ENTERIC DISEASE OUTBREAK INVESTIGATION MODEL

Developed by:
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a working group of epidemiologists, laboratorians, public health nurses, and environmental health staff from state and local public health agencies

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Introduction, Purpose, and Development

The vast majority of communicable disease outbreaks investigated by public health are of enteric origin (affecting the intestines). Local health departments in Utah have expressed interest in collaborating to develop a guidance document for enteric outbreak investigations, which can then be a model for investigating other types of outbreaks. Enteric disease outbreak investigation can be good "practice" for bioterrorism or pandemic events.

The vision of the Enteric Disease Outbreak Investigation Model is to provide local health departments with guidelines for conducting an enteric disease outbreak investigation. These best-practices guidelines have been developed with input from investigators statewide. Through Utah's Surveillance, Laboratory, and Epidemiology Workgroup (SLEW), a committee was formed to work on enteric disease issues. This committee has representation from local and state public health agencies, including individuals from environmental, nursing, and epidemiology bureaus within those agencies. In a series of meetings and email discussions, this group developed an outline and detailed guidance for enteric disease outbreak investigations. Various sources, listed in References (page 30), were consulted during the development process. This document is the sum of the committee's efforts on this task.

The Model addresses all facets of and enteric disease outbreak investigation: epidemiologic, environmental, nursing, legal, and public information. Users of this Model should remember that outbreak investigation is not a linear process, though the Model is linear for ease of discussion and explanation. Each investigation has a unique direction and flow. The Model contains suggestions and recommendations, but the steps are not mandated.

The Model consists of three investigative stages with clear stopping points, giving investigators a chance to decide as a group how far to take the investigation. Again, these stopping points are general guidelines for a non-linear process. Also, investigators may combine tasks from different stages as necessary**.**

Investigators are encouraged to review and use this Model for enteric disease outbreak investigations. This document is also designed to be used as a training model for outbreak investigators.

Utah Department of Health, Bureau of Epidemiology
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ENTERIC DISEASE OUTBREAK INVESTIGATION MODEL OUTLINE

STAGE 1 INVESTIGATION

1. Is this an outbreak or an unusual event? Determine if what you're seeing is an event of interest needing further resources or attention for:

1a. An event reported by *a call from the public.*

1b. An event identified through *disease surveillance.*

1c. An *epidemiologic link.*

2. Organize and share preliminary information.
- Inform decision makers
- Is there consensus that this is an outbreak or unusual event?

3. Decide next steps
- Intervention
- Why are we investigating/not investigating this outbreak or unusual event?

Stage 1 Summary for the Record

---------- **Stopping Point** ----------

STAGE 2 INVESTIGATION

4. Assemble an investigation team and perform assigned tasks
- Coordinator, communicable disease nurse, epidemiologist, environmental health scientist, public health laboratorian, UDOH epidemiologist, LHD administrator, public information officer, law enforcement agent, UDAF representative, key players within the facility.
- Make assignments and clarify roles

5. Develop a case definition

6. Define the scope of the outbreak or unusual event
- Conduct an environmental inspection
- Verify the diagnosis
    - Perform clinical laboratory testing
    - Encourage those ill to visit PCP
    - Request PFGE or other laboratory testing
- Search for additional cases
    - Active surveillance: call laboratories, conduct chart reviews, notify physicians
    - Notify other LHDs and UDOH
    - Identify other groups who may have been exposed

7. Analyze the preliminary data and develop an initial hypothesis concerning the outbreak
- Create a line list or database of case information
- Draw an epidemic curve
- Develop a hypothesis

8. Decide next steps (see Section 3)

- Intervention
- Why are we continuing/not continuing to investigate this outbreak or unusual event?

Stage 2 After-Action Report or Summary of Investigation

---------- **Stopping Point** ----------

STAGE 3 INVESTIGATION

9. Determine how to test the hypothesis

- Descriptive studies, e.g. additional environmental specimen collection
- Analytical studies, e.g. case-control studies

10. Develop a questionnaire

11. Administer the questionnaire

12. Data analysis

13. Final action steps

- Intervention
- Write, distribute, and present investigation results

Stage 3 After-Action Report or Summary of Investigation

Acronyms and Definitions

CDC ..... Centers for Disease Control and Prevention

Enteric .....
Affecting the intestines.

FDA ..... U.S. Federal Drug Administration

Laboratory- and physician-based reporting .....
Refers to reports of notifiable diseases by laboratories, physicians, and other required entities as mandated by Utah law (Utah Code Ann. §26-6).

LHD ..... Local Health Department

MMWR .....Morbidity and Mortality Weekly Report (CDC publication)

NEDSS .....National Electronic Disease Surveillance System
Under development, this will be a web-based data collection, case management, and surveillance system for public health investigation.

NETSS ..... National Electronic Telecommunication System for Surveillance
The data management system currently used by UDOH and many local health departments.

PCP .....Primary Care Physician

PFGE ..... Pulsed Field Gel Electrophoresis

PFGE is a laboratory technique that uses electric pulses to pull large fragments of DNA through a transparent gelatinous material called an agarose matrix or gel. First, DNA from certain bacteria is cut into different sized pieces using special enzymes. Then, the electric pulsing pulls the DNA through the gel, the smaller pieces traveling further than the larger pieces. This produces a banding pattern that is unique to that DNA. The DNA has a dye added so that the fragments glow through the gel when a picture is taken. A computer program is used to analyze the pictures and to give that particular banding pattern a number. Different enzymes can be used to cut the DNA at different locations, creating different DNA fragments. Therefore, the same isolate can have several different PFGE patterns depending on which enzyme was used.

