

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 taken
- Unknown source
- Unknown cause
- Severe and/or widespread illness
- 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

Communication Measures



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

Water quality

- Routine samples with faecal bacteria
- Water treatment or distribution failures
- User complaints

Other signals

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



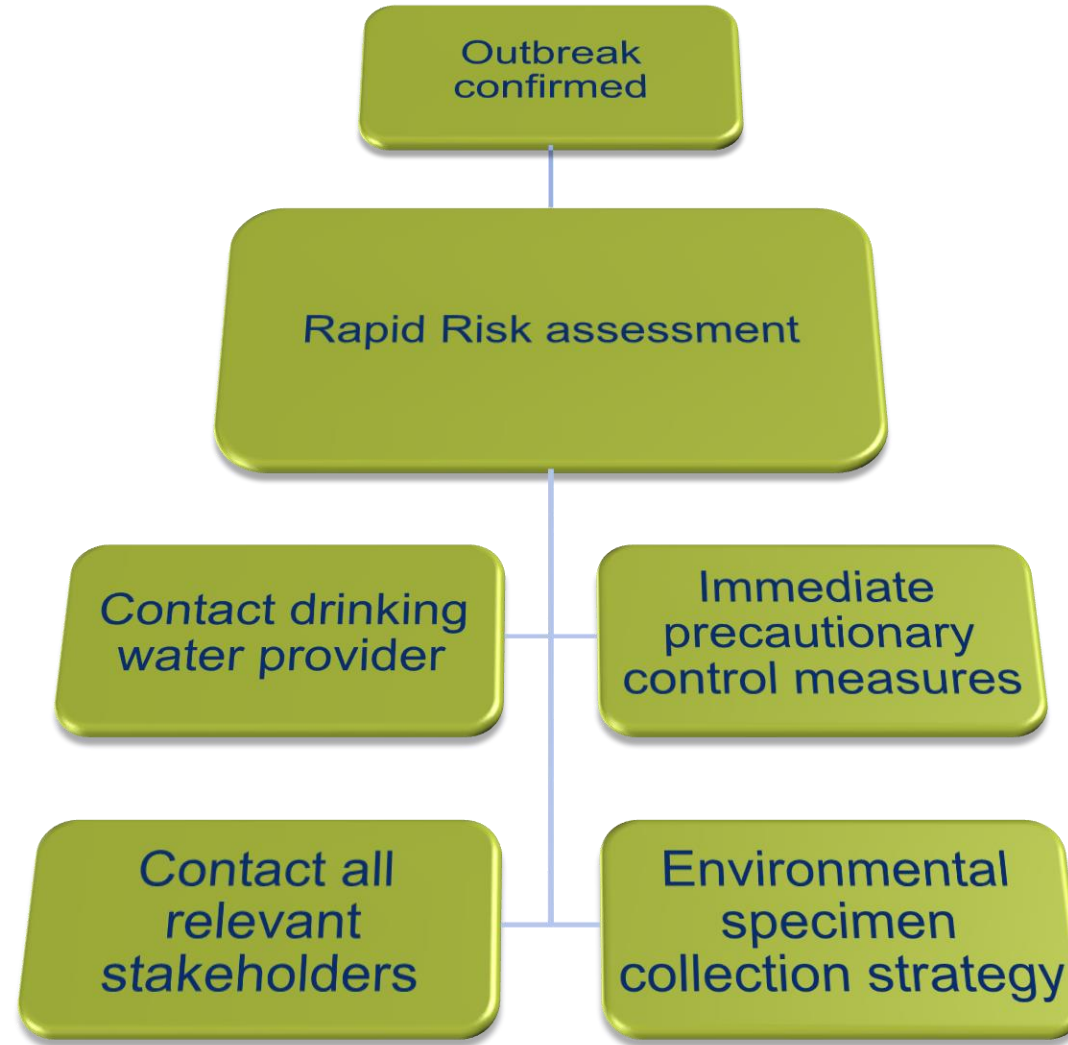
Step 1. Detect and **confirm the outbreak** and agent

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



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



Country example

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.

