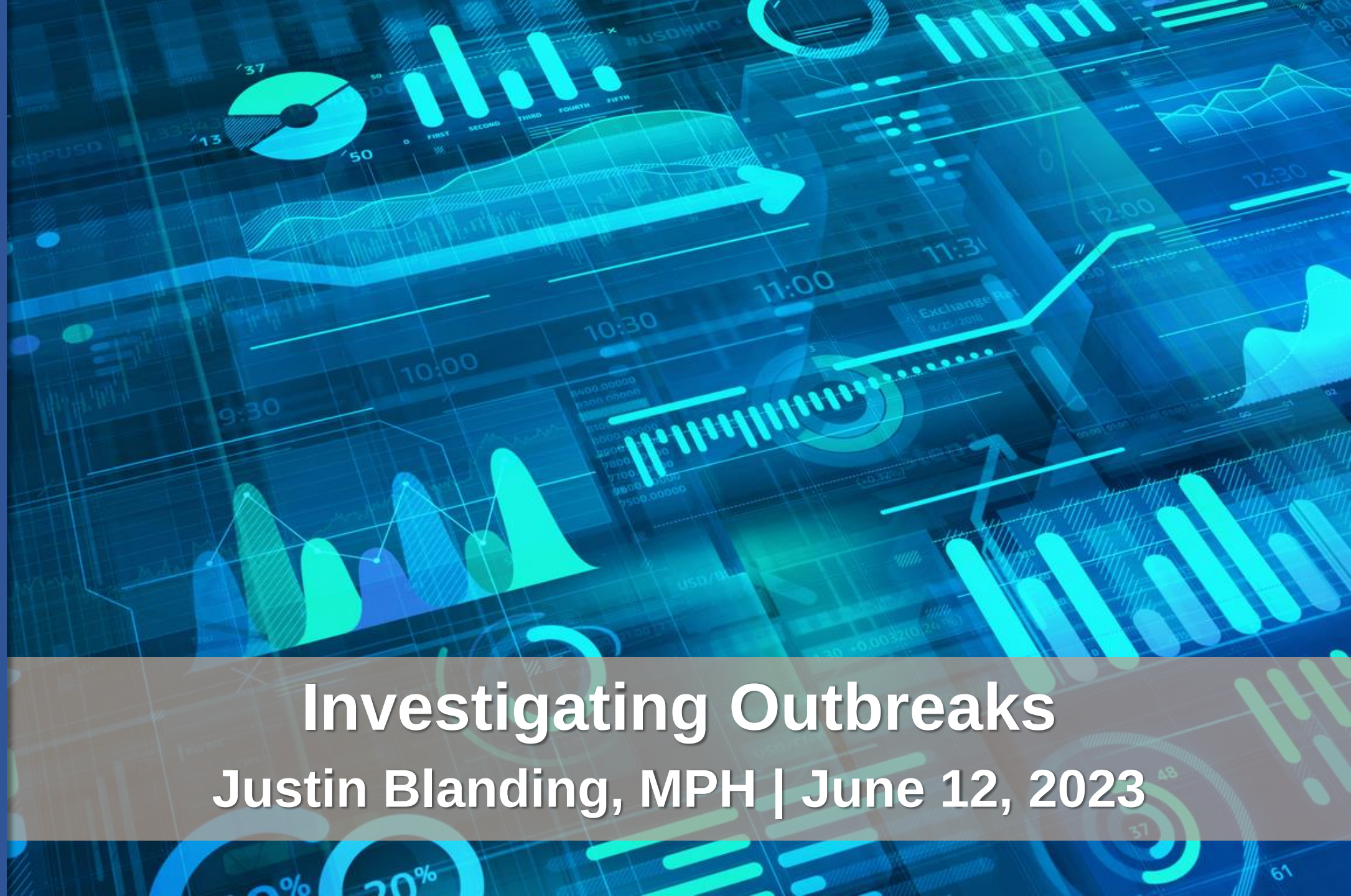


Investigating Outbreaks

Justin Blanding, MPH | June 12, 2023

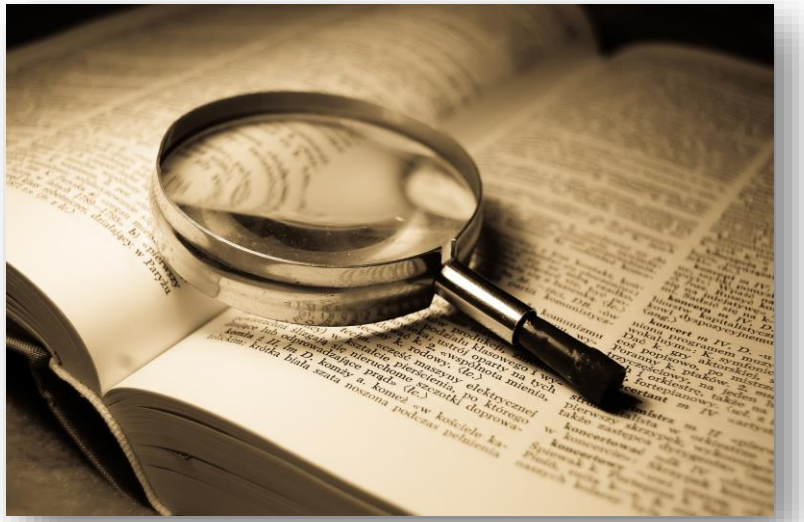
Kansas Department of Health and Environment
Division of Public Health

