Enteric Disease Surveillance and Outbreak Investigations in the United States

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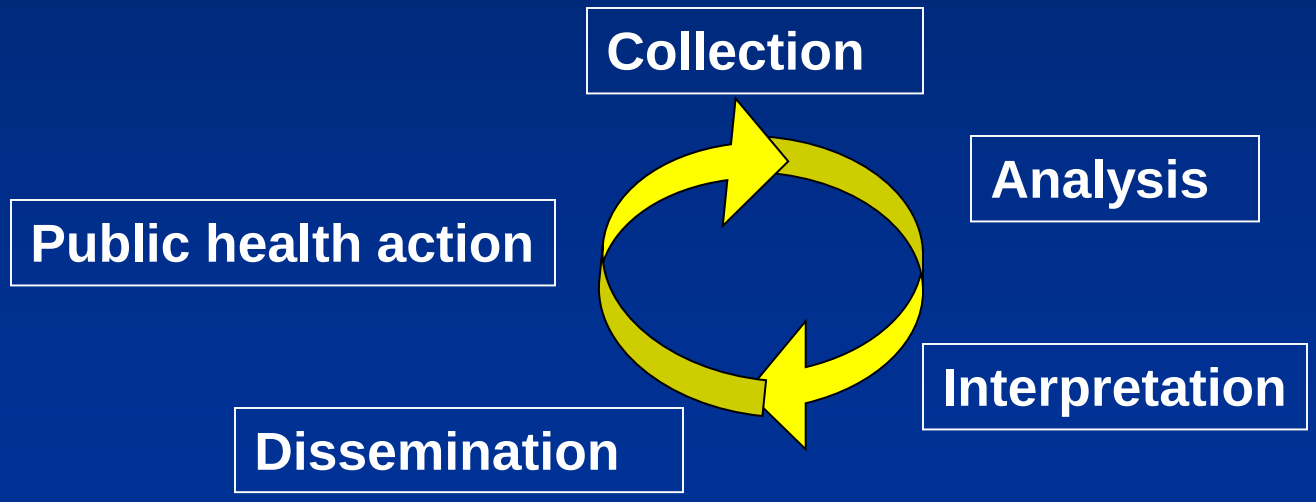
The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention

What is surveillance?

- The systematic, ongoing, collection, analysis, interpretation, and dissemination of data for public health action



Purpose of Surveillance

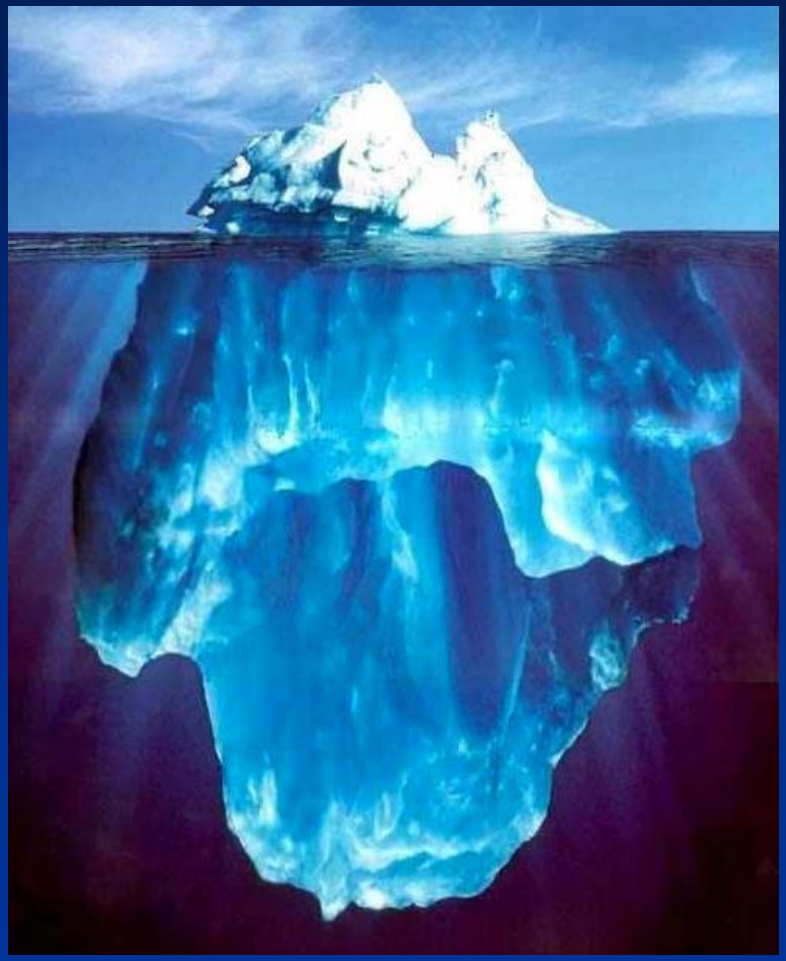
- Surveillance is NOT
  - Just collecting numbers and preparing annual reports
  - Just conducting research studies for publication

- Surveillance can include these activities, which are important communication activities

Why Do Surveillance?