Isolates with matching or similar PFGE patterns more likely came from the same source. Epidemiologists can use clusters of isolates with matching or similar PFGE patterns to identify outbreaks. PFGE is most often performed on isolates from enteric bacterial pathogens such as *Salmonella*, *Shigella*, shigatoxin-producing *E. coli*, and *Campylobacter*. PFGE is only performed at public health laboratories like UPHL.

RODS .....Real-time Outbreak Detection System

SLEW .....Utah's Surveillance, Laboratory, and Epidemiology Workgroup
Utah's working group of epidemiologists, laboratorians, public health nurses, and environmental health staff from state and local public health agencies.

UDAF ..... Utah Department of Agriculture and Food

UDOH ..... Utah Department of Health

USDA ..... U.S. Department of Agriculture

UPHL ..... Utah Public Health Laboratory

Greater than ..... >

Less than ..... <

ENTERIC DISEASE OUTBREAK INVESTIGATION MODEL:

STAGE 1 INVESTIGATION

Basic investigative steps that happen in all outbreak situations:

- ☐ **Recognize the event/outbreak** (Section 1)
- ☐ **Look at data at the group level** (Section 2)
- ☐ **Convene decision makers** (Section 2)
- ☐ **Intervene if necessary** (Section 3)
- ☐ **Decide as a group to continue or not** (Section 3)
- ☐ **Summarize and Report** (Stage 1 Summary for the Record)

Section 1. Recognize the event/outbreak.

A large proportion of health department's workload is enteric disease investigation. It is a key part of the job to determine if the enteric disease event is an event of interest needing further resources or attention. There are three ways in which a foodborne disease event comes to the attention of the investigator. Each of these is discussed further in ***Sections 1a-1c***.

- 1a. Call from the public
- 1b. Routine public health disease surveillance
- 1c. Recognized epidemiologic links

Regardless of how the event is identified, a key first step is to **verify the diagnosis**. This will be done differently depending on the situation. Some ways to verify the diagnosis include:

- arranging for clinical specimens to be collected and tested;
- verifying that laboratory results have been reported correctly;
- and requesting laboratory confirmation through the public health laboratory.

For more information on verifying the diagnosis, see ***Section 6***.

Section 1a. For an event reported by a *call from the public,* determine if what you are seeing is an event of interest needing further resources or attention.

Enteric disease illness report calls come to the health department from the public through both communicable disease nursing/epidemiology bureaus and environmental health bureaus. These two arms must communicate in order to both identify valid reports and clusters of reports and to respond appropriately. Many health departments have implemented this communication successfully through a simple spreadsheet log or other database that is shared between bureaus. The data should be analyzed regularly to identify trends and person, place, and time associations. Ideally, public-based foodborne illness reports are also analyzed at the regional and statewide level.

Public reports are generally real-time reports of illness, without the delay inherent in the laboratory- and physician-based reporting system. However, there is generally no physician's diagnosis or laboratory confirmation at the time of report. Therefore, many public reports are invalid, meaning that the source to which the reporter attributed the illness is not the actual source of illness, or the illness is not a communicable enteric disease.

There are two general types of public foodborne illness reports:

(1) **Single:** An individual or small-group event in which few people are ill and many were potentially exposed.
   Examples: Caller became ill shortly after eating at a restaurant.
   Undercooked food was reported to have been served at a restaurant.

(2) **Group:** A large-group event in which many people are ill who had the same exposure.
   Examples: A large proportion of attendees at an event became ill.
   Patients at a long-term care facility or group home became ill at about the same time.

Guidelines:

The decision to expend further resources or attention on an event identified by a call from the public is a decision generally made within the LHD. The following questions should be considered in making the decision. Although the answer may be *no* to some of the questions, a *yes* answer to other questions may dictate the need for further investigation.

1. Did the event occur recently?
2. Were a lot of people affected by the event?
3. Was the causative agent identified or could it potentially be identified?
4. Were the illnesses severe?
5. Is illness spread ongoing?
6. Are those that are ill willing to participate in the investigation by providing stool specimens and being interviewed?
7. Are resources available at the LHD to investigate further? If not, are resources available through UDOH?
8. Is there political pressure or public demand to investigate?

Additional guidance for deciding to investigate an event is found in ***Section 3***.

Additional Resources:

Electronic Appendix A: Form for taking a public report of enteric illness
Electronic Appendix B: Spreadsheet for logging public reports
Enteric Disease Complaint Log Materials, available from UDOH.

Section 1b: For an event identified through *routine public health surveillance,* determine if what you are seeing is an event of interest needing further resources or attention.

Surveillance is the collection, analysis, and interpretation of data. The most commonly used data source in routine public health surveillance is **laboratory and physician reports**, which are reports of notifiable diseases or unusual diseases and outbreaks required to be reported by law. Syndromic surveillance systems (e.g. RODS) are also important sources of public health disease data.

Surveillance should be conducted on a regular basis at the local, state, and national levels. Common tools used for routine public health surveillance include:

- Frequency tables by disease, demographic factors, and date of illness.
- Review of case reports from routine investigation for common risk factors.
- Comparing current rates with previous rates.

Public health surveillance identifies several types of events that may be of interest:

- Sudden increases in reported cases.
- Gradual increases in reported cases.
- Unusual clustering of cases by person, place, or time.

Guidelines:
The decision to expend further resources or attention on an event identified through routine public health surveillance is generally made within the LHD or in consultation with UDOH and other LHDs that may have related cases. UDOH may request additional information on cases for events identified through statewide or national surveillance systems.

The following questions should be considered in making the decision to expend further resources. Although the answer may be *no* to some of the questions, a *yes* answer to other questions may dictate the need for further investigation.