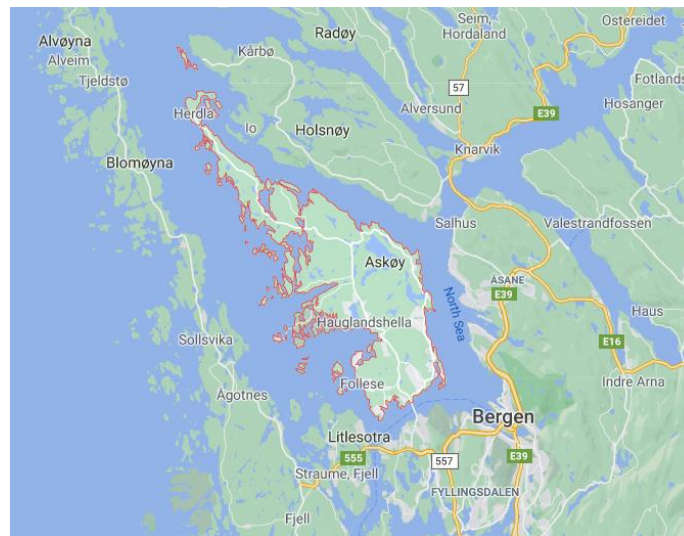
- In 24 h, 10 people **hospitalized** with fever, abdominal pain and diarrhea, and 30 **consultations** from out-of-hours primary healthcare services.
- Many patients presenting with gastroenteritis **had home addresses near each other**
 - drinking-water?
- One person tested positive for **Campylobacter**
- 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



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Outbreak context

- 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

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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

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 2. Form the Rapid Response Team (RRT)



Step 2. Form the Rapid Response Team (RRT)

Stakeholder	Role
Local/regional public Health agency	Overall coordination
Food/water authority	Environmental investigation
Water supplier	Control measures implementation
Health- care providers	Case management
Laboratory	Microbiological investigation

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

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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

	A	B	C	D	E	F	G	H
1	ID	Sex	Age	District	Adress	Phone	Hospital admision	Interviewed?
2	1	M	17	A	Water Street	99999	N	Y
3	2	M	27	A	Water Street	88888	N	Y
4	3	F	53	A	Water Street	77777	N	Y
5	4	F	81	A	Water Street	66666	N	Y
6	5	F	23	B	Water Street	55555	Y	Y
7	6	M	44	B	Lake Street	44444	N	N
8	7	F	38	B	Pound Square	33333	?	N
9



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?

Does the water come from a water work or do you have a private water supply for just your household?

	Yes	No	Unsure	Details (for instance name of the water work):
Water work for at least 20 households	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Water work for fewer than 20 households	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Private water supply for just your household	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

10. Is your drinking water treated (disinfected with chlorine or UV)?

Yes ☐ No ☐ Unsure ☐ If yes, what kind of treatment?

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

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 source?

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

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?

1. What kind of symptoms did you have?

Please specify when the symptoms started (date, time) and how long they lasted (no. of days or hours)

	Yes	No	Unsure	When did the symptoms begin?	Duration?
Nausea	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Vomiting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Abdominal pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Diarrhea (how frequent?)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Bloody stools	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Fever	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Joint pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other symptoms (what kind?)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

If the fever was measured: How many degrees?

2. When did you become ill?

Date / time: (Date when you first noticed symptoms)

3. How long lasted your illness?

Days / hours: Are you still sick?

4. Do you know other persons who had similar symptoms in the week before or the week after the day when your illness started?

If the answer is yes, did the person(s) become ill before or after your illness began?

Norwegian Institute of Public Health (2018): Guidelines for investigation of outbreaks, of food and waterborne diseases.

