going on?

Please, discuss with your group.

(5 minutes)
II. The outbreak team.
Members, roles, responsibilities and first actions

QUESTION 3

Who has a role in the response to this outbreak?

Please, discuss with your group.

(15 minutes)
III. Define cases

**QUESTION 4**

Why is it important to define cases? What information should be included in a case definition? Any strengths and weaknesses for this case definition?

Please, discuss with your group.

(10 minutes)
IV Identify cases and obtain information. Microbiological confirmation

QUESTION 5

What do you think of the adjustments done in the case definition at this point?

Please, discuss with your group.

(10 minutes)
V. Conduct a descriptive epidemiological investigation (time, place, person)
For questions 6,7,8 you will use Epi Info...

What is Epi Info?

For the next questions you will use Epi info!
Epi Info Tools are in the public domain and free to download and use.

Epi Info™ Downloads

Epi Info™ is a public domain software package designed for the global public health community of practitioners and researchers. It provides for easy questionnaire and database construction, data entry and analysis with epidemiologic statistics, graphs, and maps.

Epi Info™ For Windows

Download Version 7.2

Download ZIP File  Download Installer

Build 7.2.4  April 27, 2020

*Requires Microsoft Windows 7 or higher with Microsoft .NET 4.6.1
Load the data
Load the data
V. Conduct a descriptive epidemiological investigation (time, place, person)

Descriptive analysis: TIME

QUESTION 6

Describe the distribution of cases over time, using Epi-info

(25 minutes)
Epi Curve Chart

Variables
Select the variables for the Epi curve chart.

Grouping and Sorting
Set a sort order and create list groups.

Display
Change display options.

Colors and Styles
Set cell shading and color gradient.

Labels
Customize chart labels.

Legend
Set Legend options.

Data Filters
Set data filters for this model.

Variables

Main variable:

Date

One graph for each value of:

Step:
1

Interval:
Day

Start value:

End value:

OK
Cancel
V. Conduct a descriptive epidemiological investigation (time, place, person)

Descriptive analysis: PERSON

QUESTION 7

Describe cases by age, sex, symptoms, and severity.

(25 minutes)
V. Conduct a descriptive epidemiological investigation (time, place, person)

Descriptive analysis: PERSON

QUESTION 7

Describe cases by age, sex, symptoms, and severity

(25 minutes)

<table>
<thead>
<tr>
<th>Case type</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmed</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Probable</td>
<td>96</td>
<td>98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>52</td>
<td>53.1</td>
</tr>
<tr>
<td>Male</td>
<td>46</td>
<td>46.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>11</td>
<td>11.2</td>
</tr>
<tr>
<td>5-14</td>
<td>10</td>
<td>10.2</td>
</tr>
<tr>
<td>15-24</td>
<td>21</td>
<td>21.4</td>
</tr>
<tr>
<td>25-44</td>
<td>28</td>
<td>28.6</td>
</tr>
<tr>
<td>45-64</td>
<td>17</td>
<td>17.6</td>
</tr>
<tr>
<td>≥65</td>
<td>11</td>
<td>11.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Abdominal</td>
<td>78</td>
<td>80</td>
</tr>
<tr>
<td>Nausea</td>
<td>47</td>
<td>48</td>
</tr>
<tr>
<td>Anorexia</td>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td>Vomiting</td>
<td>36</td>
<td>37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital admission</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>14</td>
<td>14.3</td>
</tr>
<tr>
<td>No</td>
<td>84</td>
<td>85.7</td>
</tr>
</tbody>
</table>
V. Conduct a descriptive epidemiological investigation (time, place, person)

Descriptive analysis: PERSON

QUESTION 8

Can you say anything about the severity of disease in the elderly?

(25 minutes)
V. Conduct a descriptive epidemiological investigation (time, place, person)

Descriptive analysis: PLACE

QUESTION 9

What does the map tell you? Any additional information you would need to better interpret this map?

(10 minutes)
V. Conduct a descriptive epidemiological investigation (time, place, person)

Descriptive analysis: PLACE

**QUESTION 10**

Fill in the table below and interpret the results. Use epi info to extract number of cases per zone.

(25 minutes)

<table>
<thead>
<tr>
<th>Residential area</th>
<th>Number of cases</th>
<th>Percentage of cases</th>
<th>Total population</th>
<th>Attack rate per 10,000 residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td>13.750</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td>32.125</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern</td>
<td>28.540</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>24.672</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>36.913</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
V. Conduct a descriptive epidemiological investigation (time, place, person)

Descriptive analysis: PLACE

QUESTION 10

Fill in the table below and interpret the results. Use epi info to extract number of cases per zone.

(25 minutes)

<table>
<thead>
<tr>
<th>Residential area</th>
<th>Number of cases</th>
<th>Percentage of cases</th>
<th>Total population</th>
<th>Attack rate per 10,000 residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td>11</td>
<td>11</td>
<td>13,750</td>
<td>8</td>
</tr>
<tr>
<td>Western</td>
<td>50</td>
<td>51</td>
<td>32,125</td>
<td>15.6</td>
</tr>
<tr>
<td>Southern</td>
<td>28</td>
<td>29</td>
<td>28,540</td>
<td>9.8</td>
</tr>
<tr>
<td>Eastern</td>
<td>5</td>
<td>5</td>
<td>24,672</td>
<td>2</td>
</tr>
<tr>
<td>Northern</td>
<td>4</td>
<td>4</td>
<td>36,913</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency Area</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum. Percent</th>
<th>Exact 95% LCL</th>
<th>Exact 95% UCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td>11</td>
<td>11.22%</td>
<td>11.22%</td>
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<tr>
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<td>4.02%</td>
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</tr>
<tr>
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<td>28.57%</td>
<td>48.13%</td>
<td>1.90%</td>
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</tr>
</tbody>
</table>
PART TWO. STEPS VI-X
VI. Conduct additional studies and collect additional information (environmental, laboratory)

QUESTION 11

Would you conduct any environmental investigation in this context?

(5 minutes)
VII. Generate hypotheses

QUESTION 12

If you were part of the team: What would be your main hypothesis so far

(10 minutes)
QUESTION 13

Which design would you choose for a epidemiological study in this setting? Discuss strengths and weaknesses of a suitable design

(10 minutes)
QUESTION 14

Please comment on the table. Which are the factors associated with infection?

(10 minutes)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted Odds Ratio</th>
<th>95% Confident interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential zone</td>
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<td></td>
</tr>
<tr>
<td>Northern</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>1.24</td>
<td>0.52-1.95</td>
</tr>
<tr>
<td>Central</td>
<td>3.13</td>
<td>2.12-4.85</td>
</tr>
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<td>Southern</td>
<td>7.58</td>
<td>4.93-9.7</td>
</tr>
<tr>
<td>Western</td>
<td>10.44</td>
<td>7.84-13.58</td>
</tr>
<tr>
<td>Consumption of water from WS 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
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<td>6.53</td>
<td>4.95-8.16</td>
</tr>
<tr>
<td>Daily water consumption</td>
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<td></td>
</tr>
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<td>Ref</td>
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</tr>
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<td>0.67-9.2</td>
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<tr>
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<td>4.34</td>
<td>0.96-18.10</td>
</tr>
<tr>
<td>≥5 glasses</td>
<td>8.42</td>
<td>1.95-27.34</td>
</tr>
</tbody>
</table>
QUESTION 15

Using Tillett et al. criteria, which level of evidence does the team have to state that this outbreak is waterborne?