1. Did the event or cluster occur recently?
2. Was the increase or cluster large?
3. Is there statewide or national interest in the event?
4. Is illness spread ongoing? Are new cases being identified?
5. Has the routine investigation been completed?
6. Did the routine investigation identify any common risk factors?
7. Do the causative organisms match by PFGE?
8. Are resources available at the LHD to investigate further? If not, are resources available through UDOH?
9. Is there political pressure or public demand to investigate?

Additional guidance for deciding to investigate an event is found in ***Section 3***.

Section 1c: For an *epidemiologic link*, determine if what you're seeing is an event of interest needing further resources or attention.

An epidemiologic link is the occurrence of common factors among two or more people associated with an event (disease/syndrome). The common factors can be identified through public reports or routine public health surveillance. Types of epidemiologic links and common factors include:

- **Person:** Family, friends, co-workers, acquaintances, age groups, race, ethnicity, presentation of illness
- **Place:** Restaurant, geographic location, gathering, recreational setting
- **Time:** Onset date, exposure date

Guidelines:
The decision to expend further resources or attention on an event in which cases have a suspected epidemiologic link is generally made within the LHD or in consultation with UDOH and other LHDs that may have related cases. UDOH may request additional information on cases for events identified through statewide or national surveillance systems.

In addition to questions listed in ***Sections 1a*** and ***1b***, the following should be considered in making the decision. Although the answer may be *no* to some of the questions, a *yes* answer to other questions may dictate the need for further investigation.

1. Has the causative organism been identified?
   a. If the causative organism has not been identified, there should be two or more epidemiologic links to warrant additional resources or attention for example:
      - Linked by place and time
      - Linked by person and place
      - Linked by person and time
2. Do the causative organisms match by PFGE?
   a. If the causative organisms match by PFGE, then cases should be reviewed for epidemiologic links. Further resources and attention should be expended under the following conditions:
      - If no epidemiologic links are immediately identified and the PFGE pattern is common then further resources and attention **are not warranted.**
      - If no epidemiologic links are immediately identified and the PFGE pattern is rare, then further resources and attention **are warranted** (i.e. continue to a ***Stage 2 Investigation***).
      - If epidemiologic links are identified then further attention and resources **are warranted** despite whether or not the PFGE pattern is common.
   b. If the causative organisms do not match by PFGE, then detected epidemiologic links should be evaluated on a case-by-case basis to determine any significance and need for additional attention or resources.
   c. If PFGE analysis is not available for the causative agent, there should be two or more epidemiologic links to warrant additional resources or attention.
3. Are resources available at the LHD to investigate further? If not, are resources available through UDOH?
4. Is there political pressure or public demand to investigate?

Additional guidance for deciding to investigate an event is found in ***Section 3***.

Section 2: Organize and share preliminary information.

Before investigating an event, decision makers must be assembled – in person, by telephone, or electronically – to come to consensus that this is an outbreak or unusual event. ***Section 3*** describes that this group also decides what are the next steps, including necessary interventions and whether or not to investigate the event further.

Depending on the scope of the event, decision makers may include: communicable disease nursing, epidemiology, environmental health, laboratory, administration, and UDOH epidemiology. Details on these roles and their responsibilities are listed in ***Section 4***. Investigators should keep in mind the additional partners that may be interested in the investigation or have information that may benefit the process.

Guidelines:
A preliminary report of the event can be disseminated through a meeting, phone call, email, written description, or other established information dissemination method, e.g. intranet. This report can also be used as a template for a ***Stage 1 Summary for the Record***. As much of the following information that is available should be included in the notification. Investigators need not gather all information before sharing preliminary information.

1. Brief description of the situation and how it was identified. Explanation of why it may be of interest.
2. Area or group affected.
3. Number of people affected by the event and number exposed.
4. Causative agent or nature of illness, including laboratory tests completed or pending.
5. Severity of illness.
6. Timeline of onset dates or epidemic curve.
7. Suspect source of illness or common risk factors.

Section 3: Decide next steps.

Once preliminary information has been shared and decision-makers have come to consensus that this is an outbreak or unusual event, they must decide next steps. Next steps include necessary interventions and whether or not to investigate the event further.

Depending on the scope of the event, decision makers may include: communicable disease nursing, epidemiology, environmental health, laboratory, administration, and UDOH epidemiology. Details on these roles and their responsibilities are listed in ***Section 4***. Investigators should keep in mind the additional partners that may be interested in the investigation or have information that may benefit the process.

Guidelines:
Decision-makers should discuss the following points:

1. Intervention. At any point during the investigation, intervention may be necessary. See ***Appendix I*** details on this subject.

2. Why should we investigate this outbreak or unusual event? ***Sections 1a-1c*** describe some of the factors and questions to consider when deciding if an occurrence is an event of interest needing further resources or attention. The decision to expend further resources should also take into consideration the following reasons for further investigation, some of which are more academic than practical in nature (see Reingold, AL. Outbreak Investigations – A Perspective. Em Inf Dis1998;4:21-7):
   - To identify and mitigate the source of the infection.
   - To see if lessons can be learned to reduce future outbreaks.
   - To reduce, eliminate, and educate people about transmission.
   - To address public concerns about the outbreak.
   - To see if this is a new or previously unrecognized disease.
   - To see whether prevention strategies, like vaccines, are working.
   - To see if there is a change in symptoms, habitat or host range in a known disease.

3. Why should we *not* investigate this outbreak or unusual event? Following are some reasons to terminate the investigation at this stage. Keep in mind additional benefits from investigating an event (listed above) before completing the investigation.
   - The event was identified too late for further meaningful investigation.
   - Illness spread is no longer ongoing.
   - Ill persons are not willing to participate in the investigation.
   - The event does not have sufficient severity and/or there is not enough value to the public health to justify further investigation.