Step 4: Identify cases and obtain information

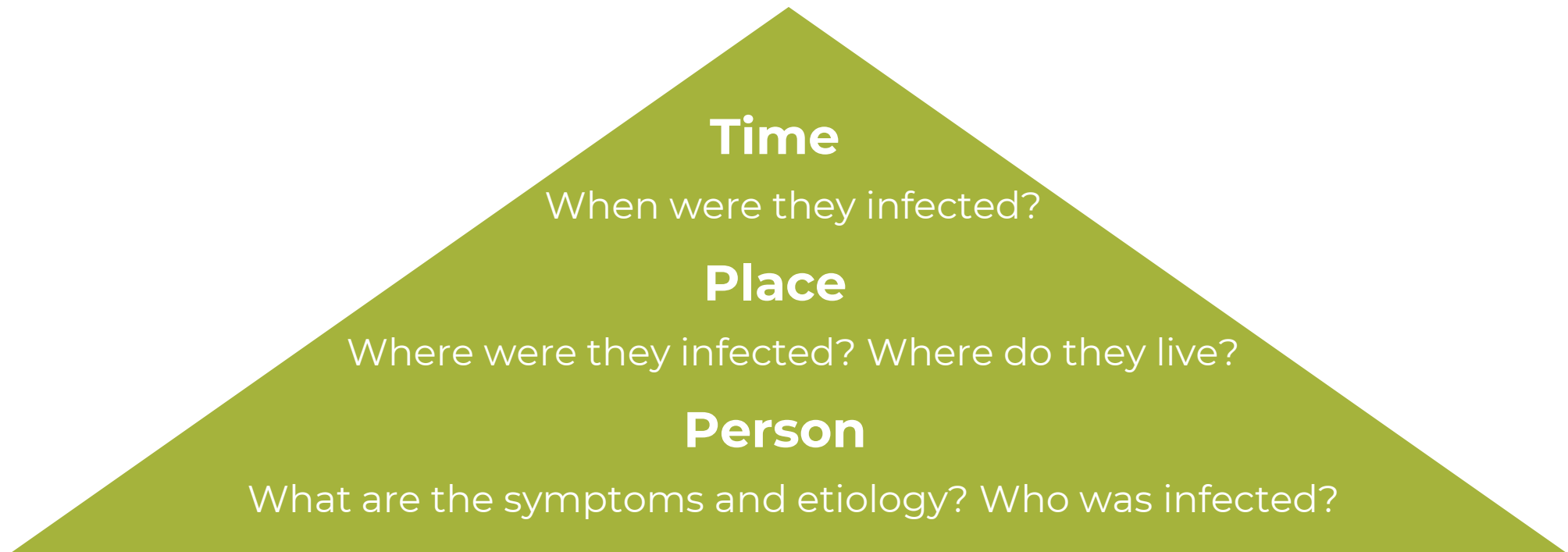
Questionnaires distribution

- Email
- Web questionnaires
- Telephone interviews
- Paper questionnaires by mail
- Social media



Step 5: Descriptive epidemiological investigation

What do cases have in common? → Generate hypothesis



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**

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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 (**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