Today's Objectives

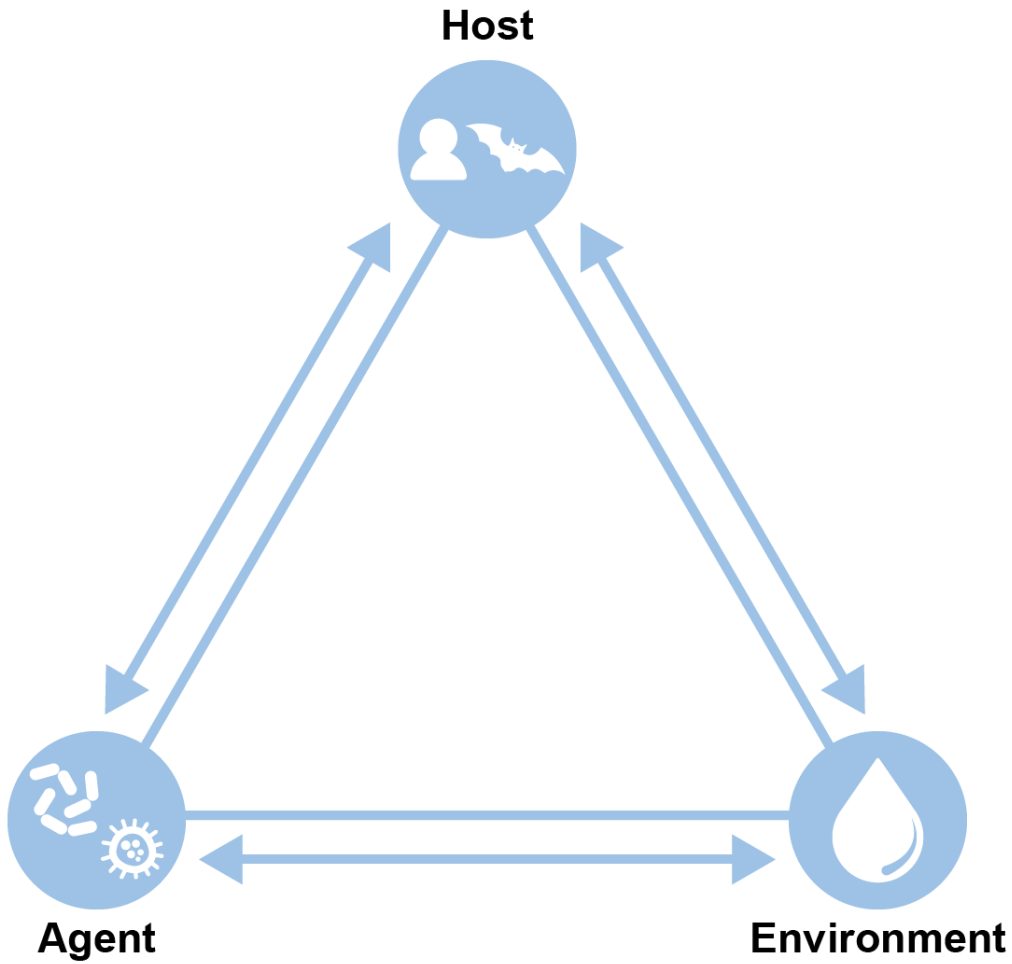
- Understand key epidemiology concepts in disease investigation.
- Identify the key steps to an infectious disease outbreak investigation.
- Define key epidemiology terms.
- Understand how to create case definition, line list and interpret an epidemic curve.

Epidemiology Key Terms

- **Epidemic/outbreak:** disease among a population is higher than what is expected in a given time and place.
- **Endemic:** Disease or condition always present among a population.
- **Attack Rate:** Number of new cases divided by study population (cases divided by controls + cases).
- **Incidence Rate:** Number of new cases during a specific period based on the size of the population.
- **Prevalence Rate:** Number of new and existing cases during a specific period based on the size of the population.



The Epidemiologic Triad (or Triangle)



Host
Organism that carries the disease such as a person. A host does not always get sick such as a bat harboring rabies or mosquitos with Zika virus.

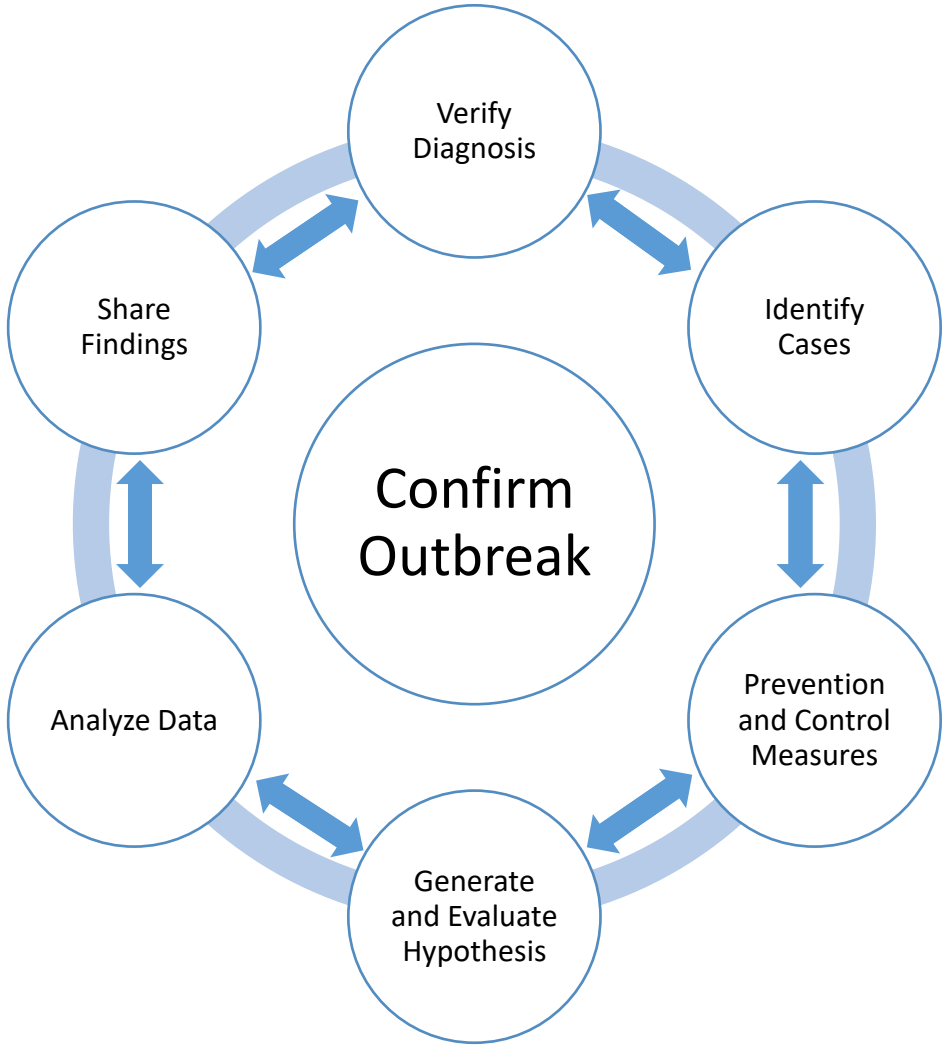
Agent
Infectious microorganism or pathogen such as a bacteria, virus, or parasite.

Environment
External influences that could impact spread of disease such as poor drinking water quality or standing pools of water for mosquitos to breed.