- Estimate burden of disease
- Monitor trends
- Detect outbreaks
- Assess control programs
- Learn more about diseases under surveillance

Pyramid of Surveillance



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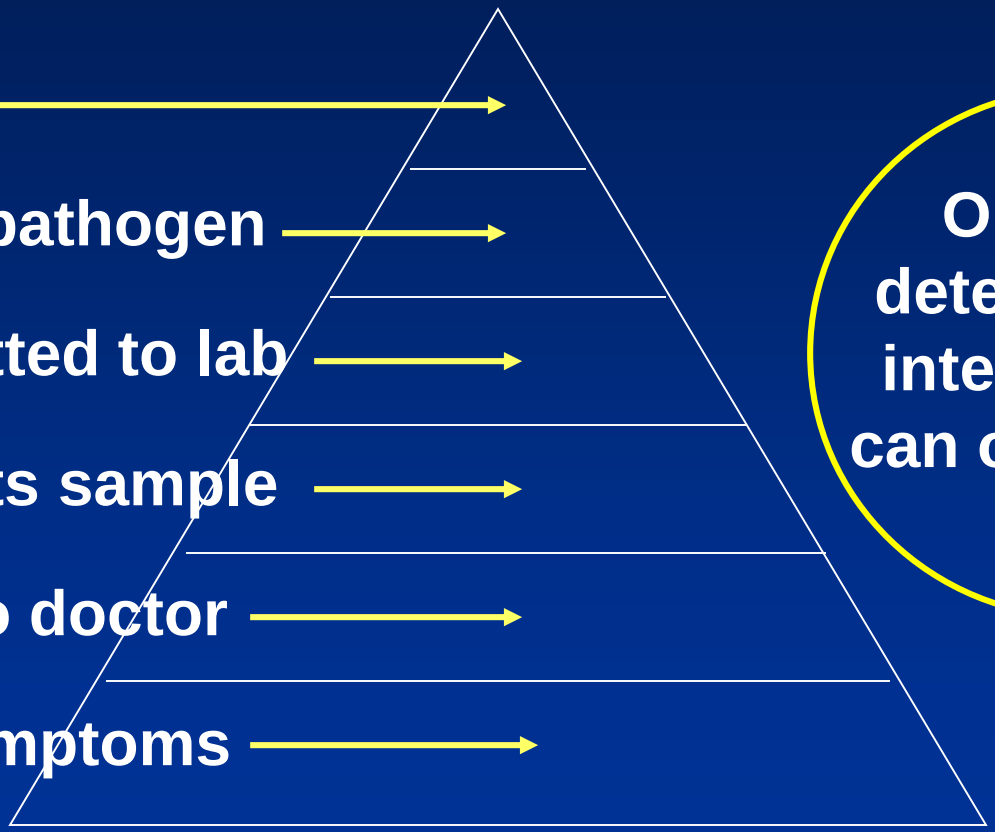


