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

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[Graphs showing the epidemic curve with cases over time]
Time- when?

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

Confirmed, probable and unlinked reported campylobacteriosis cases

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?

Halonen et al. (2012): Waterborne Outbreak of Gastroenteritis: Effects on Sick Leaves and Cost of Lost Workdays. PLOS ONE. [https://doi.org/10.1371/journal.pone.0033307]
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><strong>Sex</strong></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><strong>Age group</strong></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;5</td>
<td>61</td>
<td>553.3 (423.5, 710.2)</td>
<td></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><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Māori</td>
<td>100</td>
<td>296.4 (241.2, 360.3)</td>
<td></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><strong>Age group amongst hospitalized</strong></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;5</td>
<td>1</td>
<td>9.1 (0.2, 50.5)</td>
<td></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><strong>Serious outcomes</strong></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?
The W's of descriptive epidemiology:

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


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

- **Exposed**
  - Disease
  - No Disease

- **Not exposed**
  - Disease
  - No Disease

Study starts here
### Analytical studies- Cohort studies

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

**Attack rate (incidence) in exposed**: $\frac{a}{a+b}$

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

→ **Relative Risk (RR)**: Incidence in exposed/incidence in not exposed
Relative Risk- Interpretation

• $RR = 1$; no association

• $RR > 1$; the exposure is a risk factor

• $RR < 1$; the exposure is a “protective” factor
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
**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](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.

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- 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)

*Bocca 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
## Table 3. Attack rates and relative risks according to usual behaviors and activities of staff members, tourist resort, Italy, July 2000

<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>

aCI, 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.
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
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

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
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

Case-Control study example

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.

<table>
<thead>
<tr>
<th></th>
<th>Cases (%) (n = 27)</th>
<th>Controls (%) (n = 54)</th>
<th>Matched OR</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Having children in household</td>
<td>8 (33%)</td>
<td>17 (34%)</td>
<td>1.2</td>
<td>0.3 – 4.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Having dog/cat</td>
<td>8 (30%)</td>
<td>7 (13%)</td>
<td>5.3</td>
<td>1.0 – 26.6</td>
<td>0.04</td>
</tr>
<tr>
<td>Salad</td>
<td>20 (83%)</td>
<td>45 (90%)</td>
<td>0.7</td>
<td>0.2 – 3.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Tomato</td>
<td>19 (83%)</td>
<td>44 (85%)</td>
<td>0.8</td>
<td>0.2 – 3.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Cucumber</td>
<td>20 (83%)</td>
<td>41 (82%)</td>
<td>1.2</td>
<td>0.3 – 4.3</td>
<td>0.8</td>
</tr>
<tr>
<td>Raw leek</td>
<td>9 (38%)</td>
<td>9 (18%)</td>
<td>7.1</td>
<td>0.9 – 58.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Mineral water</td>
<td>11 (42%)</td>
<td>27 (51%)</td>
<td>0.6</td>
<td>0.2 – 1.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Coffee</td>
<td>18 (72%)</td>
<td>28 (52%)</td>
<td>2.4</td>
<td>0.7 – 7.9</td>
<td>0.2</td>
</tr>
<tr>
<td>Beer</td>
<td>8 (33%)</td>
<td>8 (15%)</td>
<td>3.3</td>
<td>0.9 – 12.7</td>
<td>0.06</td>
</tr>
<tr>
<td>Water at home (&gt;5 glass)</td>
<td>20 (74%)</td>
<td>12 (23%)</td>
<td>7.3</td>
<td>2.4 – 21.8</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Water at the gym</td>
<td>10 (38%)</td>
<td>8 (15%)</td>
<td>5.2</td>
<td>1.1 – 26</td>
<td>0.03</td>
</tr>
<tr>
<td>Water in cafe or restaurant</td>
<td>10 (38%)</td>
<td>13 (25%)</td>
<td>1.8</td>
<td>0.6 – 5.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Drinking water at work</td>
<td>14 (56%)</td>
<td>24 (45%)</td>
<td>1.6</td>
<td>0.6 – 4.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Supermarket A</td>
<td>22 (88%)</td>
<td>27 (55%)</td>
<td>6.5</td>
<td>1.4 – 29.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Supermarket B</td>
<td>12 (52%)</td>
<td>19 (40%)</td>
<td>1.2</td>
<td>0.4 – 3.5</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**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](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