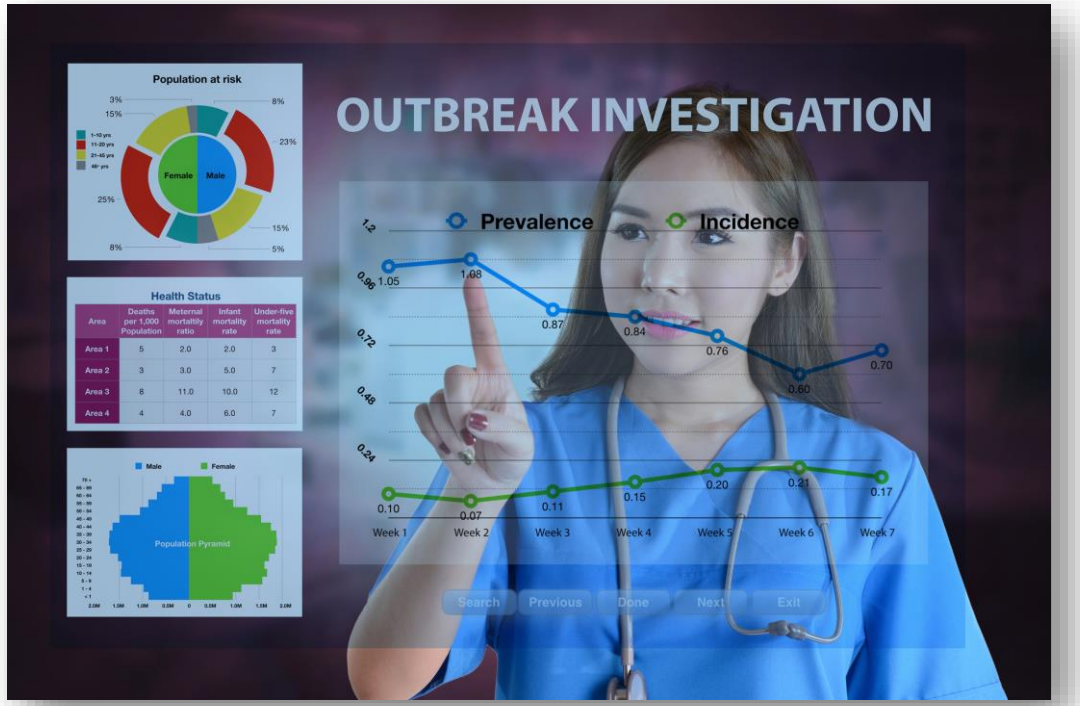
Why investigate outbreaks?

- Determine factors associated with illness
- Determine measures that can be taken to prevent further illness
- Opportunity to prepare for unintentional and intentional outbreaks
- Provides evidence for evidence-based policy decisions

Infectious Disease Outbreak Investigation Steps



Outbreak Investigations: Confirm Outbreak



- First step is to confirm you have exceeded more cases than would be expected.

- What are some ways to verify this?
  - Compare Incidence Rate. Why not just compare number of cases?
  - Advanced stats method (poison distribution model)
  - Known exposures
  - Research disease to determine disease epidemiology (i.e., incubation period, infectiousness)

Outbreak Investigations: Verify Diagnosis

Confirm Etiology

Review Lab Reports

Review Medical Records

Interview Patients

Outbreak Investigations: Verify Diagnosis

- What type of testing can KHEL perform to verify diagnosis
  - Able to send to sequencing for relatedness of human and non-human samples (salmonellosis and tomatoes)

- What about testing non-human specimens like environmental samples or food items
  - KDA and KHEL lab able coordinate for testing. Approved by KDHE epidemiologist when indicated

Outbreak Investigations: Identify Cases

- Establish an outbreak case definition.
- Use of a common case definition allows for standardization of the cases of interest both within an ongoing outbreak investigation and possibly between outbreak investigations that differ over time or geographic location.
- A case definition includes criteria for person, place, time, and clinical features. These should be specific to the outbreak under investigation.
- Can include case classification based on degree of certainty of diagnosis (confirmed, probable)

Outbreak Investigations: Identify Cases (Case Definition)

Element	Question Asked	Descriptive feature	Example
Person	Who was impacted?	Age group	Children under the age of 5 years
		Sex	Males
		Occupation	Healthcare workers at hospital X
		Exclusion criteria	Persons with no previous history of chronic cough or asthma
Place	Where did the exposure occur?	Geographic location	Resident of Y county or state
		Facility	Living in X nursing home; student at Z high school
Time	When did the exposure occur?	Illness onset	Onset of illness between May 4 and August 31, 2007
Clinical features	What were the symptoms?	Pneumonia	Clinical or radiographically confirmed pneumonia. Shortness of breath and fever
		Cultures; serology	Pneumococcus isolated from blood. Rapid influenza test positive

2018 Salmonellosis Indian Taco Outbreak Example

- On Friday, August 10, 2018, the Doniphan County Health Department reported to the epidemiology hotline that several persons were experiencing gastrointestinal illness, mainly diarrhea and vomiting.
- One person was hospitalized and diagnosed with salmonellosis after eating food served at a community Election Day Indian taco dinner held on August 7.
- Other people reported eating food at the Indian taco event and reported gastrointestinal illness.
- What would be a good starting outbreak case definition to identify additional cases?

Any person that consumed food served at the Election Day Indian taco event on August 7 and developed gastrointestinal illness.

Outbreak Investigations: Generate and Evaluate Hypothesis

Making a Hypothesis
Putting the puzzle pieces together to make a best guest to what is causing the outbreak and then check to see if your guess is accurate.

Outbreak Investigations: Generate and Evaluate Hypothesis

What characteristics do the ill persons have in common?

What information about the outbreak is available?

Organize information to determine common associations and develop a hypothesis

- Hypothesis: what you think is causing illness

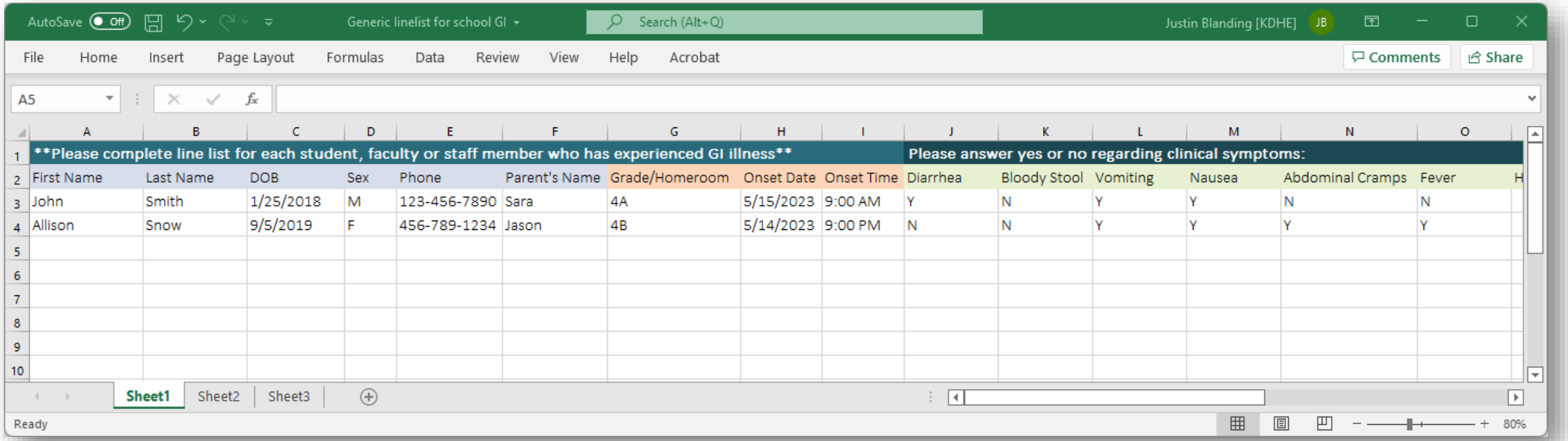
Conduct surveys using a standard case report form or use an outbreak-specific questionnaire.