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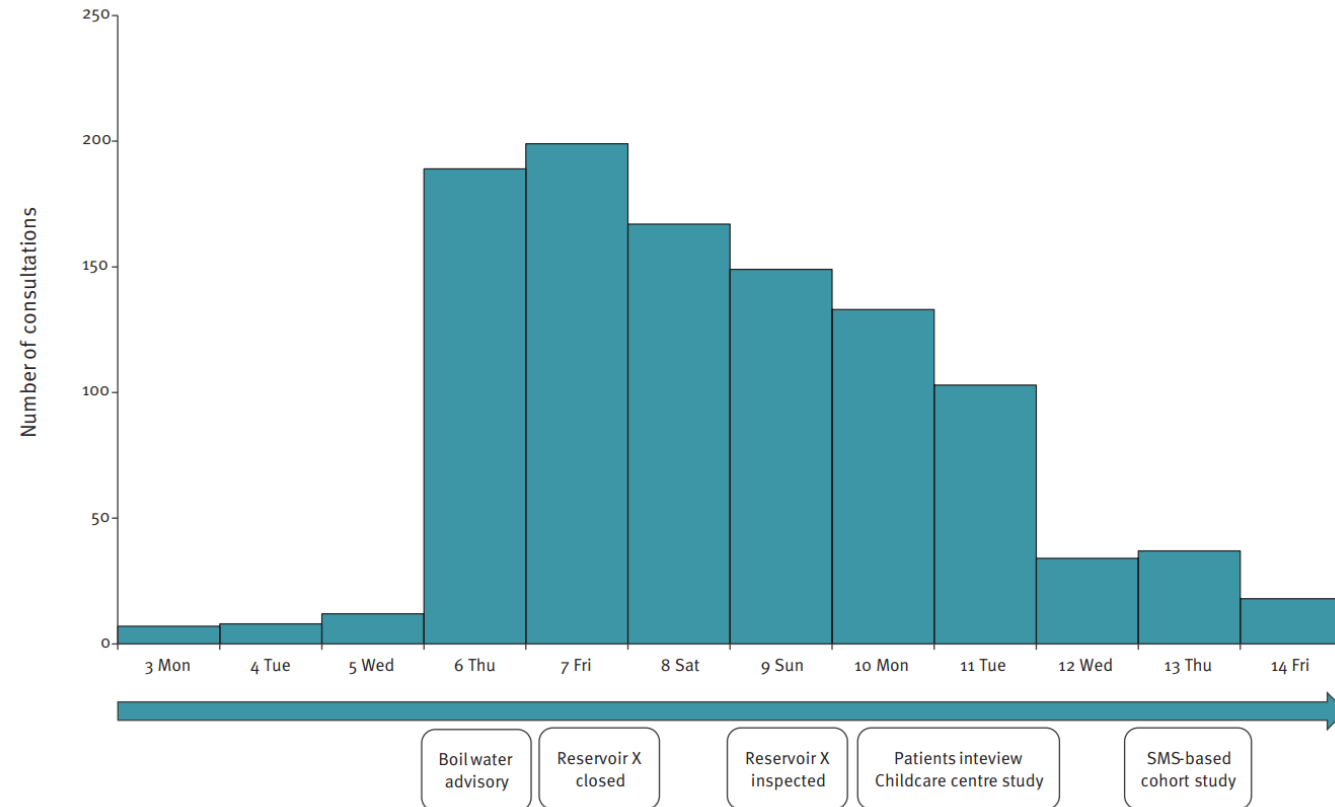