(15 minutes)

IX. Implement control measures and risk communication

QUESTION 16

Communication to the public is key to keep trust and to promptly inform about recommended preventive measures. What communication activities would normally take place in your municipality in a situation like this? What mechanisms could be used to distribute messages?

(15 minutes)
X. Communication and evaluation of the outbreak response

QUESTION 17

Final question: If this outbreak had occurred in your municipality.... Would things had handled similarly?

Please, identify three strengths, three gaps and three areas for improvement in terms of the response to this outbreak in your municipality.

(30 minutes)
Case study on waterborne outbreak of Cryptosporidiosis
Participant Guide
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Case study on waterborne outbreak of Cryptosporidiosis
Participant Guide
Case study on waterborne outbreak of Cryptosporidiosis

Scope and objectives
The scenario presented in this case study is based around a fictional event. Workshop participants will work through the scenario and will respond to a package of questions focused on the ten steps of a waterborne outbreak investigation. Participants will discuss as if they were part of the outbreak team. In some questions, participants will be asked to elaborate an answer as if the outbreak was occurring in their country of origin.

Structure of the exercise
The exercise is divided in 1) group work and 2) plenary debrief. It will last in total around 300 minutes (5 hours).

1) Group work: Planned to last around 240 minutes (4 hours) and is divided in two parts of approximately 150 minutes (2.5 hours) and 90 minutes (1.5 hours). Each part is structured in steps that include a set of questions.

Workshop participants will be divided in small groups (preferably with no more than 5-6 persons each). There should be at least two computers per group as the use of Epi info™ is required to solve some of the questions.

Each group will discuss the entire scenario and all the questions included. In addition, each group will be responsible for presenting one specific question during the plenary debrief. At the beginning of the exercise, each group will be informed about their question so that they can allocate time to prepare it during the group work session.

Each group should appoint:

- A moderator-time keeper who will lead the group activities, guide the rest of participants through the case study and who will ensure the group keeps the time allocated for each question. This will be the only person in the group having the “facilitator version” of the case study. This version includes facilitator probes that will help the moderator to develop the discussions within the group.

- Note taker and a spokesman who will be responsible for presenting the group´s work during the plenary debrief.

The workshop facilitator will be available in the room to solve doubts to all groups during the entire session.

2) Plenary debrief: Planned to last around 60 minutes. Each group´s spokesman will briefly present and discuss the solution to their question. The presentation will not take more than
5 minutes each. The presentation’s format, structure and design will be flexible and decided by each group. The number of different questions subject to be presented in this session will depend on the number of groups in each workshop. Each group will present at least one question.

See the proposed case study structure below:

<table>
<thead>
<tr>
<th>GROUP WORK TOPIC</th>
<th>Question for discussion</th>
<th>Allocated time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PART ONE</strong></td>
<td></td>
<td>240 minutes</td>
</tr>
<tr>
<td>Step I. Outbreak alert and detection. First hypotheses</td>
<td>Question 1</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 2</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step II: The outbreak team. Member roles, responsibilities and first actions</td>
<td>Question 3</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Step III. Define cases</td>
<td>Question 4</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Step IV. Identify cases and obtain information. Microbiological information</td>
<td>Question 5</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step V. Conduct a descriptive epidemiological investigation (time, place, person)</td>
<td>Question 6</td>
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</tr>
<tr>
<td></td>
<td>Question 7</td>
<td>25 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 8</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 9</td>
<td>10 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 10</td>
<td>25 minutes</td>
</tr>
<tr>
<td><strong>PART TWO</strong></td>
<td></td>
<td>90 minutes</td>
</tr>
<tr>
<td>Step VI. Conduct additional studies and collect additional information (environmental, laboratory)</td>
<td>Question 11</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step VII. Generate hypotheses</td>
<td>Question 12</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step VIII. Evaluate hypotheses</td>
<td>Question 13</td>
<td>10 minutes</td>
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<tr>
<td></td>
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<td>10 minutes</td>
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<td>Question 15</td>
<td>15 minutes</td>
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<tr>
<td>Step IX. Implement control measures and risk communication</td>
<td>Question 16</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Step X. Communication and evaluation of the outbreak response</td>
<td>Question 17</td>
<td>30 minutes</td>
</tr>
<tr>
<td><strong>PLENARY DISCUSSION</strong></td>
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<td>60 minutes</td>
</tr>
</tbody>
</table>
Sources

The narrative of the fictional scenario used in this case study is based on the case study presented in the WHO publication *Surveillance and outbreak management of water-related infectious diseases associated with water-supply system*. It has been expanded with additional details, questions for discussion and facilitator probes to guide the discussion. The structure of the case study is inspired and adapted from the pilot training modules used in the national capacity building workshops on water-related disease surveillance conducted in the framework of the United Nations Economic Commission for Europe and World Health Organization Regional Office for Europe Protocol of Water and Health. The content and structure of the training modules were based on scenarios developed by World Health Organization, the RAND Corporation, the Norwegian Institute of Public Health and from real outbreak investigations.

Course materials available for this case study

- Case study participant handbook: it includes the case scenario and participant questions
- Case study facilitator handbook: additionally, it includes facilitator probes to guide the discussion
- Case study presentation slides: a set of slides are available to be used and edited as needed by the workshop facilitators. They include the case study structure and solutions/discussions to the questions.
- A blank PowerPoint template: a set of slides to be used to document and present outcomes of the exercises on the case study

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3 https://www.rand.org/content/dam/rand/pubs/technical_reports/2006/RAND_TR319.pdf
PART ONE: Steps I-V

I. Outbreak alert and detection. First hypotheses.

On Wednesday 12 September (week 37) at 17:45, just before she is planning to go home from the office, the municipal medical officer (MMO) at municipality XXXX, 136.000 inhabitants, receives a call from one doctor from the infectious disease unit at the reference university hospital. She is informed about an increase in gastroenteritis consultations during the previous days. To explore further the situation, she decides to call the head medical officers of six primary healthcare centres in the municipality to ask whether they have noticed any changes. She finds their telephone numbers at the contact list in one of the annexes of the preparedness plan at her shelf. Those primary healthcare centres placed at the western area of the municipality had noticed an increase in consultations in the previous days.

The MMO enters the electronic-based surveillance system with her username and password, exports some data to conduct some analysis, and realises a three-fold increase in the number of gastroenteritis consultations in the municipality during week 36. She calls the regional health authorities to ask whether they have identified any increase in gastroenteritis cases in any other municipalities of the region, which was not the case.

The MMO hangs up the phone and looks for one of her colleagues at the next door´s office: “Something is going on, we might have an outbreak in our municipality”.

Questions to participants:

1) Would this chain of events be likely to happen at the municipality/district level of your country? What would be similar? What would be different?

Please, discuss with your group.

(10 minutes)
The MMO, with the help of the hospital staff, gets the contact details from seven cases and interviews them. Two are admitted in the hospital. After exploring potential common exposures, such as events or gatherings, she does not manage to disentangle common links between the cases. None of them had travelled outside the municipality in previous weeks. However, it draws MMO´s attention that cases live in neighbouring areas in the municipality. The MMO encouraged cases to deliver a stool specimen to the hospital´s lab so that they can be analysed for enteric bacteria, viruses, and parasites.