- Depending on outbreak and size, press release if facility can't identify all exposed.
- Issue email/letters to parents of a daycare
- Important to gather information from ill and non-ill persons.

Create line listing

- Can be saved in excel file or, if disease LHD normally investigates, enter information in EpiTrax.

Outbreak Investigations: Generate and Evaluate Hypothesis



AutoSave Off | Generic linelist for school GI | Search (Alt+Q) | Justin Blanding [KDHE] JB

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A5

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Please complete line list for each student, faculty or staff member who has experienced GI illness**									Please answer yes or no regarding clinical symptoms:					
2	First Name	Last Name	DOB	Sex	Phone	Parent's Name	Grade/Homeroom	Onset Date	Onset Time	Diarrhea	Bloody Stool	Vomiting	Nausea	Abdominal Cramps	Fever
3	John	Smith	1/25/2018	M	123-456-7890	Sara	4A	5/15/2023	9:00 AM	Y	N	Y	Y	N	N
4	Allison	Snow	9/5/2019	F	456-789-1234	Jason	4B	5/14/2023	9:00 PM	N	N	Y	Y	Y	Y
5															
6															
7															
8															
9															
10															

Sheet1 Sheet2 Sheet3

Ready 80%

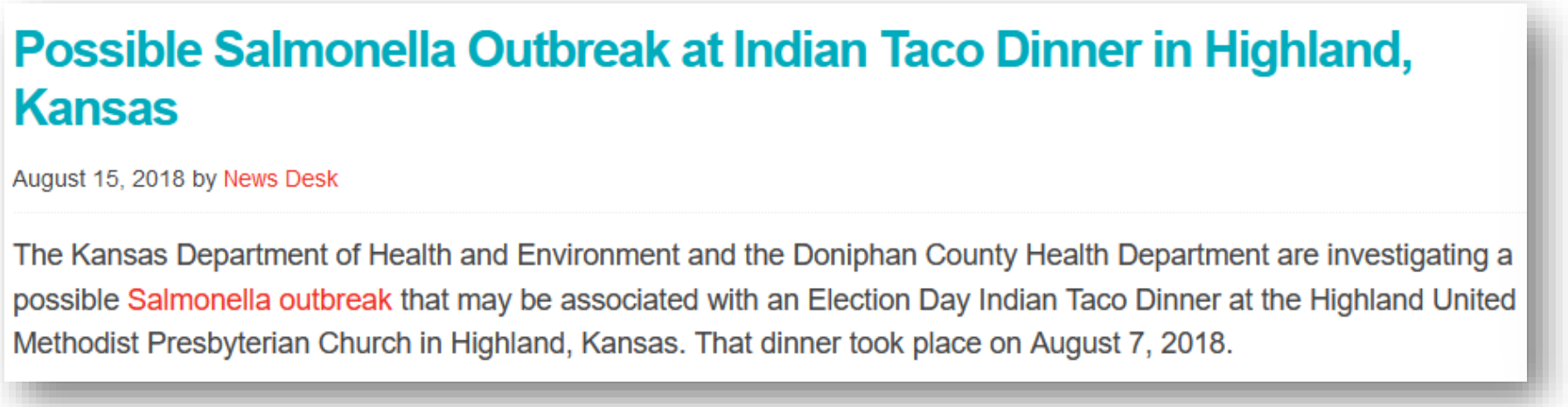
Line listing should collect:

- Identifying information (patient name, DOB)
- Demographic information (sex)
- Data and time of illness and recovery
- Other important factors such as what foods consumed

2018 Salmonellosis Indian Taco Outbreak Example

- DPHD and KDHE performed onsite visit at location where Indian taco event held to look for possible sources of contamination.
  - Background information: place that served Indian tacos was a place not under regulation by the Kansas Department of Agriculture Food Safety and Lodging Program; however, KDA inspectors did go onsite at the request of the facility.
- Interviewed organizers and determined food served and ingredients.
- Organizers estimated around 125-150 attendees.
- KDHE created online survey and requested anyone that attended the event to complete the survey.
  - Given number of attendees, a case control study was conducted.