Step 3: Define cases

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

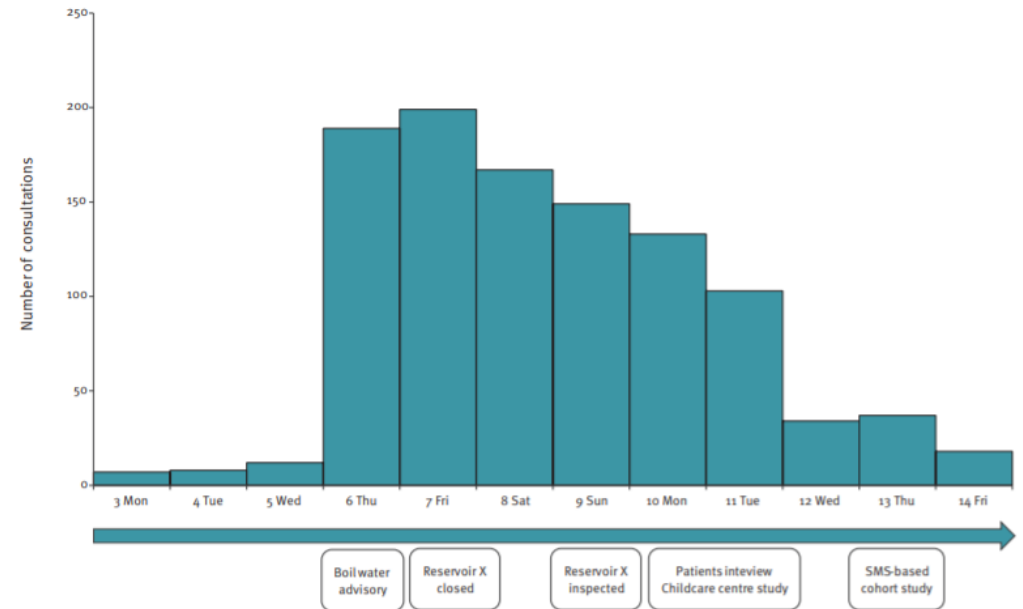


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Step 3: Define cases
Step 4: Identify cases and obtain information
Step 5: Descriptive epidemiological investigation

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



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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



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Step 3: Define cases

Step 4: Identify cases and obtain information

Step 5: Descriptive epidemiological investigation

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.



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Step 3: Define cases

Step 4: Identify cases and obtain information

Step 5: Descriptive epidemiological investigation

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**

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 3: Define cases

Step 4: Identify cases and obtain information

Step 5: Descriptive epidemiological investigation

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

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 3: Define cases

Step 4: Identify cases and obtain information

Step 5: Descriptive epidemiological investigation

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

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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



Step 6: Additional studies

Environmental investigation

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



Step 6: Additional studies (environmental, laboratory)

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



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 6: Additional studies (environmental, laboratory)

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, where birds could gather
 - Risk of bird faeces contaminating the area below
- No animals observed
- No unusual malfunctions reported before the outbreak

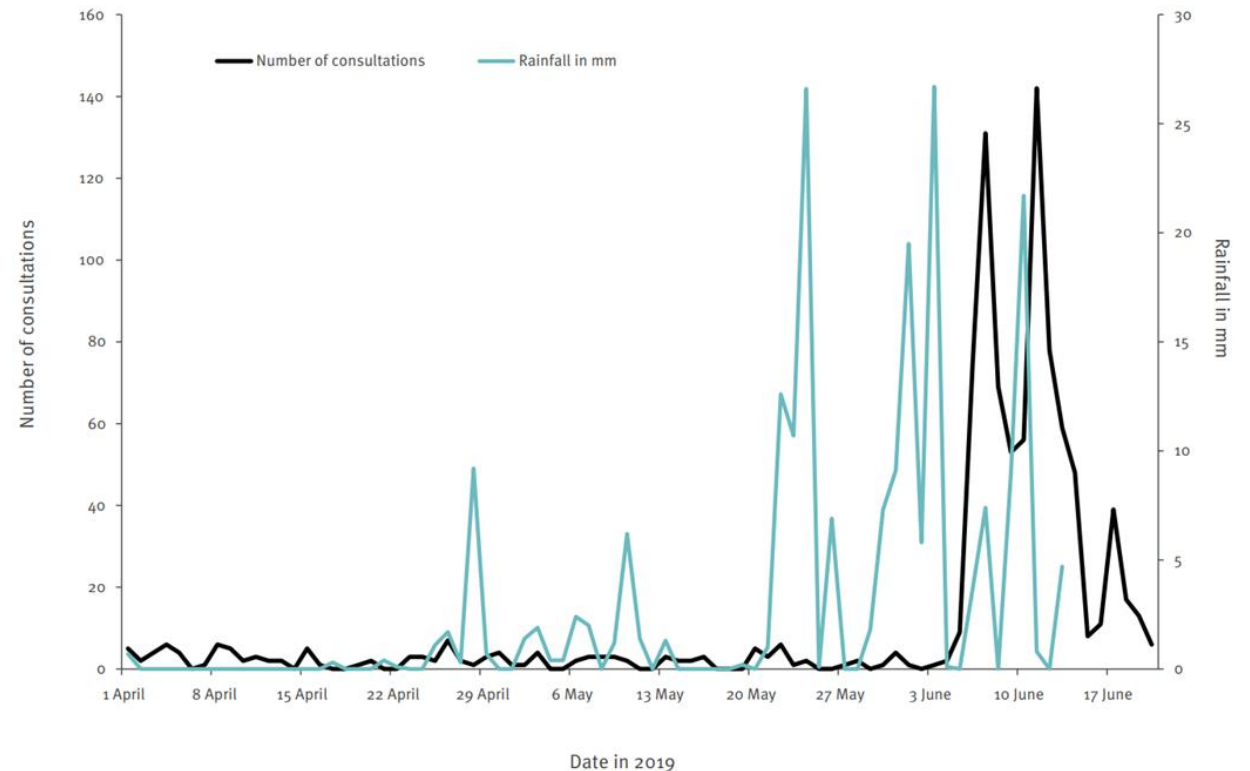
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Step 6: Additional studies (environmental, laboratory)

