Salmonella Thompson: A Case Study in Enteric Illness Outbreak Investigation

**Epidemiologic Investigation**
1. Confirm existence of outbreak.
2. Confirm diagnosis.
3. Determine the number of cases.
4. Orient data by time, person, and place.
5. Develop a hypothesis.
6. Compare hypothesis with established facts.
7. Execute control and preventive measures.
8. Write a report.

**Salmonella Thompson Outbreaks**
- More common
- Summer months
- Children under the age of 5 years
- Certain medications can increase risk of salmonellosis
  - Antacids
  - Antibiotics
- Severe infection
  - Children under 5 years of age
  - Adults over 65 years of age
  - People who have weakened immune systems

**Salmonella Statistics**
- Approximately 1.2 million illnesses
- Over 23,000 hospitalizations
- 450 deaths
- Estimated total cost of illness in 2013: $3.7 billion

**Salmonella Risk Factors**
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**Salmonella Nomenclature**

- **Family:** Enterobacteriaceae
- **Genus:** Salmonella
- **Species:** enterica or bongori (formerly subspecies V)
- **Subspecies of S. enterica:** enterica (I), salamae (II), arizonae (IIIa), diarizonae (IIIb), houtenae (IV), indica (VI)
- **Serotypes:** 2,463

**Salmonella Lab Work-up**

- Organism isolated from cultured specimen or Culture Independent Diagnostic Testing (CIDT) performed
- Isolate or raw specimen sent to state lab
- Serotype identification
  - Based on series of agglutination tests, phase testing
- Pulsed-Field Gel Electrophoresis (PFGE)
  - Bacterial DNA is lysed, then digested by restriction enzymes and exposed to an alternating electric field
  - DNA fragments migrate according to size

**Salmonellosis**

- **Incubation period**
  - Typical: 6—72 hours
  - Most common: 12—36 hours
  - Can be as long as 16 days!
- **Symptoms**
  - Diarrhea, fever, abdominal cramps/pain, nausea, vomiting
- **Duration of illness**
  - About 4—7 days
- **Treatment**
  - Usually none

**Severe Illness**

- Infection can spread to blood stream and other sites
  - Bacteremia/Septicemia
  - Focal infection
- Treatment with antibiotics
  - Usually 14 days
- Relapse can occur

**S. Thompson Outbreak**

- As of July 30, 2015, four cases of Salmonella Thompson had been identified in Ward County and surrounding area
  - 2014 S. Thompson cases in ND: 2
  - 2013 S. Thompson cases in ND: 0
  - 2012 S. Thompson cases in ND: 1
- Field staff were alerted and the investigation into the identification of commonalities amongst cases began
- The following week, four additional S. Thompson cases were reported
  - National Hypothesis Generating Questionnaire (HGO) implemented
**S. Thompson Outbreak Case Definition**

A confirmed case is defined as a clinical case of *Salmonella* Thompson infection with isolate matching PFGE XbaI pattern JP6X01.0001 with isolation date on or after July 17, 2015 in a person who lives in or near Minot, ND, or who reported travel to Minot, ND, prior to onset of illness.

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**Investigation Methods**

- Standard enteric illness case investigation
  - Demographic information
  - Clinical information
  - Exposure history
  - Travel history
  - Food history
  - Other risk history information
    - Food handler?
    - Health care worker?
    - School or day care worker?
  - Household and non-household contact information
  - Epi-linked and outbreak information

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- National Hypothesis Generating Questionnaire
  - Standardized or “shotgun” questionnaire
  - Collects standard set of information about food and other exposures
  - 16 sections, over 200 questions
  - Data analysis is more efficient
Case-Control Study

- Gather food history information from well people in the community
  - 30 mi radius of Minot
  - 18—69 yoa
- Compare data from cases to that from controls
- What’s different?
Control Data

- 8/14/2015
  - Attempted to gather information from well family members and/or friends of cases
  - Ran frequency analysis against data from MN’s FoodNet survey
- 9/28/2015
  - News release about MPH students contacting people in the Minot area via random digit dialing
- Now
  - Focused online questionnaire
  - Minot State University
  - Minot AFB