2018 Salmonellosis Indian Taco Outbreak Example



Possible Salmonella Outbreak at Indian Taco Dinner in Highland, Kansas

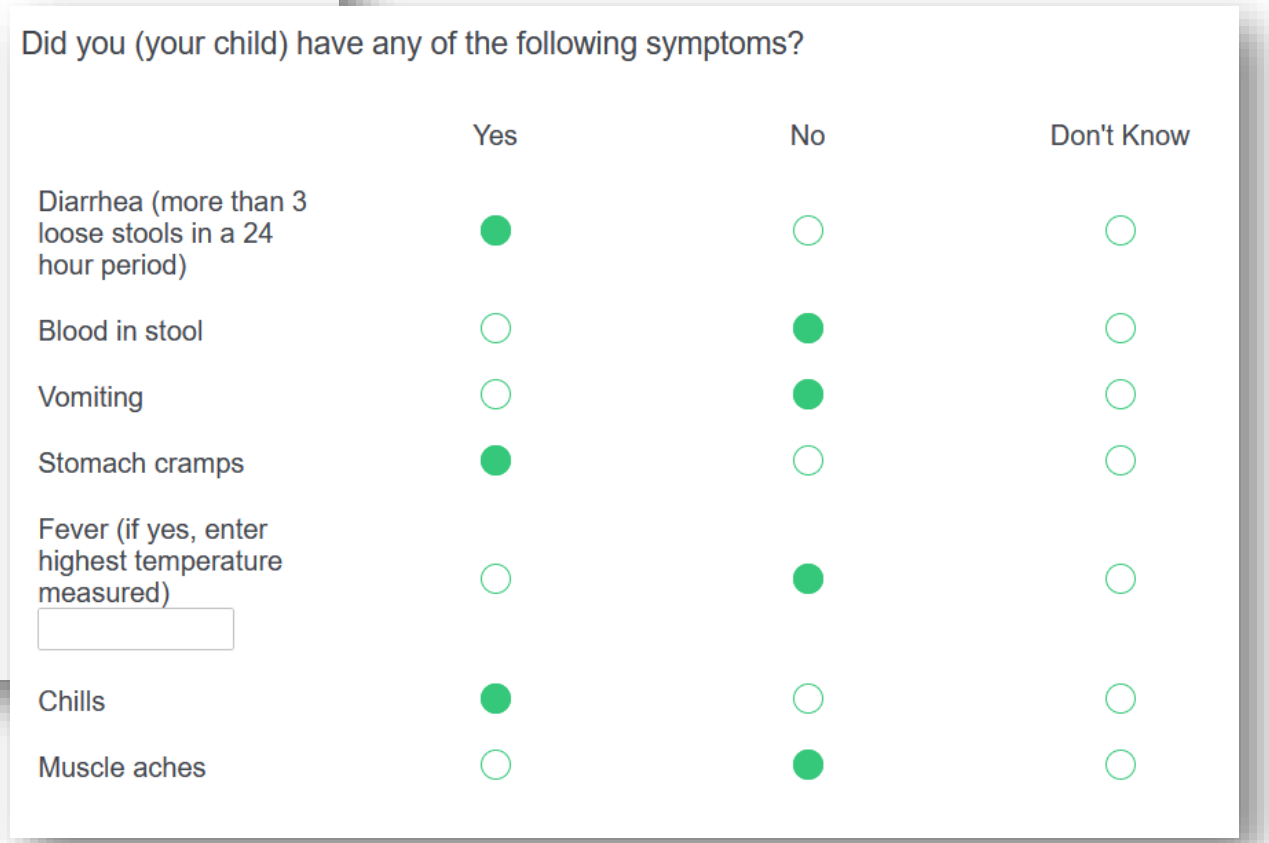
August 15, 2018 by News Desk

The Kansas Department of Health and Environment and the Doniphan County Health Department are investigating a possible Salmonella outbreak that may be associated with an Election Day Indian Taco Dinner at the Highland United Methodist Presbyterian Church in Highland, Kansas. That dinner took place on August 7, 2018.

Why a press release announcing the outbreak?

- Confidentiality vs need to protect the public health and identify the scope of the problem
- Given large scope of the event it was necessary to survey everyone that attended so a case-control study could be performed.
- Organizers did not have contact information, credit card receipts, phone numbers/email address to communicate to attendees.
- Large number sought healthcare – information provided to clinicians to keep on differential while evaluating patient and to determine appropriate treatment pending tests

2018 Salmonellosis Indian Taco Outbreak Example



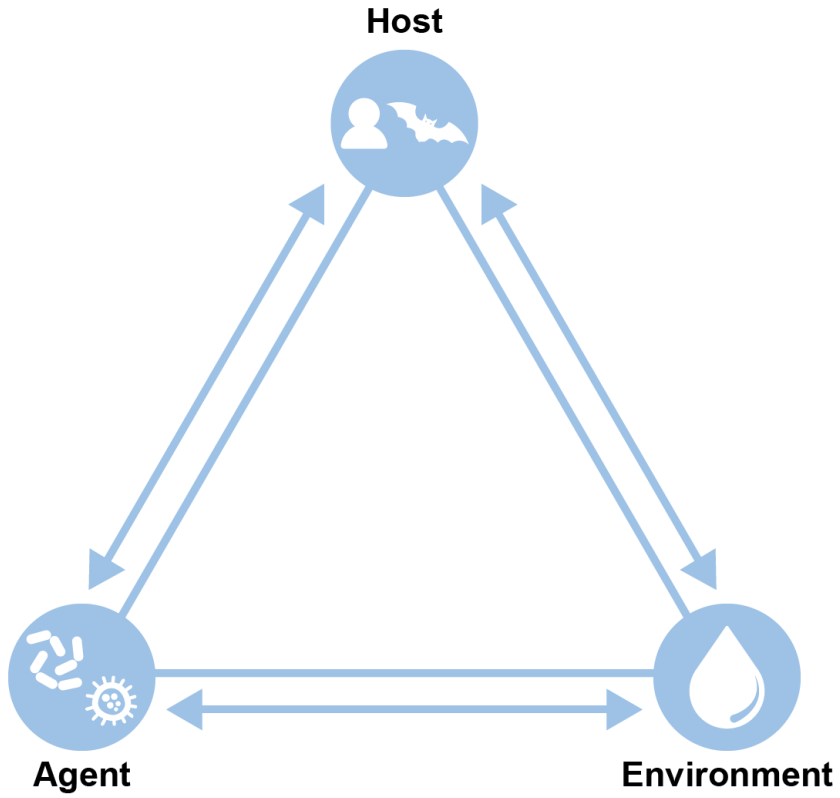
Also collect onset dates, symptoms prior to exposure, along with food ingredients

Outbreak Investigations: Prevention and Control Measures

- Control and prevent additional cases.

- Communications tailored to appropriate audience
  - Cases – stay home while ill, don't return until negative test, fever-free for 24 hours without fever-reducing medicine
  - Contacts – possibly quarantine susceptible contacts (per KS regulation) Go on as normal but stay home if develops signs and symptoms
  - Healthcare facilities – what symptoms to be on the look out for, how to report cases to LHD

- Think back to the epidemiologic triad – what tools are available to interrupt transmission?



2018 Salmonellosis Indian Taco Outbreak Example

- What would be some example prevention and control measures to recommend for the Indian taco outbreak?

- What if the outbreak was a vaccine-preventable disease? What would be some recommendations to control and prevent additional cases?

Outbreak Investigations: Analyze Data

Analyzing the outbreak data from line listing/case reports help to understand population impacted, key characteristics shared among cases and severity of outcomes. These type of analysis is called descriptive statistics.

Table 1: Clinical Symptoms Reported Among Ill Persons

Symptoms	*# of Ill Persons/Total*	*% of Ill Persons*
Diarrhea	64/65	98.5%
Bloody stools	7/56	12.5%
Vomiting	24/59	40.7%
Fever	44/56	78.6%
Urinary tract infection	1/63	1.6%

Table 2: Demographics Among Ill Persons

Sex	*# of Ill Persons*	*% of Ill Persons*
Female	37	57%
Male	28	43%
Age Group		
1-4 years	1	2%
5-9 years	2	3%
10-19 years	5	8%
20-49 years	11	17%
50-74 years	34	52%
≥75 years	12	18%

Outbreak Investigations: Analyze Data

Odds Ratio analysis can be performed for case control studies conducted in outbreak investigations.

