FOODBORNE ILLNESS OUTBREAK INVESTIGATION

Purpose
This exercise intends to demonstrate how epidemiological investigations of outbreaks are performed. Participation in this case study illustrates the principles of hypothesis formation and testing by epidemiologic study in the setting of an acute foodborne disease outbreak. The potential to answer important scientific questions about the cases and non-cases and their food histories in the scenario outbreak will be emphasized.

Overview
This case study consists largely of a series of questions and answers about an evolving outbreak scenario that are designed for open discussion and calculation. Using the Symptom Tally Work Sheet, students will determine the most commonly occurring symptoms. Then they will prepare a graph to illustrate the epidemic curve. Using the Attack Rate Work Sheet, students will calculate the attack rate for each food served. On the basis of this additional evidence, students will try to determine the suspect foods and try to explain how the food became infective. Differences in attack rates among people who ate and people who did not eat a specified food item are then compared. Students will then be asked to summarize their data and present their conclusions.

Time
1 two hour block class period or can be broken up with homework calculations.

Key Concepts
Outbreak investigations, an important and challenging component of epidemiology and public health, can help identify the source of ongoing outbreaks and prevent additional cases. Even when an outbreak is over, a thorough epidemiologic and environmental investigation often can increase our knowledge of a given disease and prevent future outbreaks. Finally, outbreak investigations provide epidemiologic training and foster cooperation between the clinical and public health communities.

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Skills
Graphing, proportions, 2x2 table analysis, critical thinking

Materials
Scientific calculator

Facilitator Preparation
You will need to divide the students into groups or teams. Prior knowledge of the Food/Foodborne Illness Primer, as well as other modules, will prepare you for the range of issues addressed in this section.

Procedure

As a Public Health Consultant, you and your colleagues have been asked by the Cruise Line to investigate the apparent outbreak of food poisoning aboard the luxury cruise ship, the AMBIENT. The outbreak appears to have started among people who attended a Final AMBIENT Banquet on June 11, the evening before the end of cruise. The total number of people who attended the banquet was 1000 people.

Over a 48 hour period starting on 6/12, multiple cases of an acute illness have been reported from the Ship's Medical Facility, as well as various healthcare provider offices and emergency room/health posts from several states as people returned to their homes.

The first reported case was a 20 year old woman, previously completely healthy, who presented at the Ship's Medical Facility complaining of nausea, vomiting, and diarrhea. She was afebrile (no fever), but quite dehydrated due to the vomiting and diarrhea. After a few hours, she also noted pain and tingling in her gums, muscle pains, and severe tiredness. In the 12 hours prior to presenting at the Ship's Medical Facility, she had attended the Final AMBIENT Banquet and had eaten everything with great gusto! She reported that others in her family were sick with a similar illness and that all the food had tasted delicious.

1. What are some of the initial steps that you need to take to investigate and control this illness(es)?

2. Based on the information from a random selection of reported cases of illness in Table 1, create an epidemic curve (i.e. Number of people ill vs date of onset of symptoms/disease).

Table 1. A random selection of reported cases of illness

Case of Illness number	Gender	Age	Date of Sx Onset	Initial Symptoms	24 hour Food Consumption prior to illness	Attended Banquet
1	F	30	6/11	GI, neuro	Shellfish soup only	Yes
2	M	15	6/12	GI	Seafood	Yes
3	M	14	6/12	GI, neuro	Shellfish soup only	Yes
4	M	17	6/12	GI	Seafood	No
5	F	30	6/1	GI, Respiratory	No Seafood	Yes
6	F	19	6/12	GI, neuro	Seafood	Yes
7	M	16	6/12	GI, neuro	Seafood	Yes
8	M	21	6/11	GI, neuro	Seafood	Yes
9	M	15	6/11	GI	No seafood	No
10	F	25	6/12	GI, neuro	Seafood	Yes

F=Female; M=Male
GI = gastrointestinal (vomiting, diarrhea, abdominal pain)
Neuro = neurologic (paresthesias)
Respiratory = difficulties breathing

An epidemic curve plots the date of onset of symptoms/disease vs. the number of people with illness. The epidemic curve not only describes the timing and course of an epidemic, it can also be used to evaluate if there is a possible point source or contagious origin. It can also evaluate the progress of the epidemic and any interventions enacted to prevent further cases of illness. This curve can be done initially as a histogram and then a smooth linear line.

PLACE A GRAPH HERE OF THE EPIDEMIC CURVE

VERTICAL AXIS=NUMBER OF PEOPLE
HORIZONTAL AXIS=DATES

This curve can be done initially as a histogram and then a smooth linear line.

3. Is this epidemic probably of point source origin (i.e. a single exposure event) or contagious etiology (i.e. can be passed from person to person)?