Case reported

Lab identifies pathogen

Sample submitted to lab

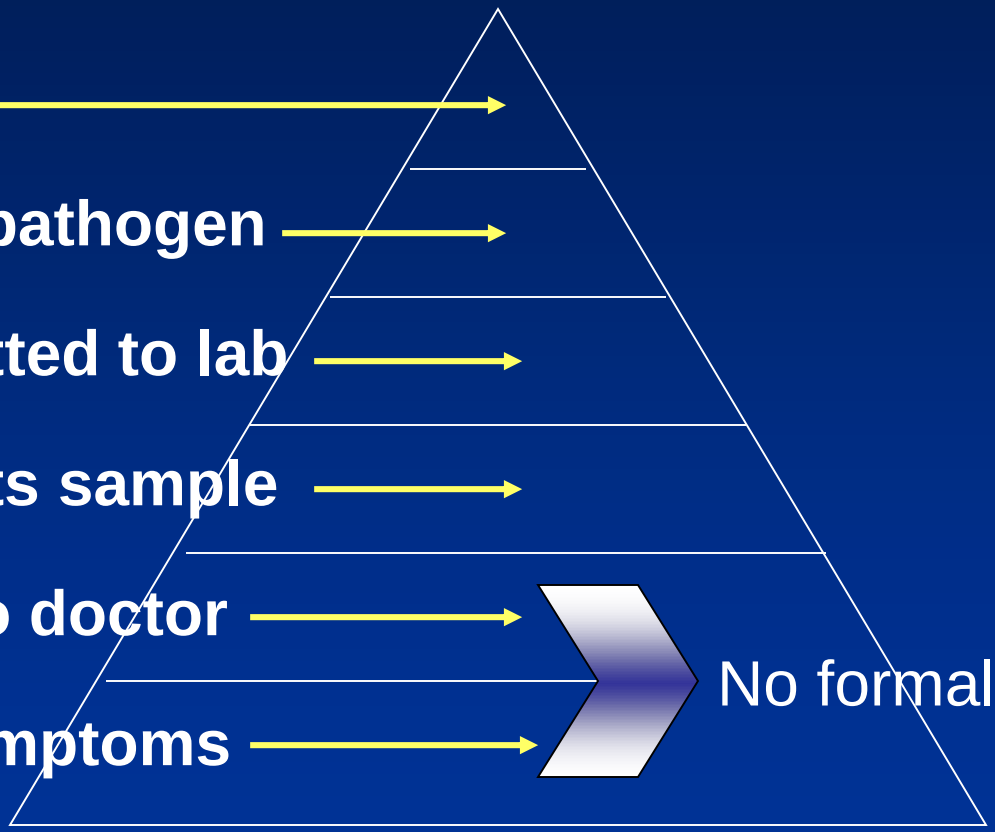
Doctor requests sample

Person goes to doctor

Person has symptoms

Outbreak detection and interventions can occur at all levels

Pyramid of Surveillance



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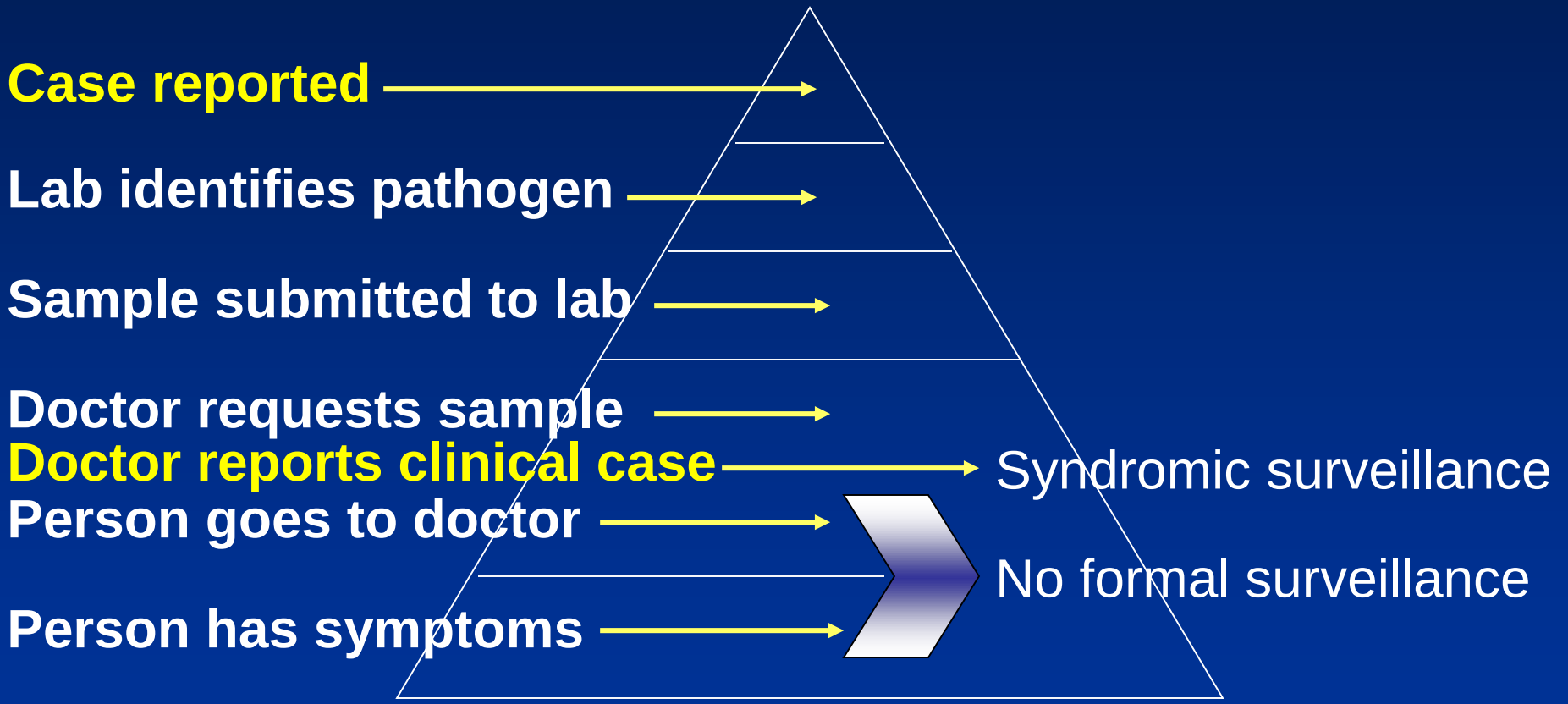

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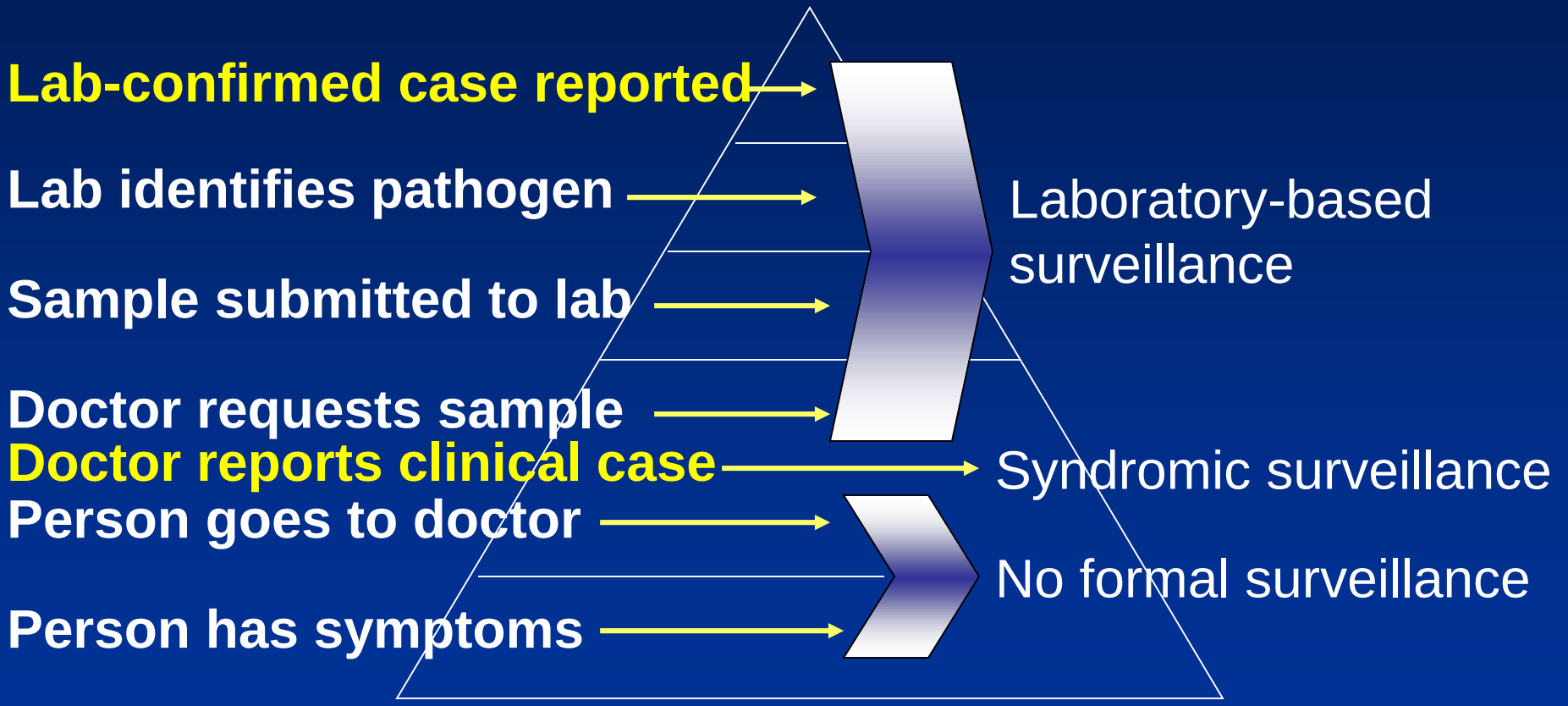