There had been recent heavy rains and flooding in the municipality. Bearing this in mind, the MMO contacts the municipal water authority, whose contact details are also included in the preparedness plan, to ask if there had been any recent issues with the water-supply system. They inform about an exceedance of acceptable turbidity levels in two samples taken from the water distribution system in the western zone of the municipality some days ago.

**Questions to participants:**

2) *Any hypothesis so far about what is going on?*

Please, discuss with your group.

(5 minutes)
II. The outbreak team. Members, roles, responsibilities, and first actions.

Given the available meteorological and water quality information, the MMO suspects that the municipal water supply could be a potential source of the problem and confirms the outbreak. On Friday 14 September, an urgent meeting is organized, and an outbreak team is assembled.

Questions to participants:

3) Who has a role in the response to this outbreak?

Please, discuss with your group.

(15 minutes)

The team implements immediate control measures, including the issue of a precautionary boil water notice that is disseminated via social media.
III. Define cases.

The microorganism causing this outbreak is still unknown and therefore the team formulates the following preliminary possible case definition:

“A person who lives in municipality XXXX, with diarrhoea (≥ 3 loose stools in 24 hours) and any one of the following symptoms – abdominal pain, nausea and vomiting – and date of onset of symptoms from 15 August.”

Questions to participants:

4) Why is it important to define cases? What information should be included in a case definition? Any strengths and weaknesses for this case definition?

Please, discuss with your group.

(10 minutes)
IV. Identify cases and obtain information. Microbiological confirmation

The hospital and primary healthcare centres at the municipality agree to notify to the outbreak team daily gastroenteritis consultations (syndromic surveillance data). The outbreak team develops a list of all cases in a spreadsheet in which they included relevant sociodemographic information. They collect additional epidemiological data on a subset of these cases to help generate hypotheses on the cause of the outbreak.

On Sunday 16 September, the regional laboratory confirms that two of the seven initially tested cases have tested positive for *Cryptosporidium parvum*.

“*Cryptosporidia are intestinal parasites infecting a variety of animals. Human infections occur due to Cryptosporidium parvum, a species that also affects domestic animals. Person-to-person or animal-to-person disease transmission occurs mainly through contaminated water and food. Cryptosporidium eggs can survive for months in moist soil or water and survive harsh environmental conditions for extended periods of time. In humans, infections without symptoms are common. Especially healthy individuals, may, after an incubation period averaging one week, get a diarrhoea that spontaneously resolves over a couple of weeks. By contrast, patients with impaired immune system may develop profuse, life-threatening, watery diarrhoea.*

*Outbreaks have been reported in hospitals, day-care centres, within households, among bathers (affecting participants in water sports in lakes and swimming pools), and in municipalities with contaminated public water supplies. Water distribution systems are particularly vulnerable to contamination with Cryptosporidium, which can survive most disinfection procedures such as chlorination*”

*(European Centre for Disease prevention and Control) https://www.ecdc.europa.eu/en/cryptosporidiosis*

The laboratory characterises the specimens to assess if they are genetically identical and enhances *Cryptosporidium* laboratory surveillance testing all specimens routinely collected from gastroenteritis cases in the municipality.

The team updates the case definitions for the outbreak:

**Probable case:** “*a person who lives in municipality XXXX, with diarrhoea (≥ 3 loose stools in 24 hours) and any one of the following symptoms – abdominal pain, nausea, vomiting, anorexia – and date of onset of symptoms from 15 August*”

**Confirmed case:** “*a person who lives in municipality XXXX, with laboratory-confirmed cryptosporidiosis and onset of symptoms from 15 August*”
Questions to participants:

5) What do you think of the adjustments done in the case definition at this point?

Please, discuss with your group.

(5 minutes)
V. Conduct a descriptive epidemiological investigation (time, place, person)

By the end of week 37, 118 cases of gastroenteritis have been notified. Of these, 96 meet the probable case definition, and two are confirmed cases. The first case started with symptoms on 27th August and the last one on 15th September. All 98 are included in the line list to help to have a good overview. The line list includes the following information: case type, date of onset of symptoms, sex, age, symptoms, hospital admission and residential area. The line list is a spreadsheet that looked like this:

Using the information collected in the line list, the team decides to conduct a descriptive analysis in to better understand what was going on.

For the next three questions you will use Epi-info.

Get started!

You will use the Excel sheet called “descriptive dataset”. The first step is to load the data into Epi Info

Open Epi Info→ Click “visual Dashboard”→ Click “set a data source”→ A dialog box will open. Select Excel as the Database type and find the excel file in your computer. Press on “Descriptive dataset$” and click OK. Your dataset is loaded now in Epi-info 7
Descriptive analysis: TIME

Questions to participants:

6) Describe the distribution of cases over time, using Epi-info

(25 minutes)

Epicurve in Epi-info:

Right click on the mouse ➔ Click “Add analysis gadget” ➔ Charts ➔ Epi curve chart ➔ Main variable “Date” ➔ OK

Below you can see how the same epicurve looks designed manually in excel. The first identified case dates from 27 August, so the likely period of exposure is from 15–26 August. The curve shows a continuous common source outbreak.

Descriptive analysis: PERSON

Questions to participants:

7) Describe cases by age, sex, symptoms, and severity. Fill in the table below

(25 minutes)
<table>
<thead>
<tr>
<th>Case type</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmed</td>
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<td></td>
</tr>
<tr>
<td>Probable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
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<tr>
<td>Age group</td>
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<td>0-4</td>
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<td>5-14</td>
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<td>15-24</td>
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</tr>
<tr>
<td>Symptoms</td>
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<tr>
<td>Diarrhoea</td>
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<tr>
<td>Abdominal pain</td>
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</tr>
<tr>
<td>Nausea</td>
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<td></td>
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<tr>
<td>Anorexia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital admission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
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</tr>
<tr>
<td>No</td>
<td></td>
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</tr>
</tbody>
</table>

**Frequencies in Epi-info:**

Right click on the mouse → Click “Add analysis gadget” → Frequency → Select each of the variables of interest

**Questions to participants:**

8) Can you say anything about the severity of disease in the elderly? (15 minutes)

**Epicurve in Epi-info:**

Right click on the mouse → Click “Add analysis gadget” → Frequency → Select “admission to hospital” in the “variable section” and “age group” in the “Grouping and sorting section”
Descriptive analysis: PLACE

The municipality is divided into different geographic zones. For each of the cases, the residence addresses were obtained and plotted on a map of the municipality as shown below:

![Map of probable and confirmed cases of cryptosporidiosis, Waterfall, weeks 35-37](image)

**Figure 1** Map of probable and confirmed cases related to the outbreak. Municipality XX. Weeks 35-37

**Questions to participants:**

9) What does the map tell you? Any additional information you would need to better interpret this map?

(10 minutes)

With the help of the town hall, the team finds the number of inhabitants in each zone to be able to calculate attack rates per zone.

**Questions to participants:**

10) Fill in the table below and interpret the results. Use epi info to extract number of cases per zone.

(25 minutes)

**Epicurve in Epi-info:**

Right click on the mouse → Click “Add analysis gadget” → Frequency → Select “Residential area”
<table>
<thead>
<tr>
<th>Residential area</th>
<th>Number of cases</th>
<th>Percentage of cases</th>
<th>Total population</th>
<th>Attack rate per 10,000 residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
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<td>13.750</td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td></td>
<td></td>
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<tr>
<td>Southern</td>
<td></td>
<td></td>
<td>28.540</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
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<td>24.672</td>
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<tr>
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<td></td>
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<td>36.913</td>
<td></td>
</tr>
</tbody>
</table>
PART TWO. Steps VI-X

VI. Conduct additional studies and collect additional information (environmental, laboratory)

Questions to participants:

11) Would you conduct any environmental investigation in this context?