KDHE epidemiologists can assist in conducting and interpreting case control analysis.

Table 3. *Salmonella* Newport Exposure Information Among Dinner Attendees

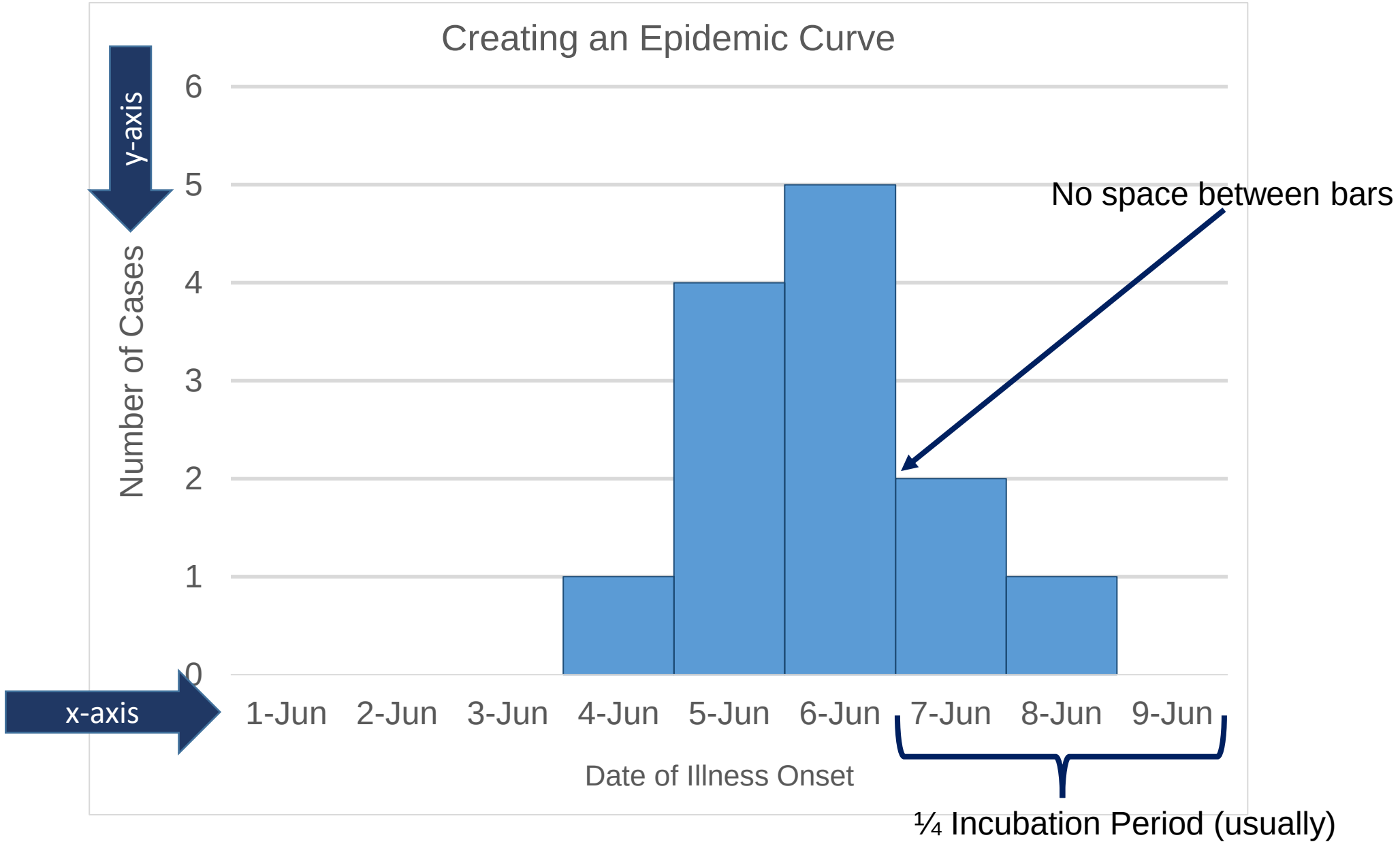
	Controls n (%)	Cases n (%)	OR	95% CI
Food Item				
Indian taco	38 (38)	62 (62)	1.7	0.1 – 27.3
Pie (any)	31 (39)	49 (61)	1.1	0.4 – 2.9
Watermelon	8 (57)	6 (43)	0.4	0.1 – 1.2
Black beans	22 (41)	32 (59)	0.7	0.3 – 1.7
Iced tea	21 (60)	14 (40)	0.9	0.4 – 2.0
Water	20 (35)	37 (65)	1.1	0.4 – 2.7
Indian Taco Ingredient				
Beef	38 (38)	63 (62)	1.7	0.1 – 27.3
Black beans	21 (38)	34 (61)	1.2	0.5 – 2.9
Lettuce	35 (39)	54 (61)	0.7	0.2 – 3.3
Tomato	28 (38)	46 (62)	1.1	0.4 – 3.0
Onion	22 (33)	45 (67)	1.6	0.7 – 4.1
Cheese	38 (38)	62 (62)	0.8	0.1 – 9.3
Sour cream	32 (39)	50 (61)	0.8	0.3 – 2.3
Picante sauce	30 (43)	39 (57)	0.6	0.2 – 1.6

OR= Odds ratio; CI= Confidence interval

Outbreak Investigations: Epidemic Curve (Epi Curve)

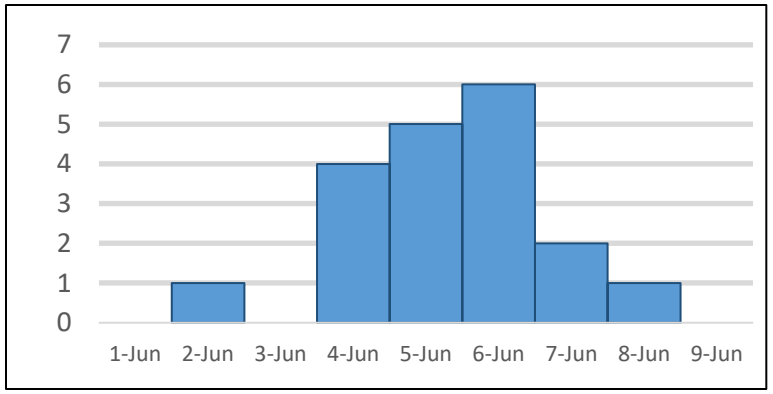
- An epi curve is a visual display of the onset of illness among cases associated with an outbreak.