4. Based on the information in Table 1, describe the date of onset, gender and age range, symptoms, 24 hour consumption pattern, and Banquet Attendance of a typical reported case (i.e. Create a "case definition"). If there are any persons who do not fit this definition, discuss why they do not fit the case definition.

5. What are possible known diseases that fit this case definition (using the Table)?

6a. You find that there are 60 cases in total among the sample of 100 persons who ate at the banquet that fit this case definition. What was the prevalence of this illness for the Final AMBIENT Banquet at this time (prevalence = number of cases/population at risk)?

6b. What would the incidence of this illness for the Cruise Ship AMBIENT if there were 340 additional cases in 2 similar outbreaks earlier in the same year (incidence=number of new cases/population at risk/year) with 40,000 passengers/year?

You decide to focus on those people who attended the Final AMBIENT Banquet. You discover that a total of 100 people of all ages attended the Final AMBIENT Banquet. You are able to interview a random selection of 7 cases of ill persons and 3 controls (non ill persons), all of whom attended the Banquet (Table 2).

Table 2. A random selection of Banquet attendees

Case/Control	Gender	Age	Consumed Shellfish soup	Consumed Cream Puff Desert	Drank Alcohol with meal	Other
Case	F	25	Y	Y	N	
Case	M	15	Y	N	Y	
Control	F	54	N	Y	Y	
Case	M	30	Y	N	Y	
Case	M	15	Y	Y	Y	
Control	F	10	Y	Y	N	
Case	M	16	N	N	Y	
Control	M	70	N	N	N	
Case	M	18	Y	N	N	
Case	M	25	Y	N	Y	

7. Based on a random selection of persons attending the Banquet in Table 2, describe the approximate “attack rate” of illness where “exposure” is attending the Banquet (“attack rate” = number of people who exposed and became ill divided by the number of people who exposed).

8. Describe the typical “case” and “control” in terms of gender, and mean age and range.

9. Summarize your results to date.

10. What is the most likely source of illness and what is your diagnosis at this point (Use the Table)?

11. What do you need to confirm your diagnosis?

12. What can you do now and in the future to prevent outbreaks of this illness?

Table 2. Human Intoxication Syndromes caused by Marine Microbial Toxins

Toxin(s) (Number)	Saxitoxin (18+)	Brevetoxin (10+)	Okadaic Acid (4)	Domoic Acid (3)	Ciguatoxin (10+), Maitotoxin, Scaritoxin	Brevetoxin (10+)	Anatoxins (3+), Saxitoxins (2+), Microcystins, Nodularins, cylindrosperm-opsins
Disease(s)	**Paralytic Shellfish Poisoning[1] (PSP)**	**Neurotoxic Shellfish Poisoning (NSP)**	**Diarrheic Shellfish Poisoning (DSP)**	**Amnesiac Shellfish Poisoning (ASP)**	**Ciguatera Fish Poisoning**	**Respiratory Illness, Asthma exacerbations**	**Skin irritation, GastroIntestinal (liver) disease**
Causative Organism(s)	Red tide dinoflagellate	Red tide dinoflagellate	Red tide dinoflagellate	Red tide Diatom	Epibenthic dinoflagellate	Red tide dinoflagellate	Blue green algae, Cyanobacteria
Route of Exposure(s)	Ingestion	Ingestion	Ingestion	Ingestion	Ingestion	Inhalation, ?Skin	Ingestion, ?Inhalation, ?Skin
Major Transvector(s)	Shellfish	Shellfish	Shellfish	Shellfish, ?Fish	Fish	Water	Water
Moleculary Mechanism(s)	Na+ Channel Blocker	Na+ Channel Activator	Phosphorylase Phosphatase Inhibitor	Glutamate Receptor Agonist	Na+, Ca++ Channel Activators	Na+ Channel Activator	Acetylcholinesterase Inhibitor, Na+ Channel Blocker, Phosphorylase Phosphatase Inhibitor, Protein Synthesis Inhibitor
Incubation Time	5-30 min	30 min-24 hrs	<24 hrs	<24 hrs	<24 hrs	Minutes	Hours to days
Duration	Days	Days	Days	Years	Months	Unknown	Days to Unknown
Acute Symptoms	GI, N, R	GI, N, R	GI, N	GI, N	GI, N, R	R	GI, N, R, D
Chronic Symptoms	Unknown	Unknown	Unknown (Carcinogen)	Amnesia	Paraesthesias	Unknown	Unknown (Carcinogens)
Fatality Rate	1-14%	0%	0%	3%	0.1-12%	Unknown	0-50%
Diagnosis	Clinical, Mouse bioassay, HPLC, ?ELISA	Clinical, Mouse bioassay, HPLC, ?ELISA	Clinical, Mouse bioassay, HPLC	Clinical, Mouse bioassay, HPLC	Clinical, Mouse bioassay, HPLC, ?ELISA	Clinical, Mouse bioassay, HPLC, ?ELISA	Clinical, Mouse bioassay, HPLC, ?ELISA
Therapy	Supportive (?Antibody)	Supportive	Supportive	Supportive	IV Mannitol, Supportive; TCA chronic	?Anti-Asthma Medications	Supportive
Prevention	Red Tide Monitor & Seafood/Case Surveillance	Red Tide Monitor & Seafood/Case Surveillance	Red Tide Monitor & Seafood/Case Surveillance	Red Tide Monitor & Seafood/Case Surveillance	?Fish/Case Surveillance	Red Tide Monitor & Case Surveillance	Bloom & Water Monitor & Case Surveillance