(5 minutes)

The outbreak team conducts a sanitary inspection and an environmental risk assessment of the water-supply system, including reviewing potential sources of contamination. They checked water-quality data as well as maintenance records for the system since 15 August and collected information on weather events. The municipality is served by two water supplies. The northern and eastern zones are served by water from a groundwater source to the north of the municipality (water supply 1, WS1). The western and southern zones are served by water from a lake to the west of the municipality (water supply 2, WS2). The central area receives water from both. For WS1, water is extracted from an aquifer and piped to a reservoir. The water is chlorinated before entering the distribution system. The water distribution system for WS1 has recently been upgraded and the inspection of the system did not identify any hazards. For WS2, water is extracted from the lake at a depth of 20 meters and is filtered and chlorinated before entering the distribution system. The distribution system for WS2 is quite old, with some parts dating from the 1930s. Some of the pipes are corroded and ingress into the distribution system was identified as a risk at several points in the system. Heavy rainfall occurred in the municipality continuously during three days between 16 and 19 August, which generated flood warnings. A sewage overflow was documented by the municipal authorities on 19 August in the western district of the municipality.

The sanitary inspection of the water supply system identified several contributing factors to the outbreak: a) the heavy rainfall led to likely contamination of the lake with animal waste runoff from surrounding pasture lands; b) the filtration system at the water treatment plant for WS2 temporarily was breached, which likely led to contamination of the treated water with raw water; and c) the sewage overflow may have caused an ingress of contaminated water into the WS2 water distribution system in the western zone.

The team took large water samples (2000 L) from the source water, water-treatment plants, reservoirs and pumping stations, Samples were taken on Saturday 15 September, prior to flushing of the water-supply system. Cryptosporidium oocysts were isolated from the lake (25 oocysts/1000 L) and from a pumping station in WS2 (65 oocysts/1000 L). Genotyping revealed that the isolated oocysts were genotype 1.
VII. Generate hypotheses

By the end of week 39, 330 cases have been identified as part of the outbreak, of which 83 are laboratory confirmed as *Cryptosporidium*. A subset of these have been genotyped and confirmed to be genetically identical to the *Cryptosporidium* isolated from the water-supply system.

Questions to participants:

12) If you were part of the team: What would be your main hypothesis so far?

(5 minutes)
VIII. Evaluate hypotheses

Questions to participants:

13) Which design would you choose for an epidemiological study in this setting? Discuss strengths and weaknesses of a suitable design.

(10 minutes)
The team decided to conduct a case-control study to identify factors associated with Cryptosporidium infection.

Only confirmed cases were included. Three potential secondary cases (those with onset of symptoms between one and 14 days after another case in the same household) were excluded. Controls were selected randomly from the population register for the municipality and matched by sex, age, and water-supply system. Two controls were selected for each case. The team sent an SMS with a link to a web-based questionnaire to 80 confirmed cases and 160 controls. The questionnaire included data on water consumption and other risk factors for Cryptosporidium infection, such as contact with farm animals or bathing in a swimming pool. Data were collected on exposures from one week before 15 August.

R software (https://www.r-project.org/) was used to conduct the statistical analysis.

The table below shows factors associated with Cryptosporidium infection.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted Odds Ratio</th>
<th>95% Confident interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residencial zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>1.24</td>
<td>0.52-1.95</td>
</tr>
<tr>
<td>Central</td>
<td>3.13</td>
<td>2.12-4.85</td>
</tr>
<tr>
<td>Southern</td>
<td>7.58</td>
<td>4.93-9.7</td>
</tr>
<tr>
<td>Western</td>
<td>10.44</td>
<td>7.84-13.58</td>
</tr>
<tr>
<td>Consumption of water from WS 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6.53</td>
<td>4.95-8.16</td>
</tr>
<tr>
<td>Daily water consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 glass</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>1-2 glasses</td>
<td>2.11</td>
<td>0.67-9.2</td>
</tr>
<tr>
<td>3-4 glasses</td>
<td>4.34</td>
<td>0.96-18.10</td>
</tr>
<tr>
<td>≥5 glasses</td>
<td>8.42</td>
<td>1.95-27.34</td>
</tr>
</tbody>
</table>

Questions to participants:

14) Please comment the table above. Which are the factors associated with infection?

(10 minutes)
Questions to participants:

15) Using Tillett et al criteria. Which level of evidence does the team have to state that this outbreak is waterborne?

(15 minutes)
IX. Implement control measures and risk communication

In addition to the boil water notice issued on 15 September, the entire water-supply system was flushed to eliminate oocysts from the distribution system and disinfection after flushing was conducted. The filtration system was repaired and flushed to eliminate oocysts. Leaking and corroded pipes in the water-distribution system were replaced; Sewage system pipes were improved to enhance their capacity to cope with increased volumes during flooding events.

Advice on hand hygiene and infection control measures was available to the public to prevent secondary transmission within households. The public was regularly informed about the developments in the outbreak investigation.

Questions to participants:

16) Communication to the public is key to keep trust and to promptly inform about recommended preventive measures. What communication activities would normally take place in your municipality in a situation like this? What mechanisms could be used to distribute messages?

(15 minutes)
X Communication and evaluation of the outbreak response

Throughout the entire investigation, daily status reports were shared among all actors involved. Daily updates were posted on the municipality website and on social media. The team published an outbreak report within one month of declaring the outbreak over, in which several recommendations were included:

- Introducing ozonation of raw water to deactivate Cryptosporidium in the source water prior to treatment.
- Upgrading parts of the distribution system by replacing pipes.
- Undertaking work to protect the water filtration system from future flooding.
- Introducing a protection zone around the lake within which livestock grazing will be prohibited, to minimize faecal pollution runoff into the source water.
- Increasing the frequency of inspection of the water-supply system, including the filtration system, after extreme weather events.
- Increasing the frequency of water-testing at all stages of the system during and after extreme weather events.

The team conducted an after-action review of the outbreak and decided to reduce the threshold for reporting water-quality exceedances under event-based surveillance.

Questions to participants:

17) Final question: If this outbreak had occurred in your municipality… Would things had handled similarly? Please, identify three strengths, three gaps and three areas for improvement in terms of the response to this outbreak in your municipality.

(30 minutes)
Case study on waterborne outbreak of Cryptosporidiosis
Facilitator Guide
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Case study on waterborne outbreak of Cryptosporidiosis

Scope and objectives

The scenario presented in this case study is based around a fictional event. Workshop participants will work through the scenario and will respond to a package of questions focused on the ten steps of a waterborne outbreak investigation. Participants will discuss as if they were part of the outbreak team. In some questions, participants will be asked to elaborate an answer as if the outbreak was occurring in their country of origin.

Structure of the exercise

The exercise is divided in 1) group work and 2) plenary debrief. It will last in total around 300 minutes (5 hours).

1) Group work: Planned to last around 240 minutes (4 hours) and is divided in two parts of approximately 150 minutes (2.5 hours) and 90 minutes (1.5 hours). Each part is structured in steps that include a set of questions.

Workshop participants will be divided in small groups (preferably with no more than 5-6 persons each). There should be at least two computers per group as the use of Epi info™ is required to solve some of the questions.

