Food Contamination

Food safety involves protecting people from pathogens and chemicals in our food supply and—if that fails—preventing contaminated food from making people sick. Food supplies are susceptible to many different types of contaminants, for example:

Pathogens: disease-causing organisms such as bacteria, viruses, and parasites.

Food can be contaminated by pathogens at multiple points along the supply chain, including during production, processing, transport, storage, preparation and handling.

- Grasses are the natural diet of cattle. Feeding them grain, which is a standard practice in industrial operations, changes their gut environment in ways that increase populations of certain pathogens.[1]
- Poultry processing plants can legally operate at very high speeds—up to 140 birds moving down the line per minute—allowing as little as 0.43 seconds to identify and remove contaminated carcasses before they enter the food supply.[2]
- Industrial meat, dairy, and egg operations generate manure in such large quantities that it becomes difficult to safely manage. Pathogens in manure can contaminate food supplies, for example, if manure contaminates groundwater and that water is used to irrigate food crops.[3]
- Pathogens and biological toxins in food generally cause illness within hours or days of exposure. Symptoms may include cramps, nausea, and vomiting.

Chemicals: most originate from human activities, such as pesticide use in agriculture and heavy metals from coal-fired power plants.

- Industries such as mining, coal burning, and plastics manufacturing release chemicals into our environment. Many are known to be harmful, while the health effects of thousands of others are not yet understood. Because these chemicals are present in air, water, and soil, they can make their way into our food supply.
- Some potentially harmful chemicals, such as caramel color in soft drinks, are present in food or beverages because manufacturers add them directly to the product.[4]
- Agricultural pesticides give farmers some control over crop pests, such as weeds and certain insects, at least in the short term. Residues of these chemicals can remain on the fruits and vegetables we eat. Some pesticides persist in the environment and can accumulate in animals, contaminating meat and seafood.[5]
- In the U.S., growth hormones are given to cattle. It is unclear what effect these hormones may have on people who consume beef and dairy products, though some studies suggest a possible link to increased cancer risk.[6]
- Most chemical contaminants in food are associated with illnesses that develop gradually and persist over time, such as cancer, usually as a result of longer-term, repeated exposures.

1. Callaway TR, Elder RO, Keen JE, Anderson RC, Nisbet DJ. Forage feeding to reduce preharvest Escherichia coli populations in cattle, a review. *J Dairy Sci.* 2003;86(3):852-860.
2. Zuraw L. Reactions Vary to USDA's Poultry Inspection Rule. *Food Saf News.* 2014.
3. Graham JP, Nachman KE. Managing waste from confined animal feeding operations in the United States: the need for sanitary reform. *Water Heal.* 2010;December:646-670.
4. Smith TJS, Wolfson JA, Jiao D, et al. Caramel Color in Soft Drinks and Exposure to 4-Methylimidazole: A Quantitative Risk Assessment. *PLoS One.* 2015;10(2).
5. Dougherty C. Dietary Exposures to Food Contaminants across the United States. *Environ Res.* 2000;84(2):170-185.
6. California Breast Cancer Research Program. *Identifying Gaps in Breast Cancer Research.* 2007.

Outbreak Investigation: Description of the Outbreak

Scenario

On Wednesday, June 5, a local community organization held a fundraising crab feast for cancer research. Roughly 50 people attended. The menu included fresh steamed crabs, macaroni salad, egg salad, and sandwiches.

On Thursday, June 6, a woman who had attended the crab feast woke up feeling ill. She scheduled an appointment with her doctor. She described her symptoms as nausea, fever, chills, and body aches. On Friday, June 7, the physician noted that during the morning of her shift, she had seen several people with similar symptoms. She began asking questions about their previous activities and found they had all attended the crab feast. The doctor called the local health department to report what she suspected was a **foodborne illness outbreak.**

Start of the Investigation

The health department immediately began an investigation. A district health officer contacted patients and confirmed the doctor's report of their illnesses as well as their attendance at the crab feast. The investigator suspected the crab feast might have been the source of the illnesses.