- Creating an epi curve can help you learn a lot about your outbreak, such as:
  - The outbreak's time trend, that is, the distribution of cases over time
    - Have cases peaked and declining?
    - Starting to see recurrence of cases?
  - Outliers, that is, cases that stand apart from the overall pattern
    - Could help identify the index case or could help identify possible secondary transmission
  - General sense of the outbreak's magnitude
  - Inferences about the outbreak's pattern of spread
    - Point source, Continuous common spread, person-to-person spread (propagated)
  - The most likely time period of exposure


Creating an Epidemic Curve
y-axis
Number of Cases
6
5
4
3
2
1
0
x-axis
1-Jun
2-Jun
3-Jun
4-Jun
5-Jun
6-Jun
7-Jun
8-Jun
9-Jun
Date of Illness Onset
No space between bars
¼ Incubation Period (usually)

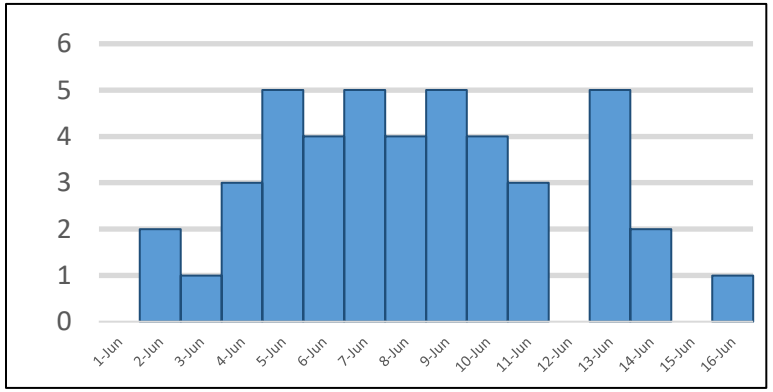
Outbreak Investigations: Epidemic Curve (Epi Curve)

Point Source Spread



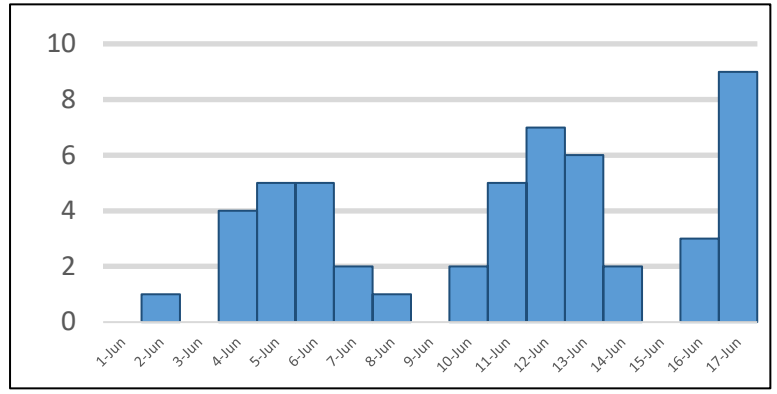
- Persons exposed at the same time, such as a meal served or conference.
- Cases rapidly increase and then rapidly decline.
- Most cases occur within one incubation period.

Common Source Spread



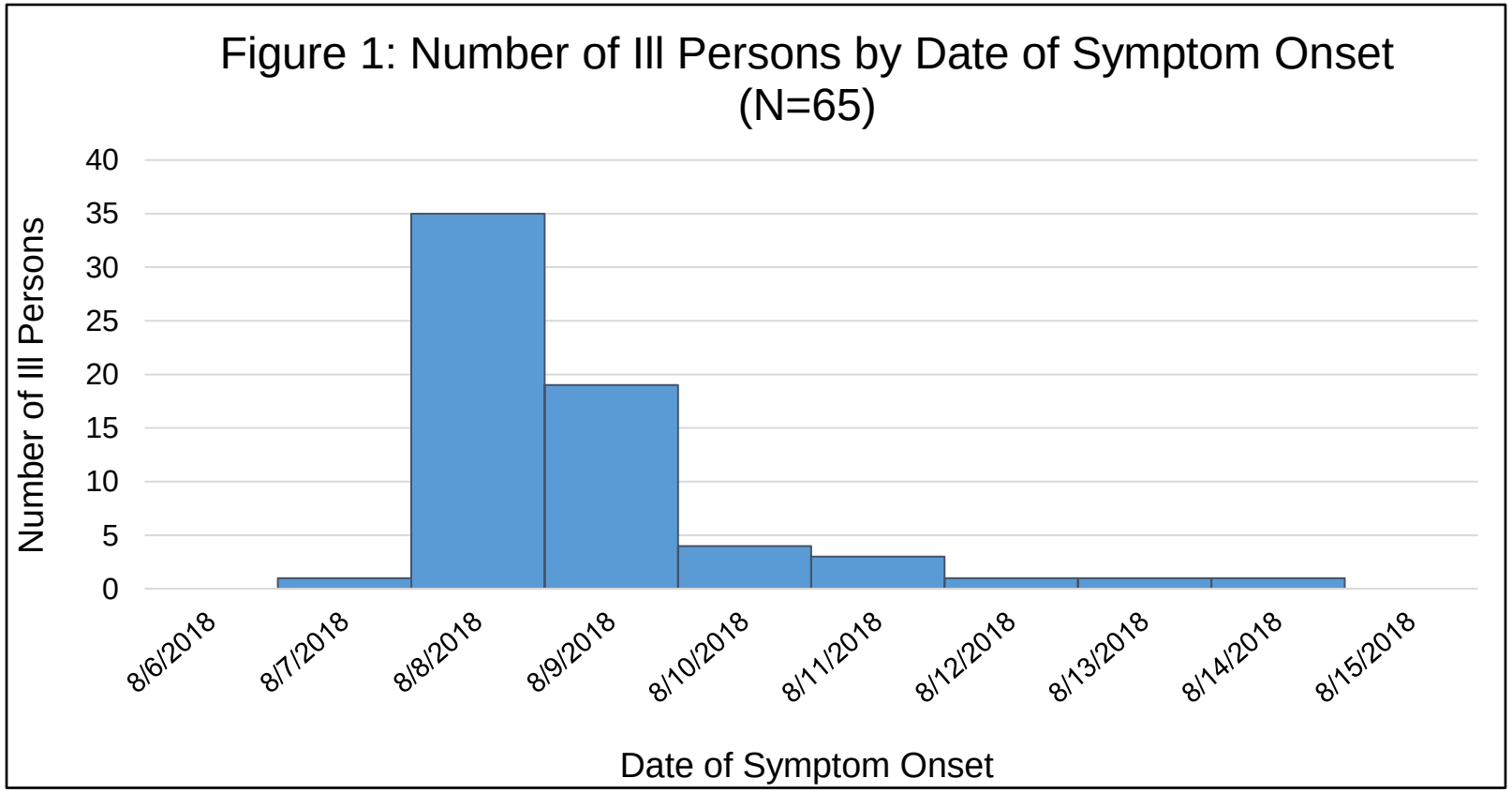
- Persons exposed to the same source; however, exposure is over a prolonged period.
- Epi curve rises gradually and might plateau.