Each group will discuss the entire scenario and all the questions included. In addition, each group will be responsible for presenting one specific question during the plenary debrief. At the beginning of the exercise, each group will be informed about their question so that they can allocate time to prepare it during the group work session.

Each group should appoint:

- A moderator-time keeper who will lead the group activities, guide the rest of participants through the case study and who will ensure the group keeps the time allocated for each question. This will be the only person in the group having the “facilitator version” of the case study. This version includes facilitator probes that will help the moderator to develop the discussions within the group.

- Note taker and a spokesman who will be responsible for presenting the group´s work during the plenary debrief.

The workshop facilitator will be available in the room to solve doubts to all groups during the entire session.

2) Plenary debrief: Planned to last around 60 minutes. Each group´s spokesman will briefly present and discuss the solution to their question. The presentation will not take more than
5 minutes each. The presentation’s format, structure and design will be flexible and decided by each group. The number of different questions subject to be presented in this session will depend on the number of groups in each workshop. Each group will present at least one question.

See the proposed case study structure below:

<table>
<thead>
<tr>
<th>GROUP WORK TOPIC</th>
<th>Question for discussion</th>
<th>Allocated time</th>
</tr>
</thead>
<tbody>
<tr>
<td>PART ONE</td>
<td></td>
<td>150 minutes</td>
</tr>
<tr>
<td>Step I. Outbreak alert and detection. First hypotheses</td>
<td>Question 1</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 2</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step II: The outbreak team. Member roles, responsibilities and first actions</td>
<td>Question 3</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Step III. Define cases</td>
<td>Question 4</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Step IV. Identify cases and obtain information. Microbiological information</td>
<td>Question 5</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step V. Conduct a descriptive epidemiological investigation (time, place, person)</td>
<td>Question 6</td>
<td>25 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 7</td>
<td>25 minutes</td>
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<td>Question 8</td>
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<td></td>
<td>Question 9</td>
<td>10 minutes</td>
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<tr>
<td></td>
<td>Question 10</td>
<td>25 minutes</td>
</tr>
<tr>
<td>PART TWO</td>
<td></td>
<td>90 minutes</td>
</tr>
<tr>
<td>Step VI. Conduct additional studies and collect additional information (environmental, laboratory)</td>
<td>Question 11</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step VII. Generate hypotheses</td>
<td>Question 12</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Step VIII. Evaluate hypotheses</td>
<td>Question 13</td>
<td>10 minutes</td>
</tr>
<tr>
<td></td>
<td>Question 14</td>
<td>10 minutes</td>
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<tr>
<td></td>
<td>Question 15</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Step IX. Implement control measures and risk communication</td>
<td>Question 16</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Step X. Communication and evaluation of the outbreak response</td>
<td>Question 17</td>
<td>30 minutes</td>
</tr>
<tr>
<td>PLENARY DISCUSSION</td>
<td></td>
<td>60 minutes</td>
</tr>
</tbody>
</table>
Sources

The narrative of the fictional scenario used in this case study is based on the case study one included in the WHO document *Surveillance and outbreak management of water-related infectious diseases associated with water-supply system*. It has been expanded with additional details, questions for discussion and facilitator probes to guide the discussion. The structure of the case study is inspired and adapted from the pilot national training workshops on water-related disease surveillance previously run by the World Health Organization Regional Office for Europe under the framework of the Protocol of Water and Health. In those workshops, some aspects of the content and structure were loosely based on scenarios developed by World Health Organization, the RAND Corporation, the Norwegian Institute of Public Health and from real outbreak investigations.

Course materials available for this case study

- Case study participant handbook: it includes the case scenario and participant questions
- Case study facilitator handbook: additionally, it includes facilitator probes to guide the discussion
- Case study presentation slides: a set of slides are available to be used and edited as needed by the workshop facilitators. They include the case study structure and solutions/discussions to the questions.
- A blank PowerPoint template: a set of slides to be used to document and present outcomes of the exercises on the case study


PART ONE: Steps I-V

I. Outbreak alert and detection. First hypotheses.

On Wednesday 12 September (week 37) at 17:45, just before she is planning to go home from the office, the municipal medical officer (MMO) at municipality XXXX, 136,000 inhabitants, receives a call from one doctor from the infectious disease unit at the reference university hospital. She is informed about an increase in gastroenteritis consultations during the previous days. To explore further the situation, she decides to call the head medical officers of six primary healthcare centres in the municipality to ask whether they have noticed any changes. She finds their telephone numbers at the contact list in one of the annexes of the preparedness plan at her shelf. Those primary healthcare centres placed at the western area of the municipality had noticed an increase in consultations in the previous days.

The MMO enters the electronic-based surveillance system with her username and password, exports some data to conduct some analysis, and realises a three-fold increase in the number of gastroenteritis consultations in the municipality during week 36. She calls the regional health authorities to ask whether they have identified any increase in gastroenteritis cases in any other municipalities of the region, which was not the case.

The MMO hangs up the phone and looks for one of her colleagues at the next door’s office: “Something is going on, we might have an outbreak in our municipality”.

Questions to participants:

1) Would this chain of events be likely to happen at the municipality/district level of your country? What would be similar? What would be different?

Please, discuss with your group.

(10 minutes)
Facilitator probes

The introductory text to this question presents how a probable outbreak is detected in a municipality and describes certain details of the information in this municipality. It seems that there is a smooth communication channel between primary care centres, hospitals, and the public health authorities at the local level. Also, between the public health authorities at local and regional level. There is a preparedness plan where the municipal medical officer can find relevant information, such us contact details of relevant actors. She has access to the online surveillance system through which she can find relevant information for her municipality. Please, discuss with participants whether they think the chain of events would be similar at the district/municipal level in their countries. You can guide the discussion with additional questions such as

- Do hospitals have a system in place to notify events to the municipal medical officer at the municipality? What about primary healthcare centres?
- Who would report, how and to whom?
- Is there a preparedness plan or outbreak guidelines at the local level in which this chain of information sharing and notification is described?
- Is there an electronic-based surveillance system through which the municipal medical officer can obtain information on disease notification or consultation levels at the municipality?

This first question should be used as an introduction to the fictional outbreak and warming up the discussion

The MMO, with the help of the hospital staff, gets the contact details from seven cases and interviews them. Two are admitted in the hospital. After exploring potential common exposures, such as events or gatherings, she does not manage to disentangle common links between the cases. None of them had travelled outside the municipality in previous weeks. However, it draws MMO´s attention that cases live in neighbouring areas in the municipality. The MMO encouraged cases to deliver a stool specimen to the hospital´s lab so that they can be analysed for enteric bacteria, viruses, and parasites.

There had been recent heavy rains and flooding in the municipality. Bearing this in mind, the MMO contacts the municipal water authority, whose contact details are also included in the preparedness plan, to ask if there had been any recent issues with the water-supply system. They inform about an exceedance of acceptable turbidity levels in two samples taken from the water distribution system in the western zone of the municipality some days ago.

Questions to participants:

2) Any hypothesis so far about what is going on?

Please, discuss with your group.

(5 minutes)
Facilitator probes
This second question is an additional introductory question to help break the ice among the members of the group. Please use these five minutes to help the group to wrap up all the relevant details we know until now:

- No common exposures among the cases
- They live in neighbouring areas
- Extreme rainfall the previous days
- Water quality problems in the western zone of the municipality. This is the same area where primary health care centres identified an increase in gastroenteritis cases
- At least two cases are admitted with severe disease.
II. The outbreak team. Members, roles, responsibilities, and first actions.