4. As a group, answer the following question: Why are we investigating/not investigating this outbreak or unusual event?

5. If investigation will continue, continue to a ***Stage 2 Investigation***. If not, complete the ***Stage 1 Summary for the Record*** and close.

Stage 1 Summary for the Record

At the conclusion of a ***Stage 1 Investigation***, a Summary for the Record should be completed and filed for future reference. This is an *informal*, simple record in the form of an email to a supervisor, an entry in a monthly activities report, or an entry on a line list of completed investigations. A summary for the record is useful for quarterly or end-of-year tallies and for training or reference for new employees.

A Stage 1 Summary for the Record may contain the following elements, if known:

1. Brief description of the situation and how it was identified. Explanation of why it may be of interest. This may include a timeline of the public health response
2. Area or group affected.
3. Number of people affected by the event and number exposed.
4. Causative agent or nature of illness, including laboratory tests completed or pending.
5. Severity of illness.
6. Timeline of illness onset.
7. Suspect source of illness or common risk factors.
8. Reason for terminating the investigation.

If the outbreak was determined to be food- or waterborne, complete the appropriate form and submit to UDOH or report to CDC electronically (eFORS).

Additional Resources:
Appendix II: Sample Stage 1 Summary for the Record
Appendix VII: Investigation of a Foodborne Outbreak (CDC Form 52.13)
Appendix VIII: Waterborne Diseases Outbreak Report (CDC Form 52.12)

ENTERIC DISEASE OUTBREAK INVESTIGATION MODEL:

STAGE 2 INVESTIGATION

Summary of steps in a Stage 2 Investigation:

- ☐ **Assemble an investigation team and perform assigned tasks** (Section 4)
- ☐ **Develop a case definition** (Section 5)
- ☐ **Define the scope of the outbreak** (Section 6)
- ☐ **Analyze preliminary data at the individual level** (Sections 6 and 7)
- ☐ **Form hypotheses** (Section 7)
- ☐ **Intervene if necessary** (Section 8)
- ☐ **Decide as a group to continue or not** (Section 8)
- ☐ **Summarize and Report** (Stage 2 After-Action Report)

Section 4: Assemble an investigation team and perform assigned tasks.

Once decision makers have decided to investigate the event further, an investigation team should be assembled. This group may be the same as the decision makers assembled as described in ***Section 2***, or the team may be an expansion of the original group. Each team member should understand his role as well as the big picture. Team members should communicate regularly.

The following *core* and *supplementary* roles should be included in the investigation team. One person may fill more than one role; one role may be filled by more than one person. In the case of an investigation involving more than one jurisdiction, roles may be filled by individuals from different agencies.

Core Roles

Coordinator. Repository for all information related to the investigation. Ensures that all members of the team understand the big picture and work toward the same goal. Disseminates information to the team on a regular basis (daily). Coordinates conference calls or update meetings with team members. Ensures that duties are completed as assigned.

Communicable disease nurse(s). Investigates human cases of illness related to the event. Administers questionnaires. May conduct chart reviews on individual cases when necessary. Is the primary contact for case-patients who have questions or concerns. Provides education to the public on disease spread and prevention.

Epidemiologist. Conducts surveillance for additional cases and performs data analysis. Maintains a database or spreadsheet with case information. With the assistance of the coordinator and communicable disease nurse, verifies the diagnosis, searches for additional cases, and maintains the case definitions current. Ensures cases statuses are accurate.

Environmental health scientist. Conducts the environmental investigation of the facility under investigation. Maintains a relationship with key partners (e.g. manager) at the facility. In addition to a routine environmental inspection, collects other information key to the foodborne disease investigation, including menu items, customer contact information through payment records, food handler shifts, etc. Coordinates collection and testing of environmental samples (e.g. food and swabs). May also coordinate collection and testing of clinical specimens from food handlers associated with the event.

Public Health Laboratorian. Provides direction and expertise on laboratory testing of clinical and environmental specimens for foodborne diseases. Consults with the team on appropriate specimen collection and submission. Confirms lab results on specimens submitted from private laboratories. Performs PFGE on appropriate isolates.

UDOH Epidemiologist. Provides a statewide and national perspective on the investigation. Facilitates communication between agencies. Fills roles that cannot be filled at the local health department level when requested. Passes information on to other agencies when appropriate. Primary contact for other states and CDC.

LHD Administrator. Supports the efforts of the team coordinator to direct the investigation. Provides leadership and guidance.

Supplementary Roles

Public Information Officer. Coordinates public dissemination of information, including press releases and press interviews.

Law Enforcement Agent. Provides law enforcement perspective on possible bioterrorism or malicious events. Key facilitator of communication between public health and law enforcement.

UDAF Representative. Conducts inspection of facilities not under the health department's jurisdiction (e.g. farms, dairies, bakeries, grocery stores). Facilitates communication with national food agencies (FDA and USDA). Takes the lead in trace backs of food items under investigation.

Key Players within the Facility. May be food service manager, event coordinator, or other individual(s) with knowledge of the event that will be useful to the investigation. Provides a menu or list of activities when possible. Provides credit card receipts or other customer/participant information. Facilitates the environmental investigation. Encourages participation in the investigation among food workers and/or those ill. Thus plays an important role in the development and administration of a questionnaire (see ***Section 10***).

Section 5: Develop a case definition.

A case definition outlines the person, place, and time requirements to be included as a case in the event being investigated. *Case definitions in outbreak situations differ from case definitions already developed for reportable diseases.* Case definitions are useful for the following reasons:

- Case definition helps to define the event.
- Case definition is useful in communicating between agencies and team members to describe the event under investigation.
- Case definition guides the search for additional cases.
- Case definition can distinguish outbreak-related cases of reportable illness from sporadic cases of the same disease.
- Case definition is key to analytical studies, when reports from cases and non-cases ("controls") are analyzed to determine the possible source of illness (see ***Section 9***).