The health department also prepared a questionnaire, which was distributed a week after the crab feast to as many people as possible who had attended the event. The questionnaire asked for the following information:

- Whether the person became ill
- What symptoms are occurring, if any
- When the symptoms began
- What foods the person ate

Out of the 50 people who attended the event, 20 responded to the questionnaire. The results are given in ***Outbreak Investigation: Questionnaire Data***. Each row represents a different person.

Parts of this activity have been adapted from: Principles of Epidemiology: Problem 1: An Outbreak of Sore Throats Following a Charity Luncheon. Johns Hopkins Bloomberg School of Public Health; 2010. Farber R.E., Korff F.A. *Foodborne Epidemic of Group A Beta Hemolytic Streptococcus.* Public Health Reports, 1958; 73(3), 203-9.

Outbreak Investigation: Questionnaire Data

Response #	Date sick	Crabs	Macaroni	Egg salad	Sandwiches
1	6th	Ate	Did not eat	Ate	Ate
2	7th	Ate	Did not eat	Ate	Ate
3	Not sick	Ate	Ate	Ate	Did not eat
4	8th	Did not eat	Ate	Ate	Ate
5	7th	Ate	Ate	Ate	Ate
6	Not sick	Did not eat	Did not eat	Did not eat	Ate
7	8th	Did not eat	Ate	Ate	Ate
8	Not sick	Ate	Ate	Ate	Ate
9	10th	Ate	Did not eat	Ate	Ate
10	8th	Did not eat	Did not eat	Ate	Did not eat
11	8th	Ate	Ate	Ate	Ate
12	7th	Did not eat	Did not eat	Ate	Ate
13	8th	Ate	Did not eat	Ate	Did not eat
14	7th	Ate	Ate	Ate	Ate
15	Not sick	Ate	Ate	Ate	Did not eat
16	7th	Did not eat	Did not eat	Did not eat	Did not eat
17	Not sick	Did not eat	Did not eat	Did not eat	Ate
18	8th	Did not eat	Ate	Ate	Ate
19	8th	Did not eat	Did not eat	Ate	Ate
20	9th	Did not eat	Did not eat	Ate	Ate

Outbreak Investigation: Attack Rate

The attack rate is the percentage of the people who became sick. Knowing about the attack rate can provide clues about which food was responsible for the outbreak.

Instructions: What percentage of the questionnaire's respondents got sick? Using the Questionnaire Data, count how many people became sick. To determine the attack rate, divide the number of sick people by the number of people who responded to the questionnaire. Write your results in the table below.

Number of respondents who got sick	Number of people who responded to questionnaire	Attack rate

Outbreak Investigation: Attack Rate by Food

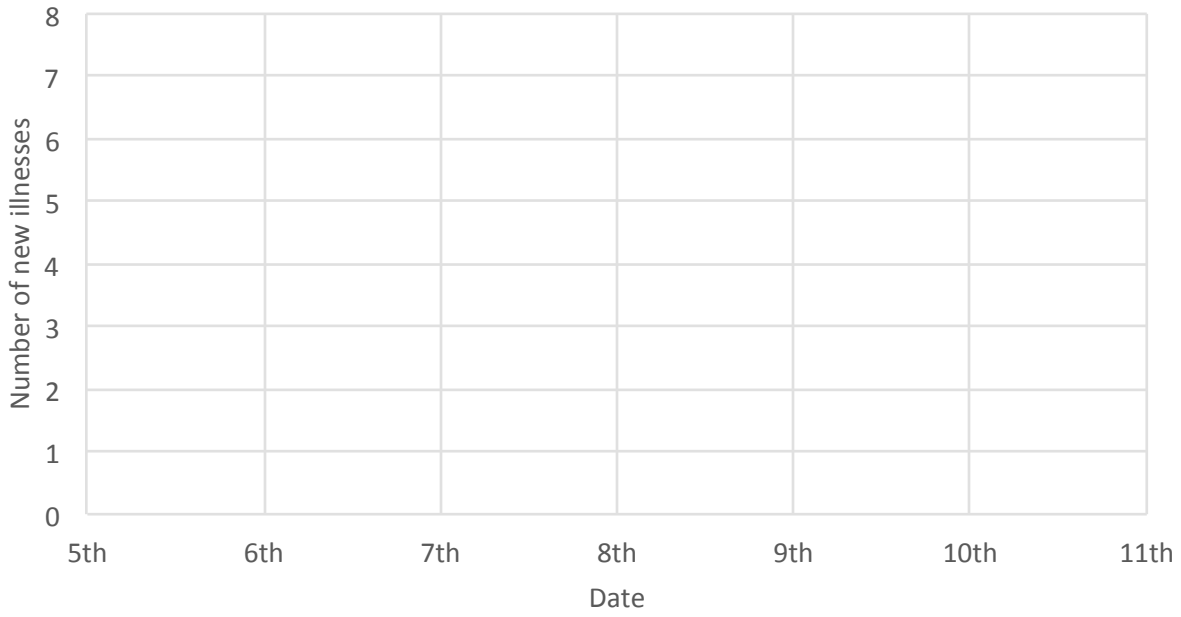
Instructions: Which food at the feast had the highest attack rate? For each food that was served, determine how many of the people who ate that food became sick. Divide this by the number of people who ate that food. The result is the attack rate for that particular food.