Given the available meteorological and water quality information, the MMO suspects that the municipal water supply could be a potential source of the problem and confirms the outbreak. On Friday 14 September, an urgent meeting is organized, and an outbreak team is assembled.

Questions to participants:

3) Who has a role in the response to this outbreak?

Please, discuss with your group.

(15 minutes)

Facilitator probes

In this setting, a multidisciplinary team including epidemiologists, healthcare professionals, microbiologists, environmental engineers, and waterworks personnel is important. All these profiles provide different angles of expertise and a good collaboration among them is paramount to identify what has gone wrong. As waterborne outbreaks can generate high media interest, communication experts are important to maintain an optimal and effective communication to the public.

As a reminder, you can provide details about the roles:

- Local public health agency, where the MMO is based, will lead the overall coordination of the investigation and response to the outbreak. The national level may provide technical support if needed.
- Water authorities will coordinate the environmental investigation.
- Water suppliers will play an active role in implementing control measures targeting the water-supply system proposed by the public health agency.
- Healthcare professionals are responsible for identifying and reporting cases and will lead on case management.
- Laboratories test clinical and environmental samples collected during the outbreak and report cases.

Ideally, professionals representing these roles should know each other from before and have had certain contact during peace team (contact meetings, for instance). It is important that all this is clearly defined in a preparedness plan. This plan should include a description of the different roles of those involved in a waterborne outbreak response and their responsibilities and chains of command. The communication component should also be included.

Please, discuss with participants who would be involved in the response of this outbreak at the district/municipal level in their countries. You can guide the discussion with additional questions such as:

- Does coordination within human and environmental health authorities exist on detection and response to waterborne outbreaks at the local level? Are there mechanisms for information exchange, between municipal medical officers and environmental health officers in this level?
- Is this multisectoral collaboration described in a preparedness plan?

The team implements immediate control measures, including the issue of a precautionary boil water notice that is disseminated via social media.
III. Define cases.

The microorganism causing this outbreak is still unknown and therefore the team formulates the following preliminary possible case definition:

“A person who lives in municipality XXXX with diarrhoea (≥ 3 loose stools in 24 hours) and any one of the following symptoms – abdominal pain, nausea and vomiting – and date of onset of symptoms from 15 August.”

Questions to participants:
4) Why is it important to define cases? What information should be included in a case definition? Any strengths and weaknesses for this case definition?

Please, discuss with your group.

(10 minutes)

Facilitator probes

A case definition is important to be able to decide which cases to include in this outbreak. It should include information on “time”, “place” and “person”.

Please, discuss advantages and disadvantages of the preliminary case definition that the outbreak team agreed at this point.

Why does the group think investigators chose the date 1st August?

What about travel history? Shouldn’t those who had travelled out of the municipality during the relevant period be excluded?
IV. Identify cases and obtain information. Microbiological confirmation

The hospital and primary healthcare centres at the municipality agree to notify to the outbreak team daily gastroenteritis consultations (syndromic surveillance data). The outbreak team develops a list of all cases in a spreadsheet in which they included relevant sociodemographic information. They collect additional epidemiological data on a subset of these cases to help generate hypotheses on the cause of the outbreak.

On Sunday 16 September, the regional laboratory confirms that two of the seven initially tested cases have tested positive for *Cryptosporidium parvum*.

“Cryptosporidia are intestinal parasites infecting a variety of animals. Human infections occur due to *Cryptosporidium parvum*, a species that also affects domestic animals. Person-to-person or animal-to-person disease transmission occurs mainly through contaminated water and food. *Cryptosporidium* eggs can survive for months in moist soil or water and survive harsh environmental conditions for extended periods of time. In humans, infections without symptoms are common. Especially healthy individuals, may, after an incubation period averaging one week, get a diarrhoea that spontaneously resolves over a couple of weeks. By contrast, patients with impaired immune system may develop profuse, life-threatening, watery diarrhoea.

Outbreaks have been reported in hospitals, day-care centres, within households, among bathers (affecting participants in water sports in lakes and swimming pools), and in municipalities with contaminated public water supplies. Water distribution systems are particularly vulnerable to contamination with *Cryptosporidium*, which can survive most disinfection procedures such as chlorination”


The laboratory characterises the specimens to assess if they are genetically identical and enhances *Cryptosporidium* laboratory surveillance testing all specimens routinely collected from gastroenteritis cases in the municipality.

The team updates the case definitions for the outbreak:

**Probable case**: “a person who lives in municipality XXXX, with diarrhoea (≥ 3 loose stools in 24 hours) and any one of the following symptoms – abdominal pain, nausea, vomiting, anorexia – and date of onset of symptoms from 15 August”

**Confirmed case**: “a person who lives in municipality XXXX with laboratory-confirmed cryptosporidiosis and onset of symptoms from 15 August”
Questions to participants:

5) What do you think of the adjustments done in the case definition at this point? Please, discuss with your group.
(5 minutes)

Facilitator probes

Please, discuss advantages and disadvantages of the case definitions that the team agreed at this point.

A proposed case definition for confirmed cases, that includes information on the agent increases precision although it may decrease the number of cases available for the study. This case definition will exclude patients who have not had a sample taken. One potential solution would be to use two case definitions, confirmed and probable case definition.
V. Conduct a descriptive epidemiological investigation (time, place, person)

By the end of week 37, 118 cases of gastroenteritis have been notified. Of these, 96 meet the probable case definition, and two are confirmed cases. The first case started with symptoms on 27th August and the last one on 15th September. All 98 are included in the line list to help to have a good overview. The line list includes the following information: case type, date of onset of symptoms, sex, age, symptoms, hospital admission and residential area. The line list is an spreadsheet that looked like this:

Using the information collected in the line list, the team decides to conduct a descriptive analysis in to better understand what was going on.

For the next three questions you will use Epi-info.

Get started!

You will use the Excel sheet called “descriptive dataset”. The first step is to load the data into Epi-info

Open Epi Info→ Click “visual Dashboard”→ Click “set a data source”→ A dialog box will open. Select Excel as the Database type and find the excel file in your computer. Press on “Descriptive dataset$’ and click OK. Your dataset is loaded now in Epi-info’

Descriptive analysis: TIME

Questions to participants:

6) Describe the distribution of cases over time, using Epi-info

(25 minutes)
Epicurve in Epi-info:

Right click on the mouse ➔ Click “Add analysis gadget” ➔ Charts ➔ Epi curve chart ➔ Main variable “Date” ➔ OK

Facilitator probes

Make sure all group members participate actively in this activity and not only those that own the computer in the group. At least one computer per three members is recommended so that all group members can easily see the screen and follow the process.

Play around and show a bit the different features epi-info has available under the “epi curve chart” part.

- Section “Variables”: different graphs can be designed for different values of a variable. For instance, selecting “sex” in the box “one graph for each value” you can design one epicurve for male and one for female. Step/interval: you can select and visualize different time intervals. Choose the one that suits you better and that provides the best information. By default, you get “Step 1” and “interval” day, which suits well our data. Try, for instance, with “weekly intervals” selecting Step: 7, interval: day. Participants will see that a lot of valuable information is missed.

- Section “Grouping and sorting”: here you can design an epicurve stratifying by a certain variable of interest. For instance, suggest design one epicurve where you show probable and confirmed cases. You will have to select “stratify by case type”

- Section “Display, colours and styles, labels, legend”: You can edit your epicurve, including titles, labels, changing colours, size...