The case definition is developed at the beginning of a ***Stage 2 Investigation*** then updated throughout the investigation as needed. The case definition is commonly narrowed as more information is collected, by defining confirmed, probable, and suspect case definitions. This helps investigators keep track of case status and the scope of the event throughout the investigation.

Guidelines:

1. Gather the following characteristics of the event under investigation. ***Section 7*** describes how a computer spreadsheet or database is used to gather, organize, and analyze preliminary information. It may be useful to begin this process at this point before developing the case definition.
   - Etiology (if known) or predominant symptoms.
   - Group, population, or place that is affected.
   - Time frame (illness onset, lab test date, date of exposure).
   - Other epidemiologic data as available (e.g. PFGE pattern).

2. Write the case definition in the following format:

A _____ case is someone with _____
(confirmed/probable/suspect) (etiology/predominant symptoms)

_____ _____ _____
(group that is affected) (time frame) (other epidemiologic data)

3. Define case definitions for confirmed, probable, and suspect cases as appropriate. It is not always necessary or appropriate to define all three classes of cases. In terms of outbreak investigations, the following distinctions are often made between the three classes of cases.
    - **Confirmed case:** Laboratory confirmation of etiology (causative agent) and recognized exposure.
    - **Probable case:** Symptoms compatible with illness under investigation with no laboratory confirmation, but recognized exposure.
    - **Suspect case:** Symptoms compatible with illness under investigation with or without laboratory confirmation, but exposure under investigation.
    - **Secondary case:** Symptoms compatible with illness under investigation, with exposure to a confirmed or probable case with no other explanation of illness.

    It may also be appropriate to narrow the case definition with new information gathered as the investigation progresses, for example when etiology is determined.

4. Examples of case definitions:

    A **confirmed** case related to this outbreak is a person diagnosed with *Salmonella* Newport who ate at Restaurant A between 1/18 and 2/8/2005. A **probable** case is a person with (1) *Salmonella* that is not serotyped as Newport or (2) symptoms consistent with salmonellosis who ate at Restaurant A between 1/18 and 2/8/2005. A secondary case is a person with symptoms consistent with salmonellosis with close contact to a confirmed case with no other explanation of illness.

    A **confirmed** case associated with this outbreak is someone with a stool sample positive for Norovirus who ate food served at a catered barbeque on Thursday, January 14th or Friday, January 15th at Workplace A in City, Utah. A **probable** case is someone who experienced (1) nausea or vomiting with (2) cramping or diarrhea after eating food served at a catered barbeque on Thursday, January 14th or Friday, January 15th at Workplace A in City, Utah.

Section 6: Define the scope of the outbreak

Once an outbreak has been identified and a case definition for that outbreak developed, investigators define the scope of the outbreak. To do this, investigators should:

- Verify the diagnosis and
- Search for additional cases.

Verify the diagnosis.

Depending on the outbreak and resources, the following activities can assist in verifying the diagnosis:

1. If laboratory testing has already been performed, confirm that the laboratory results have been reported correctly. This can be done by calling the private laboratory that performed the test and/or requesting specimens be confirmed at UPHL.

2. If laboratory testing has not been performed, collect clinical (stool) specimens for laboratory testing. Clinical specimens should come from those reporting illness and, if possible, all people who served, prepared, or otherwise handled food, symptomatic or not.

   Stool specimen collection kits are available to LHDs for public health purposes from UPHL. The kits contain photo instructions of how the stool is to be collected. If a **bacterial or viral** cause is suspected, stool should be collected in **Carey-Blair** media. If **parasitic** (e.g. Giardia) cause is suspected, stool should be collected in **Formalin** media. Specimens should be refrigerated but not frozen after collection and during transport to the laboratory.

   When deciding what organisms should be included in the laboratory testing, consult "The Diagnosis and Management of Foodborne Illness: A Primer for Physicians and Other Health Care Professionals". This primer details signs and symptoms, incubation period, duration of illness, laboratory testing, associated foods, and treatment for common causes of foodborne illness. It can be accessed at: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5304a1.htm

3. Encourage those who are ill to visit a physician, if not already done. Ill persons should notify the physician that an outbreak is suspected and that a stool specimen should be collected.

4. Request PFGE testing through UPHL on enteric bacterial isolates (*Campylobacter*, *Salmonella*, *Shigella*, and shigatoxin-producing *E. coli*). This is a genetic fingerprinting technique that estimates genetic similarity between isolates. Infections caused by bacteria with indistinguishable PFGE patterns are more likely to have come from the same source.

Search for additional cases.

Depending on the outbreak and resources, the following activities can assist in searching for additional cases:

1. Contact local physicians and hospital infection control practitioners (ICPs) to notify them of the outbreak and request that stool specimens be collected on patients who may be a case in the outbreak. This can be done by phone, fax, or email.

2. Conduct chart reviews at hospital emergency departments, urgent care centers, or physicians offices for patients that may fit the case definition. These patients may not have previously been identified as part of the outbreak.

3. Maintain frequent contact with local laboratories for any specimens positive for the causative agent (if known) in the outbreak. This will reduce reporting delay.

4. Notify UDOH and other LHDs and request information on related cases. The UDOH epidemiologist can assist with state- and nationwide searches and notification.

5. Determine if other groups with the same exposure suspected as the source of the outbreak also experienced enteric illness. Examples of ways to identify other groups include credit card receipts or other customer/participant information, and names of other parties catered by the same company.