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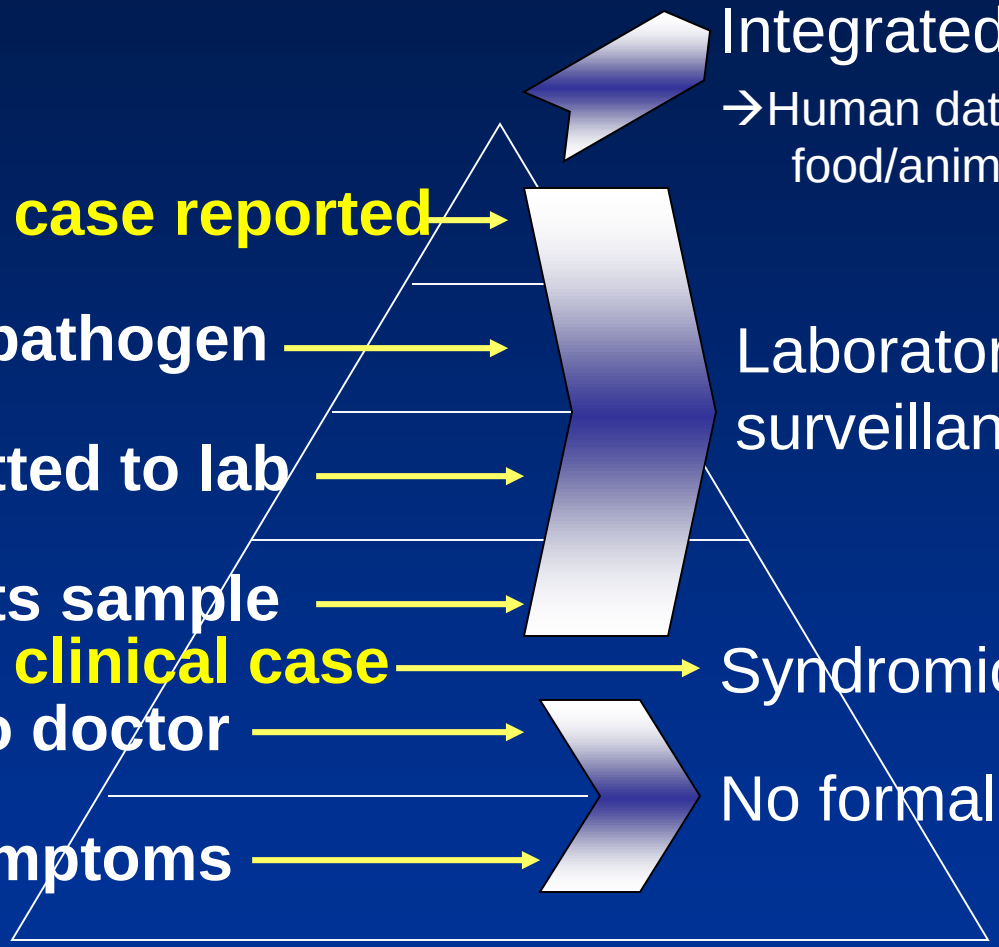

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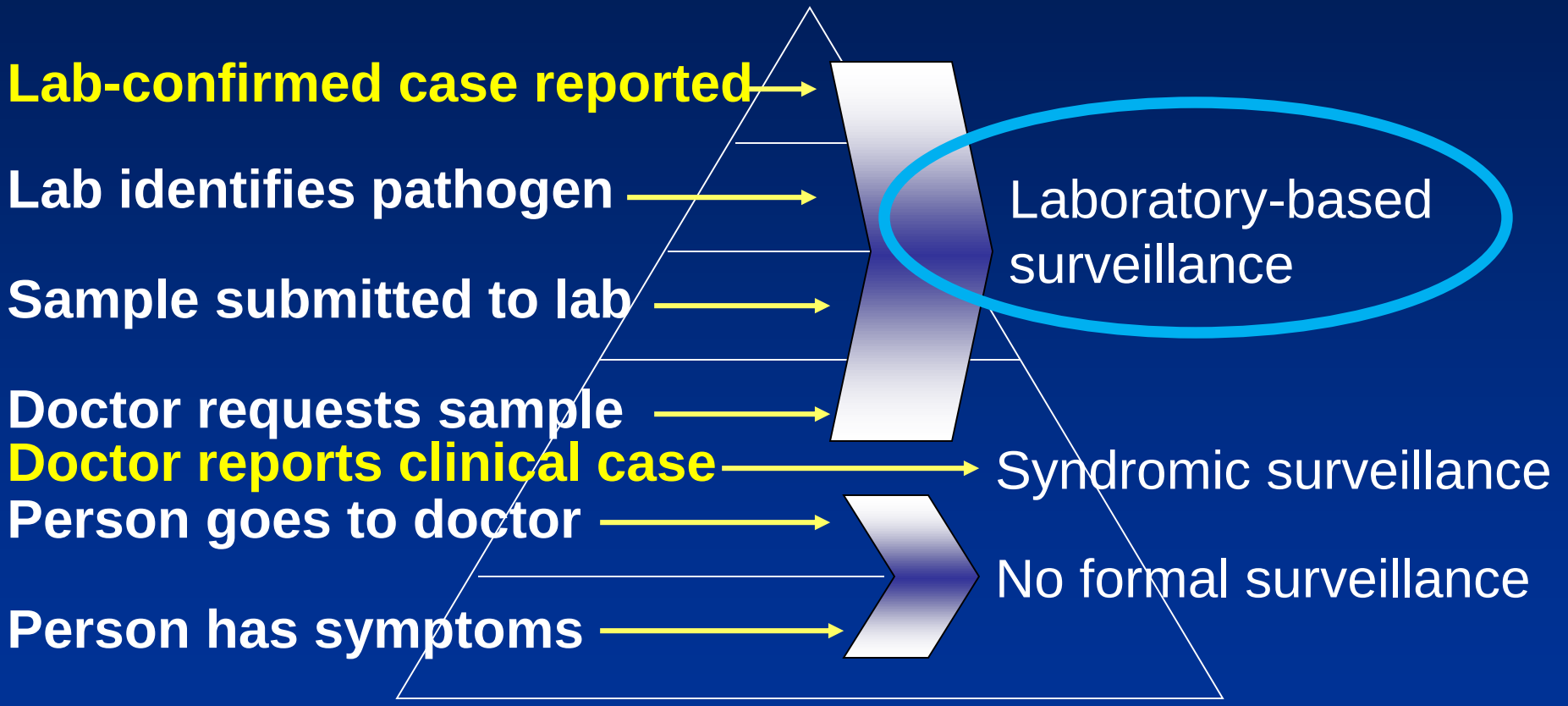