Food	Number of people who ate this food and got sick	Number of people who ate this food	Attack rate
Crabs	*7*	*10*	*0.70 (70%)*
Macaroni			
Egg salad			
Sandwiches			

Outbreak Investigation: Epidemic Curve

The incubation period is the time between exposure to a **pathogen** and the onset of symptoms. Knowing about the incubation period can provide clues about which pathogen was responsible for the outbreak.

Instructions: Determine when each person first reported his or her sickness. Graph your results below to determine when the majority of people became ill.



On what date did the most people become sick?.....

What is the mode (value that occurs most often) incubation period? In other words, how many days passed between the event and the date when the most people became sick?.....

Outbreak Investigation: Pathogen and Contaminated Food

Instructions: Answer the questions below about the pathogen and food that probably caused the outbreak. Consider the results of your investigation so far: the symptoms of people who became ill, the attack rate and the incubation period. Compare these against the descriptions of each pathogen below.

Which pathogen do you suspect caused the illnesses? .....

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Which food do you suspect was contaminated by the pathogen? .....

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Some of the people who said they ate this food did not get sick. What are some possible explanations?

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One person (#16) did not eat any of the foods on the menu. What are some possible explanations for his or her illness?

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Norovirus

Incubation period: 1-2 days

Signs and symptoms: nausea, vomiting, diarrhea

Commonly associated foods: poorly cooked shellfish, ready-to-eat foods like salads and sandwiches handled by infected persons, contaminated water

Campylobacter

Incubation period: 2-5 days

Signs and symptoms: fever, vomiting, diarrhea, abdominal cramps

Commonly associated foods: raw and undercooked poultry, unpasteurized milk, contaminated water

Salmonella

Incubation period: 1-3 days

Signs and symptoms: fever, vomiting, diarrhea

Commonly associated foods: eggs, poultry, meat, and cheese; unpasteurized milk and juice; certain raw fruits and vegetables like sprouts and melons

E. coli

Incubation period: 1-8 days

Signs and symptoms: vomiting, diarrhea, abdominal cramps

Commonly associated foods: undercooked ground beef, unpasteurized milk and juice, contaminated water