6. When necessary, use public information avenues to notify the public of the outbreak and to invite those who may be a case to come forward.

Additional Resources:
Appendix V: UPHL Instructions for stool specimen collection
Appendix VI: UPHL Requisition/Test Request form
Electronic Appendix C: Sample physician notification letter
"The Diagnosis and Management of Foodborne Illness: A Primer for Physicians and Other Health Care Professionals" (http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5304a1.htm)

Section 7: Analyze the preliminary data and develop an initial hypothesis concerning the outbreak.

Preliminary data analysis is an important step to take in a ***Stage 2 Investigation***. The preliminary data analysis will guide the upcoming decision of whether to continue to a ***Stage 3 Investigation***. It will further describe the outbreak and give a more complete picture of the situation.

At this point, the team may be able to anticipate that a ***Stage 3 Investigation*** will be necessary, based on other information gathered. In these cases, the timeline for collecting preliminary data (this section) will overlap with developing and administering a questionnaire (***Sections 10*** and ***11***) or other investigative steps.

Guidelines:

1. Use a computer to create a database or spreadsheet and populate it with case information. NETSS (or NEDSS, when available) and Microsoft Access are commonly used databases for data collection. Microsoft Excel or another spreadsheet program can be used to create a simple electronic line listing of cases.

   Each outbreak will have different preliminary elements that are available or necessary. Some common elements to collect for preliminary data analysis follow:

   a. Demographics:
      - Name
      - Address and contact information
      - Date of birth or age
      - Gender
      - Occupation or workplace

   b. Illness information:
      - Symptoms or etiology. If available, first symptom and worst symptom.
      - Illness onset date and time
      - Specimen collection date
      - Laboratory results

   c. Risk factors:
      - Travel history
      - Food history
      - Health history
      - Exposure to others with similar illness
      - If exposure is known or suspected, exposure date and time

   d. Case status (based on case definition)
   e. Comments

2. Draw an epidemic curve. An epidemic curve is a graph that gives a visual representation of an outbreak's magnitude over a specific time period. Before an epidemic curve can be drawn, the time and/or date of onset of illness for individuals associated with the outbreak should be identified. Other dates can be substituted if illness onset is unknown, for example specimen collection date or report date.

When drawing the epidemic curve, consider the time interval for the x-axis. The time intervals are based on the incubation period, if known, of the disease. The underlying pattern of the outbreak may be obscured if the time interval is too short or too long.

The epidemic curve will give clues to how an outbreak spread throughout a population, at what point you are in an outbreak, and the diagnosis of the disease by establishing the potential incubation period. Epidemic curves typically fall into one of three classifications:

- **Point source:** The shape of the curve commonly rises rapidly and contains a definite peak at the top, followed by a gradual decline. Persons are exposed to the same exposure over a limited, defined period of time, usually within one incubation period.
- **Continuous common source:** The shape of the curve commonly contains one primary peak but, because the exposure to the source is prolonged over an extended period of time, the curve may occur over more than one incubation period. The down slope of the curve may be very sharp if the common source is removed or gradual if the outbreak is allowed to exhaust itself (i.e., affect all the susceptible persons).
- **Progressive source:** The shape of the curve usually contains a series of successively larger peaks. Mixed modes of transmission may occur, and the epidemic curve could include both point source and propagated cases. The disease is most often spread by person-to-person contact**.** A case of disease serves as a source of infection for subsequent cases and those subsequent cases, in turn, serve as sources for later cases.

Using spreadsheet software (e.g. Microsoft Access), create one column with the times/dates of illness onset. The adjacent column will contain the number of cases whose illness onset corresponds with the time/date in the first column. Using the graphing or charting feature of the software, create a histogram or column chart, where each bar represents the number of cases for each day/time interval.

3. Develop a hypothesis. Based on the information gathered, develop a hypothesis about the source of illness. Take into account the incubation period (if known), epidemic curve, laboratory results, and other epidemiologic clues. The hypothesis can be simple or detailed, depending on the information available about the illnesses. ***Section 10*** describes how to use hypothesis-generating questionnaires to further specify a broad hypothesis. The hypothesis should be biologically plausible. Some examples of hypotheses follow:

   We hypothesize that …
   … the cases have a common source of illness.
   … the source of illness was food served at the catered barbeque served on Thursday, January 14th and Friday, January 15th at Workplace A in City, Utah.
   … the source of illness was food served at Restaurant A.

Additional Resources:

Electronic Appendix B: Sample electronic spreadsheet for data entry, complete and abbreviated
Sample epidemic curve

Tutorial for constructing epidemic curves:
http://www.cdc.gov/descd/MiniModules/Epidemic_Curve/page01.htm

Section 8: Decide next steps.

Once preliminary data have been analyzed and a hypothesis has been generated, the investigation team must decide next steps. Next steps include necessary interventions and whether or not to investigate the event further.

Guidelines:
Decision-makers should discuss the following points:

1. Intervention. At any point during the investigation, intervention may be necessary. See ***Appendix I*** for details on this subject.

2. See ***Sections 1*** and ***3*** for details on deciding whether to continue onto a ***Stage 3 Investigation***. The team should also consider the following:
   - Is illness spread ongoing?
   - Are those that are ill willing to participate in the investigation by being interviewed?
   - Has the good of the public health been appropriately addressed in the ***Stage 2 Investigation***?
   - Are resources available at the LHD to conduct an investigation that will properly address our hypothesis? If not, are resources available through UDOH?
   - Is there political pressure or public demand to investigate?

3. As a group, answer the following question: Why are we investigating/not investigating this outbreak or unusual event?

4. If investigation will continue, continue to a ***Stage 3 Investigation***. If not, complete the ***Stage 2 After-Action Report*** and close.