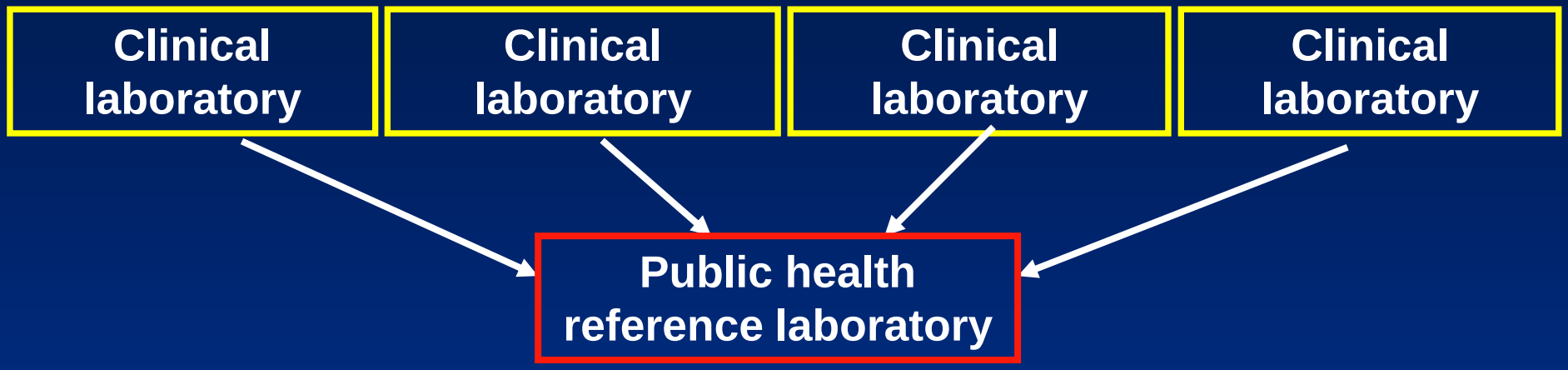
Why do laboratory-based surveillance?

- Identifies pathogens that cause illness
  - Also specific subtypes
- Aids detection and investigation of outbreaks
- Allows monitoring of trends of pathogens
  - Over time
  - In selected populations
  - Helps to inform targeted policies and programs for controlling pathogens

What is essential for laboratory-based surveillance?

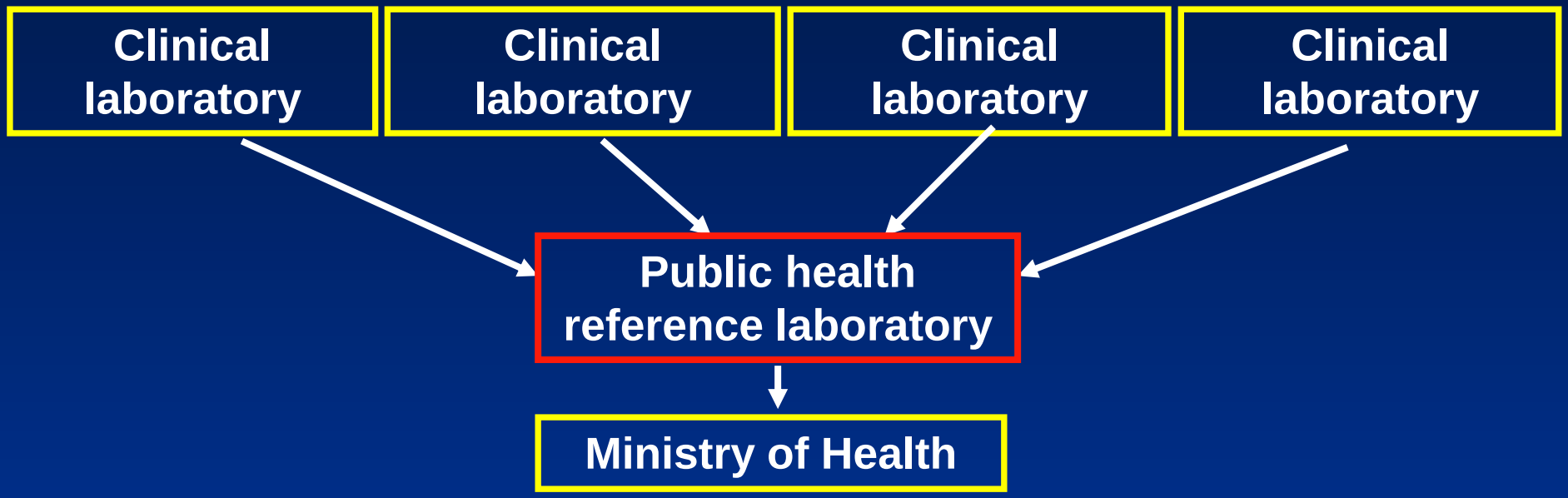
- Must have isolates from ill people
  - Clinical laboratories must send isolates to public health laboratory
  - Public health laboratory must subtype isolates
    - Speciation, serotyping, virulence testing
  - Need reference laboratory for difficult isolates
- Must have laboratory-epidemiology partnership