Remind participants that epi-info is a free tool aimed to help to design epi curves but that there are several other options available to design an epi curve, such as excel.

Below you can see how the same epicurve looks designed manually in excel. The first identified case dates from 27 August, so the likely period of exposure is from 15–26 August. The curve shows a continuous common source outbreak.
Descriptive analysis: PERSON

Questions to participants:

7) Describe cases by age, sex, symptoms, and severity. Fill in the table below

(25 minutes)

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confirmed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>15-24</td>
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</tr>
<tr>
<td>25-44</td>
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</tr>
<tr>
<td>45-64</td>
<td></td>
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</tr>
<tr>
<td>≥65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptoms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhoea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anorexia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital admission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Frequencies in Epi-info:

Right click on the mouse → Click “Add analysis gadget” → Frequency → Select each of the variables of interest
**Facilitator probes**

Make sure all group members participate actively on this activity and not only those that own the computer in the group. At least one computer per three members is recommended so that all group members can easily see the screen and follow the process.

If you keep the “Ctrl” pressed while selecting the variables you can select and analyse all variables of interest at once. Epi info provides “counts” and with percent.

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case type</strong></td>
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<tr>
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<tr>
<td>Probable</td>
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<td><strong>Sex</strong></td>
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<tr>
<td>0-4</td>
<td>11</td>
<td>11.2</td>
</tr>
<tr>
<td>5-14</td>
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<td>10.2</td>
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<td>15-24</td>
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<tr>
<td>25-44</td>
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<td>45-64</td>
<td>17</td>
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</tr>
<tr>
<td>≥65</td>
<td>11</td>
<td>11.2</td>
</tr>
<tr>
<td><strong>Symptoms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Abdominal pain</td>
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<tr>
<td>Nausea</td>
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<tr>
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<tr>
<td>Vomiting</td>
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<td><strong>Hospital admission</strong></td>
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<td>14</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>84</td>
</tr>
</tbody>
</table>

There are slightly more women and the most frequent age group is 25–44 years, followed by those aged 15–25 years. All cases have diarrhoea (as per the case definition) and 80% of cases report abdominal pain. 14 patients (14%) have been hospitalized.

**Questions to participants:**

8) Can you say anything about the severity of disease in the elderly?

(15 minutes)

**Epicurve in Epi-info:**

Right click on the mouse→ Click “Add analysis gadget”→ Frequency→ Select “admission to hospital” in the “variable section” and “age group” in the “Grouping and sorting section”
Facilitator probes

With this question you will take the opportunity to show additional features of analysis by person in Epi-Info. You can conduct stratified descriptive analysis to zoom in a bit more in deep in your data. You have to select the main variable of analysis in the section “Variable section” in Epi-info and the variable you are going so stratify by in the “grouping and sorting section”.

For instance, you can see how 50% of all admitted in the hospital are more than 65, pointing towards the fact that the infection is being more severe in this group.

Descriptive analysis: PLACE

The municipality is divided into different geographic zones. For each of the cases, the residence addresses were obtained and plotted on a map of the municipality as shown below:

Questions to participants:

9) What does the map tell you? Any additional information you would need to better interpret this map?

(10 minutes)
Facilitator probes

You can see how dots cluster on the western, centre and south of the municipality. However, this map alone is not enough to conclude that there is a risk for disease associated with those areas. What about number of inhabitants in each area? Maybe there are more cases in those areas because those areas are more populated?

And what about our main hypothesis so far about the outbreak being waterborne? How is water distributed in the municipality?

With the help of the town hall, the team finds the number of inhabitants in each zone to be able to calculate attack rates per zone.

Questions to participants:

10) Fill in the table below and interpret the results. Use epi info to extract number of cases per zone.

(25 minutes)

Epicurve in Epi-info:

Right click on the mouse ➔ Click “Add analysis gadget” ➔ Frequency ➔ Select “Residential area”

<table>
<thead>
<tr>
<th>Residential area</th>
<th>Number of cases</th>
<th>Percentage of cases</th>
<th>Total population</th>
<th>Attack rate per 10,000 residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td></td>
<td></td>
<td>13.750</td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td></td>
<td></td>
<td>32.125</td>
<td></td>
</tr>
<tr>
<td>Southern</td>
<td></td>
<td></td>
<td>28.540</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td></td>
<td></td>
<td>24.672</td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td></td>
<td></td>
<td>36.913</td>
<td></td>
</tr>
</tbody>
</table>
**Facilitator probes**

Using epi-info participants can extract the number of cases in each zone. As the table provides the total population per zone it is easy to calculate attack rates per zones.

<table>
<thead>
<tr>
<th>Residential area</th>
<th>Number of cases</th>
<th>Percentage of cases</th>
<th>Total population</th>
<th>Attack rate per 10,000 residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td>11</td>
<td>11</td>
<td>13,750</td>
<td>8</td>
</tr>
<tr>
<td>Western</td>
<td>50</td>
<td>51</td>
<td>32,125</td>
<td>15.6</td>
</tr>
<tr>
<td>Southern</td>
<td>28</td>
<td>29</td>
<td>28,540</td>
<td>9.8</td>
</tr>
<tr>
<td>Eastern</td>
<td>5</td>
<td>5</td>
<td>24,672</td>
<td>2</td>
</tr>
<tr>
<td>Northern</td>
<td>4</td>
<td>4</td>
<td>36,913</td>
<td>1</td>
</tr>
</tbody>
</table>

Over 50% of all cases live in the western zone, followed by almost 30% in the southern zone and 11% in the city centre. Few cases have been reported from the northern and eastern zones of the city. The western and southern zones are the most heavily affected by the outbreak with the highest attack rates.
VI. Conduct additional studies and collect additional information (environmental, laboratory)

Questions to participants:

11) Would you conduct any environmental investigation in this context?

(5 minutes)

The outbreak team conducts a sanitary inspection and an environmental risk assessment of the water-supply system, including reviewing potential sources of contamination. They checked water-quality data as well as maintenance records for the system since 15 August and collected information on weather events. The municipality is served by two water supplies. The northern and eastern zones are served by water from a groundwater source to the north of the municipality (water supply 1, WS1). The western and southern zones are served by water from a lake to the west of the municipality (water supply 2, WS2). The central area receives water from both. For WS1, water is extracted from an aquifer and piped to a reservoir. The water is chlorinated before entering the distribution system. The water distribution system for WS1 has recently been upgraded and the inspection of the system did not identify any hazards. For WS2, water is extracted from the lake at a depth of 20 meters and is filtered and chlorinated before entering the distribution system. The distribution system for WS2 is quite old, with some parts dating from the 1930s. Some of the pipes are corroded and ingress into the distribution system was identified as a risk at several points in the system. Heavy rainfall occurred in the municipality continuously during three days between 16 and 19 August, which generated flood warnings. A sewage overflow was documented by the municipal authorities on 19 August in the western district of the municipality.

The sanitary inspection of the water supply system identified several contributing factors to the outbreak: a) the heavy rainfall led to likely contamination of the lake with animal waste runoff from surrounding pasture lands; b) the filtration system at the water treatment plant for WS2 temporarily was breached, which likely led to contamination of the treated water with raw water; and c) the sewage overflow may have caused an ingress of contaminated water into the WS2 water distribution system in the western zone.