Stage 2 After-Action Report

The Stage 2 After-Action Report should contain the following elements:

1. Description of the situation and how it was identified. Explanation of why it may be of interest. This may include a timeline of the public health response and introduction of key players.
2. Area or group affected.
3. Summary of findings from preliminary data analysis:
    - Number of people affected by the event and number exposed.
    - Causative agent or nature of illness.
    - Laboratory testing, completed or pending.
    - Severity of illness.
    - Epidemic curve.
    - Suspect source of illness and why
    - Common risk factors.
4. Intervention steps.
5. Conclusions. If appropriate, include reason for terminating the investigation.

If the outbreak was determined to be food- or waterborne, complete the appropriate form and submit to UDOH or report to CDC electronically (eFORS).

Additional Resources:
Appendix III: Sample Stage 2 After-Action Report
Appendix VII: Investigation of a Foodborne Outbreak (CDC Form 52.13)
Appendix VIII: Waterborne Diseases Outbreak Report (CDC Form 52.12)

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ENTERIC DISEASE OUTBREAK INVESTIGATION MODEL:

STAGE 3 INVESTIGATION

Summary of steps in a Stage 3 Investigation:

- ☐ **Determine how to test hypotheses** (Section 9)
- ☐ **Test hypotheses and analyze data** (Sections 9 – 12)
- ☐ **Intervene if necessary** (Section 13)
- ☐ **Summarize and Report** (Stage 3 After-Action Report)

Section 9: Determine how to test the hypothesis.

The investigation team should discuss how to test the hypothesis(es) that has been developed. Several commonly used methods, grouped as analytical and descriptive, are described below. Many more methods are available than those listed here. The investigation team should determine which method will accurately test their hypothesis with resources that are available.

Descriptive methods

- *Chart reviews.* Reviewing medical records may be a useful, though time-consuming, way to gather information that will validate or reject a hypothesis.

- *Laboratory testing*. Additional laboratory testing of environmental (swabs and food) and clinical specimens may be useful in testing a hypothesis of the source of illness.

Analytical methods

- *Case-control study*. This is an epidemiologic study in which cases (ill persons) are compared with controls (persons with a similar exposure who did not become ill). This type of study is useful when data from only a proportion of people who were exposed are available for analysis. Administration of a questionnaire to both cases and controls is a common way to gather data about both groups. More details on questionnaire development and administration are found in ***Sections 10*** and ***11***.

  In a situation where the outbreak is recognized as an increase or clustering of reported cases of a notifiable disease, controls may be difficult to find. Investigators have used several unconventional control groups, including non-outbreak-related cases of the same disease and results from population-based surveys of risk factors for the disease in the general public.

- *Cohort study.* This type of study is used when data from everyone who was exposed, whether ill or not, are available for analysis. Questionnaires are also commonly used as the source of data in enteric disease outbreak situations.

Once the testing method(s) has been chosen, implement the study using available resources. Some guidelines for *analytical* study implementation and analysis are found in ***Sections 10*** (Develop a questionnaire), ***11*** (Administer the questionnaire) and ***12*** (Data analysis).

Section 10: Develop a questionnaire

Questionnaires are used in case-control and cohort studies, as well as for hypothesis generation:

- Case-control or cohort studies are used when both ill and well individuals are available for interview. For these studies, information from ill respondents is statistically compared to information from well respondents.
- ***Section 7*** describes how to develop a hypothesis using preliminary information gathered in earlier stages of the investigation. For a broad hypothesis, hypothesis-generating questionnaires can help to narrow the hypothesis. Hypothesis-generating questionnaires are generally used when only ill individuals are available for interview. Information from ill respondents can be compared to information available for the general public.

Questionnaires can be classified two different ways:

(1) Open or Closed. **Open**-ended questionnaires allow the respondent to provide an answer and elaborate on that answer. This type of questionnaire can elicit a wide variety of responses and is good for generating a hypothesis. However, this questionnaire can be difficult to administer, since answers must be written out completely. Also, results can be difficult to analyze.

Closed questionnaires provide the respondent with a set of answers from which they must choose. Answer types include yes/no, scale of likelihood, or checklists. This type of questionnaire is useful when the questionnaire is long, when respondents are reluctant to participate, or when there are many (more than 10) interviewees. Results are easier to analyze. However, closed questionnaires can create false options and bias if sufficient questions or answer options are not included. For a successful closed questionnaire, good design is vital and the range of questions should be exhaustive.

(2) Specific or Generic A **specific** questionnaire is used when the exposure event or meal is known or suspected. The questionnaire contains questions specific to that exposure, listing the events or meals that the respondents may have participated in. A **generic** questionnaire is used if there is no known exposure event or meal about which to interview. Examples include a "shotgun" questionnaire (exhaustive list of food items and other risk factors) and an enteric disease case report.

Guidelines:

1. ***Section 7*** contains a list of elements commonly collected for analysis. If not yet collected, include these basic elements on the questionnaire.
2. The investigation team should decide what type of questionnaire would be best suited for the investigation. *Elements of different questionnaire types can be combined into one questionnaire.* The team should take into account the method that will be used to administer the questionnaire as described in ***Section 11***.
3. For an outbreak-specific questionnaire, collect as much information as possible about the outbreak before developing the questionnaire. Be sure to consult with key players within the facility to obtain menus or information available about specific activities.