Laboratory-based surveillance



- Subtyping by public health laboratory finds clusters

Laboratory-based surveillance



- Subtyping by public health laboratory finds clusters
- Public health laboratory must share subtype results with epidemiologists

Subtyping is important

- Subtyping
  - Detects clusters
  - Provides clues about source
- Some subtyping methods
  - Serotyping – Requires isolates and good culturing techniques!
  - Antibiotic resistance profiling – Requires isolates and good culturing techniques!
  - Molecular typing, *eg*, pulsed-field gel electrophoresis (PFGE)

Subtyping is important Example: *Salmonella*

- Common cause of foodborne disease
- Over 2,500 serotypes
- Serotypes have individual biology and epidemiology
  - serotype Typhi causes typhoid fever
  - serotype Enteritidis is commonly transmitted by eggs
  - serotype Typhimurium is transmitted by a wide variety of food animals

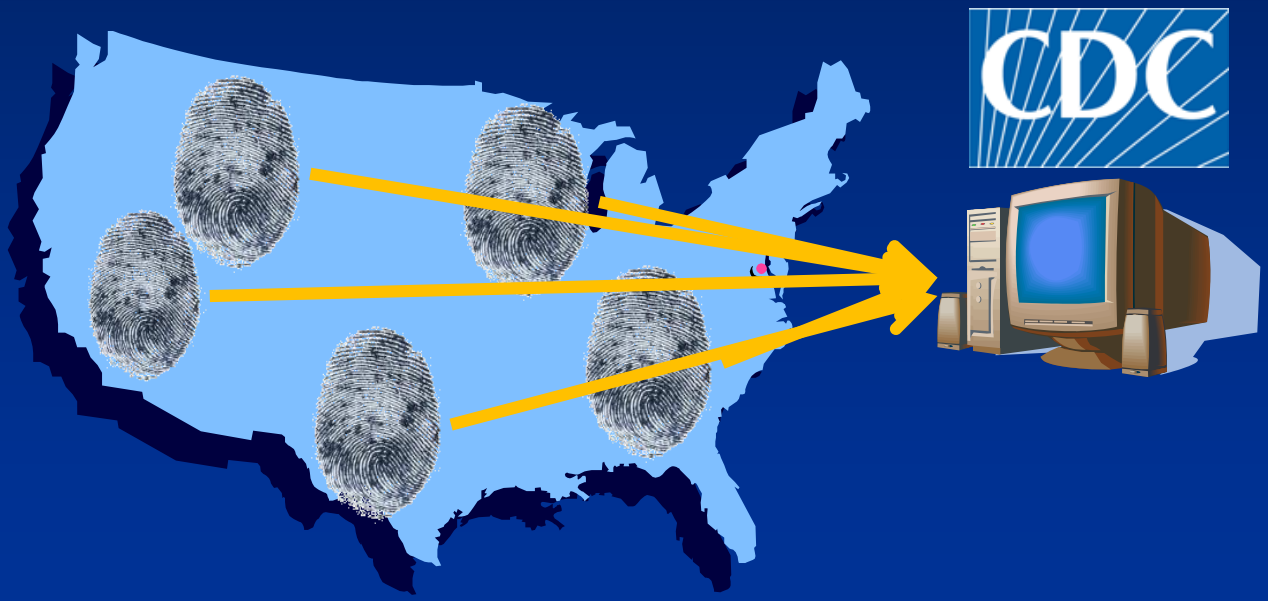
PulseNet

- National molecular subtyping network for foodborne disease surveillance
  - >80 public health and regulatory laboratories
- Perform molecular subtyping of foodborne disease-causing bacteria
  - Pulsed-field gel electrophoresis (PFGE)
  - Create PFGE pattern or DNA fingerprint for each isolate