Case Re-interviews

- Re-interview #1 on 8/4/15
  - HGQ for early cases
- Re-interview #2 on 9/8/15
  - Detailed restaurant history for eight of the most frequently mentioned restaurants
  - Menu items
- Re-interview #3 on 9/30/15
  - Specific questions about five of the most frequently mentioned restaurants
  - Location
  - Date
  - Menu items

Restaurants of Particular Interest

- Restaurant A
  - Before re-interview #2, nine cases reported eating here
  - After, 18 cases reported eating here
- Restaurant B
  - Before re-interview #2, seven cases reported eating here
  - After, nine cases reported eating here
- Restaurant C
  - Before re-interview #2, four cases reported eating here
  - After, six cases reported eating here

Spot Map

- Place dot or symbol on map showing where case lives, works, or may have been exposed
- Clusters or patterns may reflect water supplies or proximity to restaurant or grocery store
- Can also be done for hospitals or LTC facilities
  - Cluster indicates focal source or person to person spread
  - Scattering may indicate widely disseminated vehicle or source common to all residents

Epidemic Curve

- Shows progression of illnesses in an outbreak or cluster over time
  - Updated as new data becomes available
- X-axis is the date/time when a person became ill
  - Day/Week of illness onset
  - Hour if very short incubation period (e.g., S. aureus)
- Y-axis is the number of cases per unit of time

Benefits of an Epi Curve

- Pattern of spread
- Magnitude of outbreak
- Outliers
- Time trend
- Exposure and/or incubation period
**Epi Curve: Pattern of Spread**

- Overall shape may reveal type of outbreak
  - Common source
    - Intermittent exposure
    - Continuous exposure
  - Point source
    - Common source outbreak with a brief exposure period and all cases occur within one incubation period
  - Propagated
    - Spread from person to person
    - May include secondary and tertiary cases
  - Mixed

**Common Source Epi Curve**

- B. Intermittent common source
- C. Continuous common source

**Point Source Epi Curve**

- A. Point source

**Propagated Epi Curve**

- D. Propagated (person-to-person)

**Reporting Delay**

- Delay between the date an illness starts and the date the case is reported to public health authorities
  - Salmonella infections: typically 2—3 weeks
  - E.g., someone who got sick last week is unlikely to have their infection reported to public health authorities by now, and someone who got sick 3 weeks ago may just be reported now

**Infections with the outbreak strain of Salmonella Thompson, by date of illness onset**

(Note: The graph shows the distribution of infections, but the specific data is not provided in the text.)
Environmental Health

- Gathered information on restaurant suppliers
- Conducted investigations and inspections at many area restaurants
  - Interviewed managers about any ill food workers
  - Interviewed food workers
  - Gathered contact information and work schedules
  - Collected food and environmental samples for testing

Overview of S. Thompson Outbreak

- Number of PFGE matched cases: 29
- Onset
  - Range: 7/14/15—9/17/2015*
- Age
  - Range: 3—71 years
  - 66% of cases are between 18—40 yoa
- Gender
  - Female: 17
  - Male: 12

*Onset unknown for last case, specimen collected 10/2/2015

Challenges

- Many cases are not recognized
  - Not all ill people seek medical attention
  - Health care providers do not always collect specimens
  - Lab may not perform necessary testing
- Culture Independent Diagnostic Testing (CIDT)
  - Raw specimen is tested
  - Some labs use CIDT as “preliminary result” and do not report
  - State lab must culture isolate from specimen to serotype

Challenges

- Obtaining good control data
- Inherent delay between onset and reporting
  - Memory recall decreases dramatically
- Nature of the food industry
  - Low wages
  - Few, if any, benefits
  - Sick leave?
  - Health insurance?
References

CDC’s Salmonella Website
http://www.cdc.gov/salmonella/index.html


Investigation of foodborne disease outbreaks – World Health Organization
http://www.who.int/foodsafety/publications/foodborne_disease/Section_4.pdf