4. The questionnaire should include clear, written time frames about which the interviewee should respond, usually one incubation period, if known. A script for the interviewer should be written into the questionnaire. This ensures that all interviewees are prompted the same way.
5. Provide skip patterns taking into account sections of the questionnaire that may not apply to some respondents, e.g. asymptomatic (well) interviewees.
6. The questionnaire should not be changed or added to after interviews have begun. For more details on administering questionnaires, see ***Section 11***.
7. When using a hypothesis-generating questionnaire, administer the questionnaire to a few people (5 to 10) to develop a hypothesis. Then, create a more specific questionnaire based on the results and administer to the rest of the respondents.

Additional Resources:
Electronic Appendix D: Template shotgun questionnaire
Electronic Appendix E: Template event-specific questionnaire

Section 11: Administer the questionnaire

Methods for administering a questionnaire include:

(1) Interview. A trained interviewer or set of interviewers administers the questionnaire by phone or in person. The interviewee may follow along with a blank copy of the questionnaire, if in person. The interviewer attempts to reduce bias by asking each question the same way to each interviewee.

(2) Self-administered, paper. The questionnaire is provided to the interviewee in person or by mail and the interviewee completes the questionnaire himself. When mailed, a self-addressed stamped envelope is provided to ensure that the questionnaire is returned.

(3) Self-administered, electronic. For some outbreaks, the quickest and easiest way to reach interviewees is electronically. An electronic questionnaire is created online, then an email is sent to interviewees who respond via the web.

Guidelines:

1. The investigation team should determine which method of administering the questionnaire to use, taking into account personnel resources, number of interviewees, and time limitations.
2. The questionnaire should not be changed or added to after administration has begun.
3. If possible, the same method should be used to administer all the questionnaires to reduce bias.
4. If conducting a case-control study, plan to interview three controls (well) for every case (ill).
5. Interviewers should review and practice with the questionnaire before conducting interviews. Guidelines for interviewers are:
   - Ask every question on the questionnaire. Ask each question the way it is written.
   - Read the script that prompts the interviewee so that every interview is conducted the same every time.
   - Print answers legibly. When an error is made, cross it out with a single line and clearly write the correct answer.
   - Use the margins to write down responses that the respondent provides, whether or not they are directly related to the question or seem relevant.

Section 12: Data analysis

This section provides a brief summary of simple data analysis that can be performed on questionnaire data. Details on how to make these calculations can be found in Procedures to Investigate Foodborne Illness, 5th ed. (1999), published by the International Association for Food Protection. Also refer to ***Section 7*** for guidelines on data analysis.

Measures of disease-exposure association (RR and OR)
Two measurements of disease association are commonly used: relative risk (RR) and odds ratios (OR). RR is used for a cohort study, in which data are available on *all* those who were exposed, ill and well. OR is used for a case-control study, in which data are available on only a proportion of those who were exposed. These statistics tell how the risk of illness is associated with exposure (e.g. eating), a higher number indicating a stronger association between illness and exposure.

Tip: An RR or OR >1 indicates an association between illness and the exposure.

See pages 53-55 in Procedures to Investigate Foodborne Illness.

Confidence intervals
The RR and OR are point *estimates* of the association between illness and exposure. For each estimate, we can calculate a confidence interval, which gives a *range* of values for the RR or OR. This gives the investigator an idea of how likely it is that the results (RR or OR) happened by chance. There is a 95% chance that the true value of the RR or OR is contained with in the range of the confidence interval and a 5% chance that it does not.

Tip: If the confidence interval includes the value of 1, the results (RR or OR) are not statistically significant.

See pages 55-56 in Procedures to Investigate Foodborne Illness.

Other tests of statistical significance
Tests of statistical significance measure how likely it was that differences in illness rates between those who were or weren't exposed happened by chance. These tests use probability, called a *p* value. Examples of other texts of significance include chi-square (X^2) and Fisher's exact test.

Tip: A *p* value of <0.05 is usually considered statistically significant, meaning that it is unlikely that the different illness rates happened by chance.

See pages 56-62 in Procedures to Investigate Foodborne Illness.

Additional Resources:
Procedures to Investigate Foodborne Illness, 5th ed. (1999), published by the International Association for Food Protection

Section 13: Final action steps

At the conclusion of an investigation, investigators should complete final action steps. Final steps include necessary interventions and writing, distributing and presenting investigation results.

Guidelines:

1. Intervention. At the conclusion of a ***Stage 3*** investigation, intervention may be necessary. See ***Appendix I*** for details on this subject.

2. Write, distribute, and present investigation results. Different audiences for reports and presentations may be interested in different facets of the investigation, and the investigating agency may decide to produce more than one version of a report for different audiences. See ***Stage 3 After-Action Report*** for suggestions on what to include in a final report.

3. Investigators may consider publishing the results of the investigation in a peer-reviewed journal or MMWR. Other presentation opportunities include SLEW meeting, internal staff meetings, public health classes, public health or environmental health association meetings, etc. This is a useful way to promote public health activities.

Stage 3 After-Action Report

The Stage 3 After-Action Report should contain the following elements:

1. Description of the situation and how it was identified. Explanation of why it may be of interest. This may include a timeline of the public health response and introduction of key players.
2. Area or group affected.
3. Summary of findings from data analysis:
    - Number of people affected by the event and number exposed.
    - Causative agent or nature of illness.
    - Laboratory testing, completed or pending.
    - Severity of illness.
    - Epidemic curve.
    - Suspect source of illness and why.
    - Tables and graphs with results of analysis, including any statistics.
4. Intervention steps.
5. Conclusions.

If the outbreak was determined to be food- or waterborne, complete the appropriate form and submit to UDOH or report to CDC electronically (eFORS).

Additional Resources:
Appendix IV: Sample Stage 3 After-Action Report
Appendix VII: Investigation of a Foodborne Outbreak (CDC Form 52.13)
Appendix VIII: Waterborne Diseases Outbreak Report (CDC Form 52.12)

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