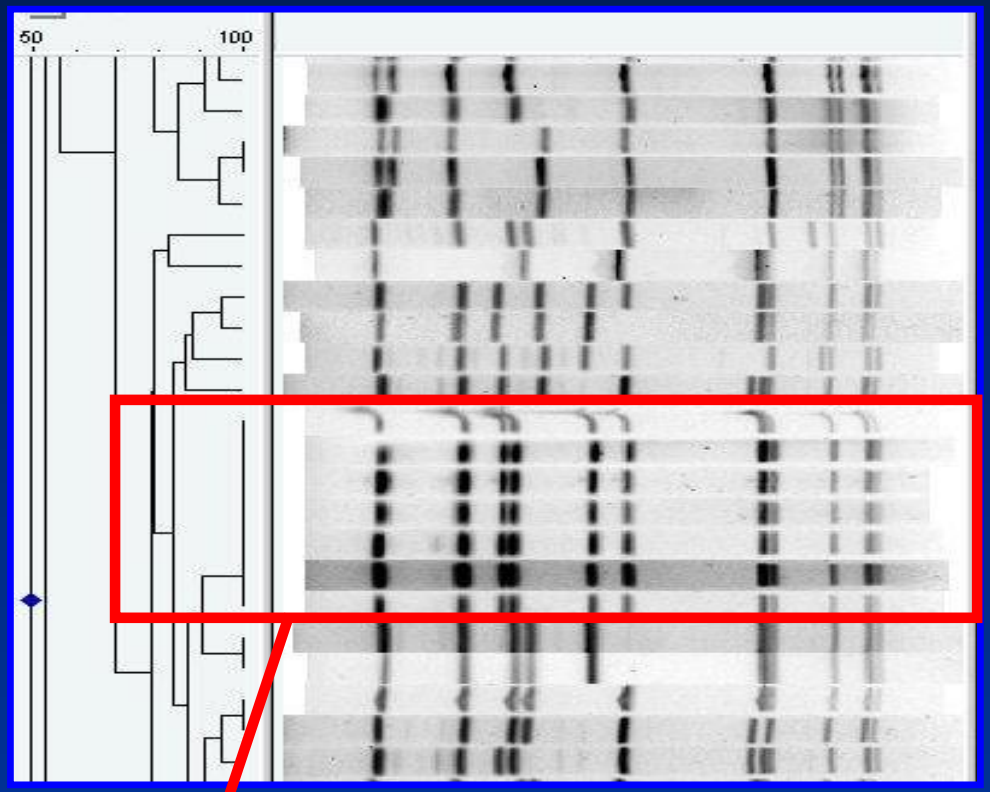
PulseNet

PulseNet USA
The National Molecular Subtyping Network for Foodborne Disease Surveillance

- Share DNA "fingerprints" electronically
- Kept in national database at CDC



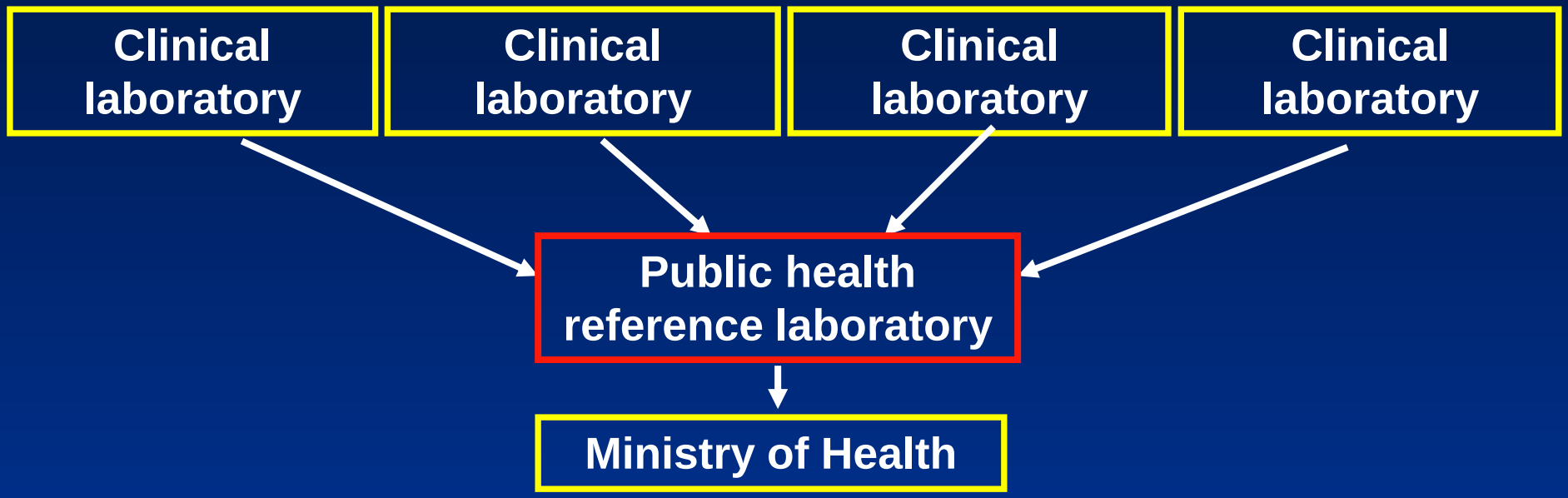
PulseNet Data Analysis: Searching for Clusters



Cluster of indistinguishable patterns

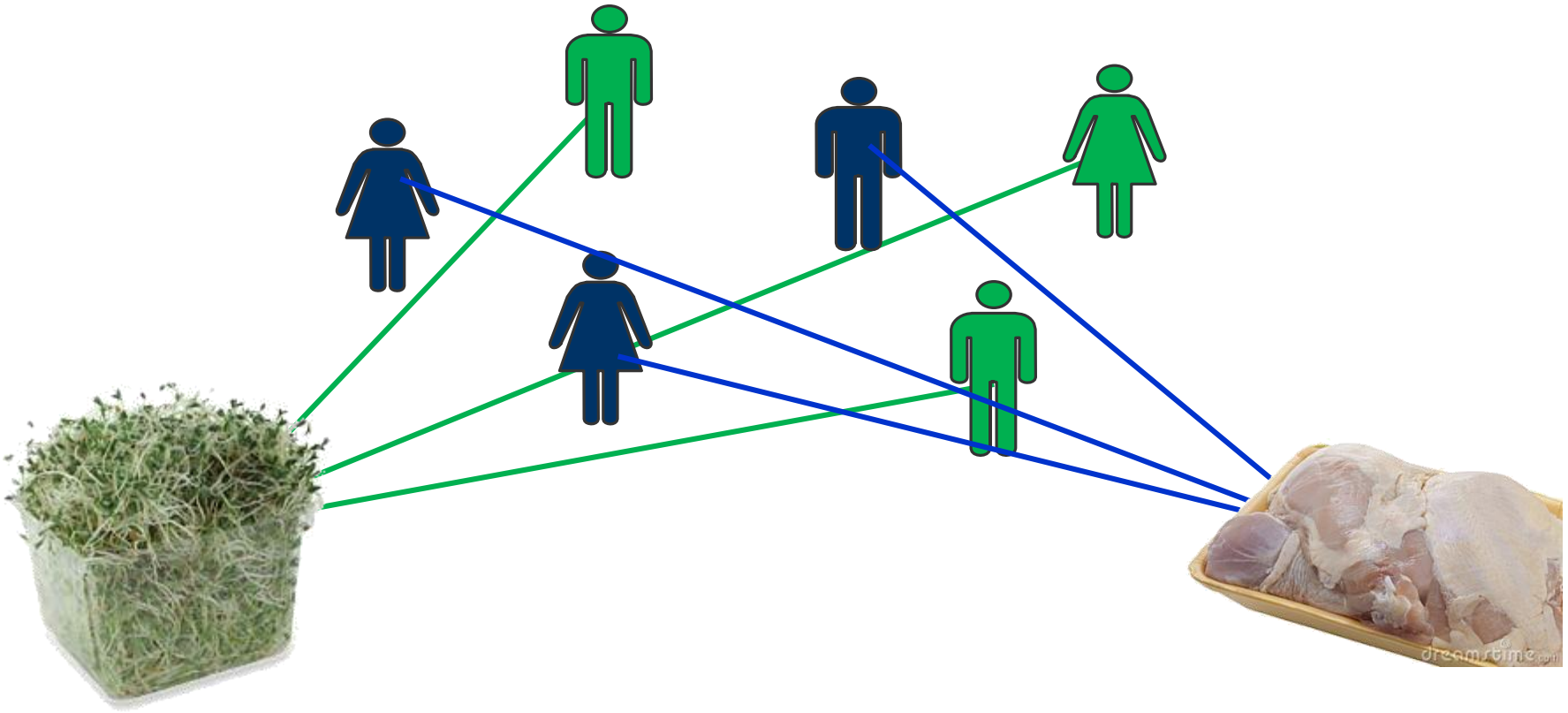
- Monitors for similar patterns in past 2–4 months
- When cluster identified, PulseNet notifies epidemiologists
- States can query PulseNet database for specific PFGE patterns