The team took large water samples (2000 L) from the source water, water-treatment plants, reservoirs and pumping stations, Samples were taken on Saturday 15 September, prior to flushing of the water-supply system. Cryptosporidium oocysts were isolated from the lake (25 oocysts/1000 L) and from a pumping station in WS2 (65 oocysts/1000 L). Genotyping revealed that the isolated oocysts were genotype 1.
**Facilitator probes**

Remind participants about the *WHO guidelines for Guidelines for drinking-water quality*: Cryptosporidium is transmitted by faecal-oral route. The major infection rout is person-to-person contact. Contaminated drinking-water has been associated with outbreaks. The infectivity of Cryptosporidium oocysts is relatively high, ingestion of fewer than 1- oocysts can lead to an infection.


**VII. Generate hypotheses**

By the end of week 39, 330 cases have been identified as part of the outbreak, of which 83 are laboratory confirmed as *Cryptosporidium*. A subset of these have been genotyped and confirmed to be genetically identical to the *Cryptosporidium* isolated from the water-supply system.

**Questions to participants:**

12) If you were part of the team: What would be your main hypothesis so far?

(5 minutes)

**Facilitator probes**

Take some time to wrap up all the information available so far with the group.

The epidemiological and environmental investigations indicate that contamination of WS2 was the likely source of the outbreak. Therefore, being a case is could likely be associated with residing in a area supplied by/consumption water from WS2.
VIII. Evaluate hypotheses

Questions to participants:

13) Which design would you choose for an epidemiological study in this setting? Discuss strengths and weaknesses of a suitable design.

(10 minutes)

Facilitator probes

A cohort or a case control study could be options in this setting. Please discuss briefly with the group potential ways of conducting each of the designs. Do you guess which one was preferred by the team?

The team decided to conduct a case-control study to identify factors associated with Cryptosporidium infection.

Only confirmed cases were included. Three potential secondary cases (those with onset of symptoms between one and 14 days after another case in the same household) were excluded. Controls were selected randomly from the population register for the municipality and matched by sex, age, and water-supply system. Two controls were selected for each case. The team sent an SMS with a link to a web-based questionnaire to 80 confirmed cases and 160 controls. The questionnaire included data on water consumption and other risk factors for Cryptosporidium infection, such as contact with farm animals or bathing in a swimming pool. Data were collected on exposures from one week before 15 August.

R software (https://www.r-project.org/) was used to conduct the statistical analysis.

The table below shows factors associated with Cryptosporidium infection.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted Odds Ratio</th>
<th>95% Confident interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential zone</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>1.24</td>
<td>0.52-1.95</td>
</tr>
<tr>
<td>Central</td>
<td>3.13</td>
<td>2.12-4.85</td>
</tr>
<tr>
<td>Southern</td>
<td>7.58</td>
<td>4.93-9.7</td>
</tr>
<tr>
<td>Western</td>
<td>10.44</td>
<td>7.84-13.58</td>
</tr>
<tr>
<td><strong>Consumption of water from WS 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6.53</td>
<td>4.95-8.16</td>
</tr>
</tbody>
</table>
### Daily water consumption

<table>
<thead>
<tr>
<th></th>
<th>&lt;1 glass</th>
<th>Ref</th>
<th>1-2 glasses</th>
<th>2.11</th>
<th>0.67-9.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4 glasses</td>
<td>4.34</td>
<td>0.96-18.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥5 glasses</td>
<td>8.42</td>
<td>1.95-27.34</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Questions to participants:

14) Please comment the table above. Which are the factors associated with infection?

(10 minutes)

### Facilitator probes

The results of the case-control study indicated that residing in the western or southern zones and consumption of water from WS2 were associated with infection. A dose–response relationship was also found between the volume of water consumed daily and illness.

Those in the western zone were over 10 times more likely, and those in the southern zone almost eight times more likely, to be infected than those in the northern zone. Consumption of water from WS2 was associated with an almost seven-fold increased risk of infection. Those who drank a higher volume of water daily were more likely to get sick.

### Questions to participants:

15) Using Tillett et al criteria. Which level of evidence does the team have to state that this outbreak is waterborne?

(15 minutes)
**Facilitator probes**

*Tillett et al criteria:*

<table>
<thead>
<tr>
<th>A. Pathogen identified in clinical cases also found in water</th>
<th>B. Water quality failure and/or water-treatment problem of relevance, but outbreak pathogen is not detected in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Evidence from an analytical (case-control or cohort) study demonstrates an association between water and illness</td>
<td>D. Descriptive epidemiology suggests that the outbreak is water-related and excludes obvious alternative explanations</td>
</tr>
</tbody>
</table>

*Strongly associated if (A+C) or (A+D) or (B+C); probably associated if (B+D) or C only or A only; possibly associated if B only or D only.*

*Source: Tillett et al. (75) (reproduced with permission from Cambridge University Press).*

In this case study, the pathogen has been identified in clinical cases and in water (A) and there is evidence from an analytical (case control) study demonstrating an association between water and illness (C). Descriptive epidemiology suggests that the outbreak is water-related (D).

The current outbreak is strongly associated with water, according to Tillett et al criteria.
IX. Implement control measures and risk communication

In addition to the boil water notice issued on 15 September, the entire water-supply system was flushed to eliminate oocysts from the distribution system and disinfection after flushing was conducted. The filtration system was repaired and flushed to eliminate oocysts. Leaking and corroded pipes in the water-distribution system were replaced; Sewage system pipes were improved to enhance their capacity to cope with increased volumes during flooding events.

Advice on hand hygiene and infection control measures was available to the public to prevent secondary transmission within households. The public was regularly informed about the developments in the outbreak investigation.

Questions to participants:

16) Communication to the public is key to keep trust and to promptly inform about recommended prevented measures. What communication activities would normally take place in your municipality in a situation like this? What mechanisms could be used to distribute messages?

(15 minutes)

Facilitator probes

Please, discuss with participants how risk communication would be conducted in the district/municipal level in their countries. You can guide the discussion with additional questions such as

• Is there a risk communication plan developed at the municipal level? Are there communication experts in outbreak response teams?

• Who in the municipality is responsible for communicating with the media? Are the clearance processes?

• How is the information disseminated? What channels are used?

• Have risk communications strategies been evaluated after public health crisis?
X. Communication and evaluation of the outbreak response

Throughout the entire investigation, daily status reports were shared among all actors involved. Daily updates were posted on the municipality website and on social media. The team published an outbreak report within one month of declaring the outbreak over, in which several recommendations were included:

- introducing ozonation of raw water to deactivate Cryptosporidium in the source water prior to treatment.
- upgrading parts of the distribution system by replacing pipes.
- undertaking work to protect the water filtration system from future flooding.
- introducing a protection zone around the lake within which livestock grazing will be prohibited, to minimize faecal pollution runoff into the source water.
- increasing the frequency of inspection of the water-supply system, including the filtration system, after extreme weather events.
- increasing the frequency of water-testing at all stages of the system during and after extreme weather events.

The team conducted an after-action review of the outbreak and decided to reduce the threshold for reporting water-quality exceedances under event-based surveillance.

Questions to participants:

17) Final question: If this outbreak had occurred in your municipality…. Would things had handled similarly?

Please, identify three strengths, three gaps and three areas for improvement in terms of the response to this outbreak in your municipality.

(30 minutes)

Facilitator probes

Please, help the group to identify three strengths, three gaps and three areas for improvement in terms of the response to this outbreak in their municipality.

Areas to be covered could be preparedness, surveillance, response, laboratory, risk communication, human resources, coordination…
Acknowledgement

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