Propagated Spread



- No common source; spread from person-to-person.
- Assumes classical epi curve shape with progressively taller peaks, usually one incubation period apart.

2018 Salmonellosis Indian Taco Outbreak Example



What can you tell from this epi curve from the Indian taco outbreak?

- Mode of spread
- Scope of outbreak

Outbreak Investigations: Share Findings

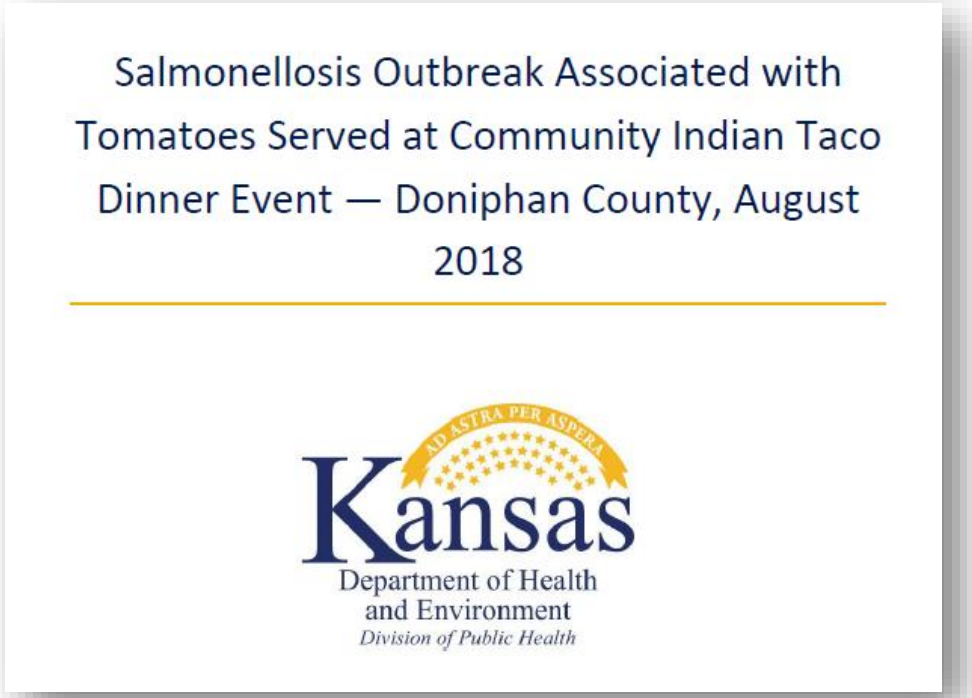
- The last step in outbreak investigations is to communicate your findings.

- Determine who needs to know.

- Determine how information will be communicated.
  - Press release
  - Social media post
  - Investigative report/publish to journal

- Identify why the information needs to be communicated.
  - Transparency
  - Prevent and limit future outbreaks
  - Policy changes

Outbreak Investigations: Share Findings



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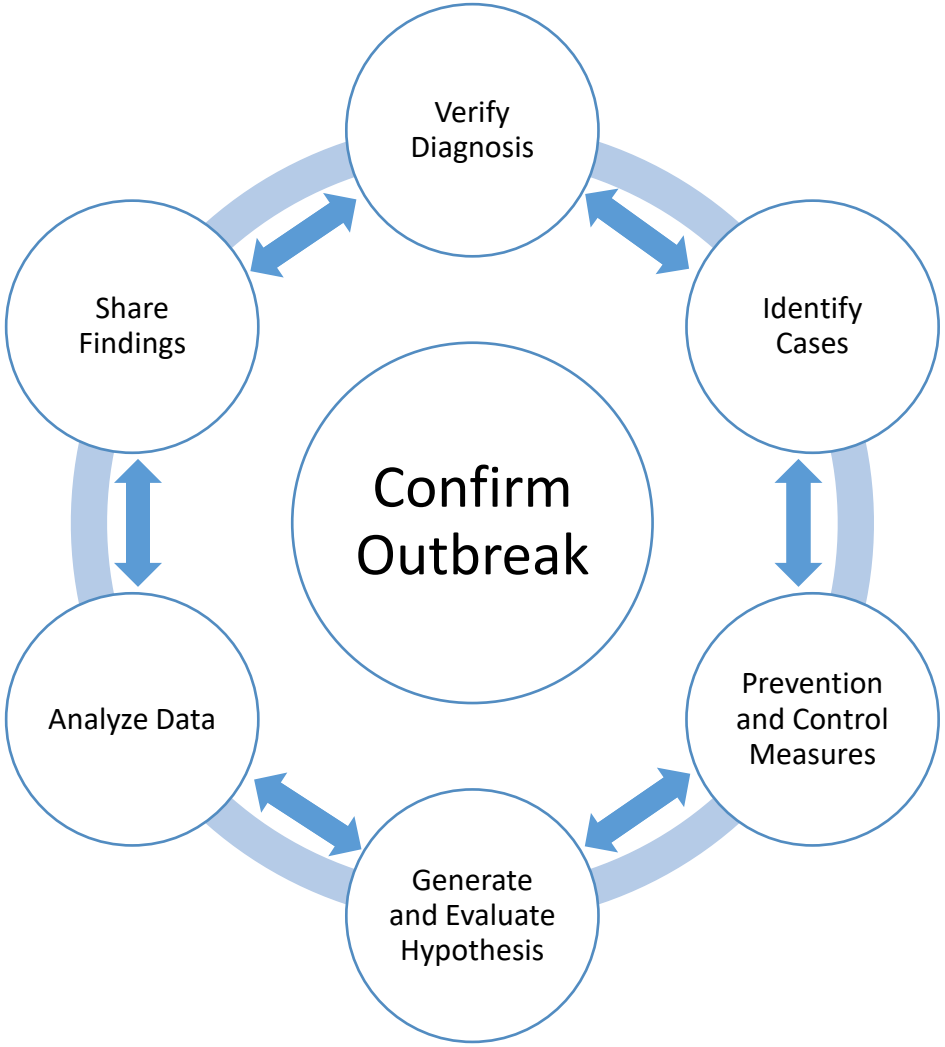
Outbreak Investigations: Recap



- KDHE epidemiologists are available 24/7 to aid in conducting outbreak investigations, data analysis and more!
- Many steps to an investigation occur at the same time and may need to be revised as additional information is collected.
- Using tools available, interrupt transmission by understanding a disease's epidemiologic triangle.

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References

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Thank You/Questions