Adapted from foodsafety.gov

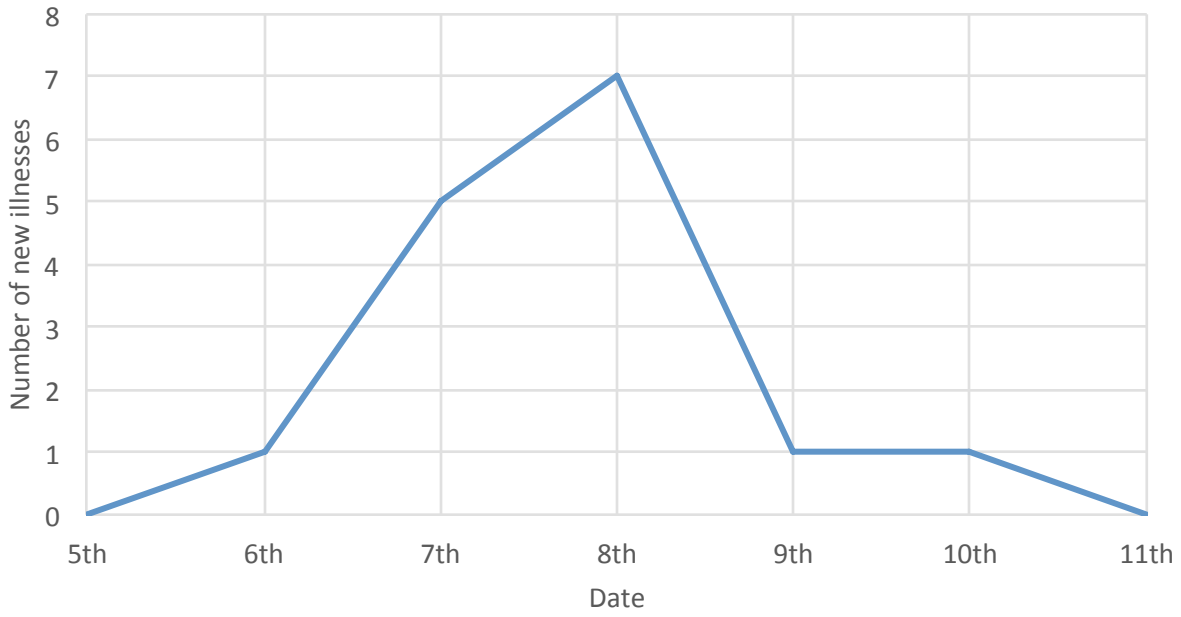
Answer Key: Attack Rate

Number of people who got sick	Number of people who responded to questionnaire	Attack rate
17	*20*	*0.85*

Answer Key: Attack Rate by Food

Food	Number of people who ate this food and got sick	Number of people who ate this food	Attack rate
Crabs	*7*	*10*	*0.70 (70%)*
Macaroni	*6*	*9*	*0.67 (67%)*
Egg salad	*14*	*17*	*0.82 (82%)*
Sandwiches	*12*	*15*	*0.80 (80%)*

Answer Key: Epidemic Curve



On what date did the most people become sick? *June 8th*

Mean, median, and mode incubation period: *3 days*

Answer Key: Pathogen and Contaminated Food

Which pathogen do you suspect caused the illness? *Salmonella*

Which food do you suspect was contaminated by the pathogen? *Egg salad*

Some of the people who said they ate this food did not get sick. What are some possible explanations?

- *People who responded to the survey may not accurately remember which foods they ate.*
- *Some people might have greater immunity to the illness because they had been exposed to it before, because they have stronger immune systems, or because they are genetically less susceptible.*
- *The people who got sick may have eaten more egg salad than those who did not. This is sometimes called "dose-response" because exposure to a larger dose of pathogens generally increases the risk and severity of illness.*
- *Because people often don't seek treatment and report their symptoms, it can be difficult to trace the source of a foodborne illness outbreak. The people who do report illness may represent only the tip of the iceberg.*

One person (#16) did not eat any of the foods on the menu. What are some possible explanations for his or her illness?

- *Person #16 may have forgotten what he or she ate.*
- *Person #16 may have been exposed to the pathogen through contact with another infected person. Proper hand washing could have prevented this type of person-to-person transmission.*
- *Person #16 may have gotten sick from a completely unrelated event, from a different pathogen. Many pathogens cause nausea, diarrhea, and vomiting.*
- *Person #16 may have suffered illness from cross-contamination from an item that did contain the pathogen. For example, someone brought leftovers home, spilled them on the counter and then, person #16 prepared food on that counter.*