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.



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Step 6: Additional studies (environmental, laboratory)

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).

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Step 7: Generate hypotheses

Descriptive 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



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

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

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

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

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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

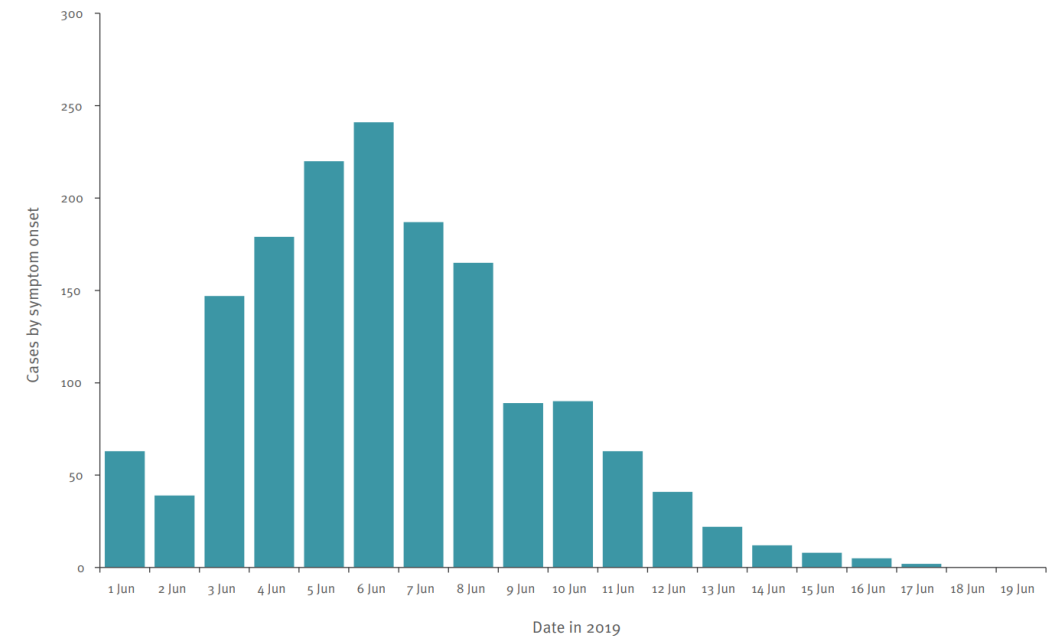
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Step 8: Evaluate the hypotheses Analytical studies Assessing the strength of evidence

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

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

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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

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

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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

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>



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>



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.

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 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



Step 10

Communicate findings, make recommendations and evaluate the outbreak response

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



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.
- The case study can be found at: Hyllestad et al, *Large waterborne Campylobacter outbreak: use of multiple approaches to investigate contamination of the drinking water supply system, Norway*. June 2019. Euro Surveill. 2020;25(35):pii=2000011. <https://doi.org/10.2807/1560-7917.ES.2020.25.35.2000011>
- Additional references are:
 - European Centre for Disease control and prevention. *Toolkit for investigation and response to food and waterborne outbreaks with an EU dimension*. Available at: <https://www.ecdc.europa.eu/en/publications-data/toolkit-investigation-and-response-food-and-waterborne-disease-outbreaks-eu>
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 - 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)



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