[1]Tetrodotoxin (Fugu or Pufferfish) Poisoning presents clinically similar to PSP except for history of pufferfish ingestion; Not included due to insufficient knowledge to characterize: Pfiesteria/Estuarine Associated Syndrome, Azaspiracidosis, Shark toxins, etc.
Acute Symptoms: GI=GastroIntestinal, N=Neurologic, R=Respiratory, D=Dermatologic
Therapy: TCA=Tricyclic Antidepressants
? = theoretical, not epidemiologically established

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Table . Reported Seafood Poisoning Outbreaks by Etiology

Etiology	Seafood	Illness
***Bacterial*:**		
Salmonella (typhi, paratyphi)	**Shellfish**	**Severe Fever and blood infection**
Vibrio (cholerae, parahaemolyticus, mimicus, hollisae, fluvialis, vulnificus)	**Shellfish, Crustaceans, Fish**	**Gastroenteritis, Blood infection (at risk immuno-compromised, liver disease)**
Shigella	**Shellfish**	**Gastroenteritis**
Camphylobacter	**Shellfish**	**Gastroenteritis**
Aeromonas hydrophila, veronii sobria, caviae	**Shellfish, seafood**	**Gastroenteritis (at risk immuno-compromised)**
Bacillus cereus	**Shellfish**	**Gastroenteritis**
Edwardsiella tarda	**Shellfish**	**Gastroenteritis**
E. coli (including enterotoxigenic)	**Shellfish, Seafood**	**Gastroenteritis**
Listeria monocytogenes	**Seafood**	**Listeriosis**
***Viral*:**		
Hepatitis A	**Shellfish**	**Hepatitis**
Small Round Structured Viruses, Norwalk-Like Viruses (Norwalk, Cockle, Snow Mountain, Calicivirus)	**Shellfish**	**Gastroenteritis**
Rotavirus	**Shellfish**	**Gastroenteritis**
Astrovirus	**Shellfish**	**Gastroenteritis**
***Parasitic*:**		

Anisakis	**Fish (raw) herring, cod, whiting, haddock, salmon**	**Abdominal discomfort, Eosinophilia (blood disorder), Allergy**
Gnathostoma	**Fish**	**Abdominal discomfort, Eosinophilia (blood disorder), Allergy, Eosinophilic Meningitis (blood disorder spine infection)**
Diphyllobothrium Latum	**Fish (raw) Gefilte fish, Salmon**	**Gastroenteritis, Anemia (B_{12}), Eosinophilia (blood disorder)**
Giardia lambia	**Salmon**	**Giardiasis**
Nanophyetus salmincola	**Fish (raw) Steelhead trout**	**Gastroenteritis, Eosinophilia**
Heterophes	**Fish (raw) Asian and Nile**	**Gastroenteritis**
Eustrongylides	**Fish (raw)**	**Peritonitis**
***Toxins (natural)*:**		
Scombrotoxin	**Fish**	**Scombroid**
Botulism Toxin E (Clostridium botulinum)	**Fish**	**Botulism**
Enterotoxin (Staphylococcus aureus)	**Seafood**	**Gastroenteritis**
Saxitoxin (Dinoflagellate)	**Shellfish**	**Paralytic Shellfish Poisoning (PSP)**
Brevetoxin (Dinoflagellate)	**Shellfish**	**Neurotoxic Shellfish Poisoning (NSP)**
Okadaic Acid (Dinoflagellate)	**Shellfish**	**Diarrheic Shellfish Poisoning (DSP)**
Domoic Acid (Diatom)	**Shellfish**	**Amnesiac Shellfish Poisoning (ASP)**
Tetrodotoxin (?Bacteria)	**Pufferfish**	**Fugu/Pufferfish Poisoning**

Ciguatoxin (Dinoflagellate)	**Reef fish**	**Ciguatera Fish Poisoning**
Toxins (other):		
Heavy metals:		
Mercury	**Fish**	**Methylmercury Poisoning**
Other:		
Polychlorinated Biphenyls (PCBs), Organochlorines	**Fish**	**?Cancer, ?Neurotoxicity, ?Immunotoxicity, ?Reproductive Toxicity**
Radioactive waste, Radionucleotides	**Seafood**	**Unknown, ?Cancer**