Laboratory-based surveillance



- Subtyping by public health laboratory finds clusters
- Public health laboratory must share subtype results with epidemiologists
- Epidemiology investigation of clusters finds outbreaks

PulseNet Groups Together Cases Most Likely To Share a Cause for Their Illnesses



Outbreak Investigation

Outbreak Detection and Initial Investigation

- Outbreak detection (laboratory) in February 2016: PulseNet identified cluster of *E.coli* O121 infections with same, uncommon PFGE pattern
- Outbreak investigation (epidemiology) begins
  - Initial interviews suggested leafy greens
  - As investigation continued leafy greens appeared less likely
    - Additional illnesses continued longer than expected
    - Signal less compelling as additional people interviewed

Open-Ended Interviews

- In mid-March, moved to open-ended hypothesis generating interviews
  - Can identify unusual or “stealth” exposures
  - Conversational style
  - All exposures in week before illness
  - Successful in solving other challenging outbreaks

- Single interviewer conducted 10 open-ended interviews

Open-Ended Interviews: Flour Hypothesis

- All 10 (100%) reported they or household member baked
- 8/10 (80%) specifically remembered baking something homemade in week before illness began (5 definite, 3 maybe)
- Of the 5 who definitely baked:
  - 4/5 ate or tasted the raw dough or batter
  - 3/4 used Gold Medal flour; 4th used either Gold Medal or other brand
  - 2 still had bags of Gold Medal flour used before illness
    - Both bags produced in same plant within one day
    - Both people reported eating raw cookie dough

Flour as a Vehicle for STEC

- Flour is a raw agricultural product
- Suspected but not proven in past STEC outbreaks
  - 2009 *E. coli* O157 outbreak linked to commercial unbaked cookie dough
  - 2012–2013 *E. coli* O121 outbreak linked to frozen food products
  - 2015 *E. coli* O157 outbreak linked to a dessert pizza at a pizza chain
- STEC had been isolated from dough and flour previously

Matched Case-Control Study

- Conducted in late April through June 2016
  - People with non-STEC enteric infections as comparison; sought 4 controls for each case
  - Matched on age group, gender, and state of residence
- Questionnaires focused on baking
  - Whether someone in household baked something homemade
  - Flour and baking mix brands used
  - Tasting or eating raw dough or batter
  - Other foods of interest
- Illness significantly associated with
  - Someone in household baking something homemade with flour
  - Using Gold Medal brand flour
  - Eating/tasting raw dough

Traceback Investigation by FDA

- Detailed product information from 3 ill people with leftover packages of Gold Medal flour
- Records collected from restaurants linked to ill people
  - In early May 2016, identified 3 young children exposed to raw dough at restaurants in several states
  - All played with the raw dough and some ate it
- Identified that flour was produced in the same week in November 2015 at the General Mills facility in Kansas City, Missouri

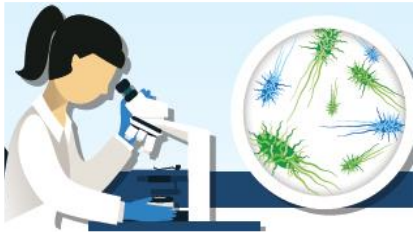
Initial Product Recall

- On May 31, 2016, General Mills recalled certain production dates of several sizes and varieties of Gold Medal Flour, Gold Medal Wondra Flour, and Signature Kitchens Flour

- On June 1, CDC and FDA post initial investigation announcements

Photos from: http://www.fda.gov/Safety/Recalls/ucm504235.htm

Product Testing by FDA



- In June, FDA isolated *E.coli* O121 from leftover flour samples from Arizona, Colorado, and Oklahoma
  - Flour isolates closely related genetically by Whole Genetic Sequencing to clinical isolates
  - Oklahoma sample from flour not included in the initial recall

- In July, FDA conducted Whole Genetic Sequencing on an *E.coli* O26 isolate provided by General Mills
  - Flour isolate closely related genetically to a clinical O26 isolate
  - This ill person subsequently included in the investigation
  - Flour tested not covered under earlier recalls

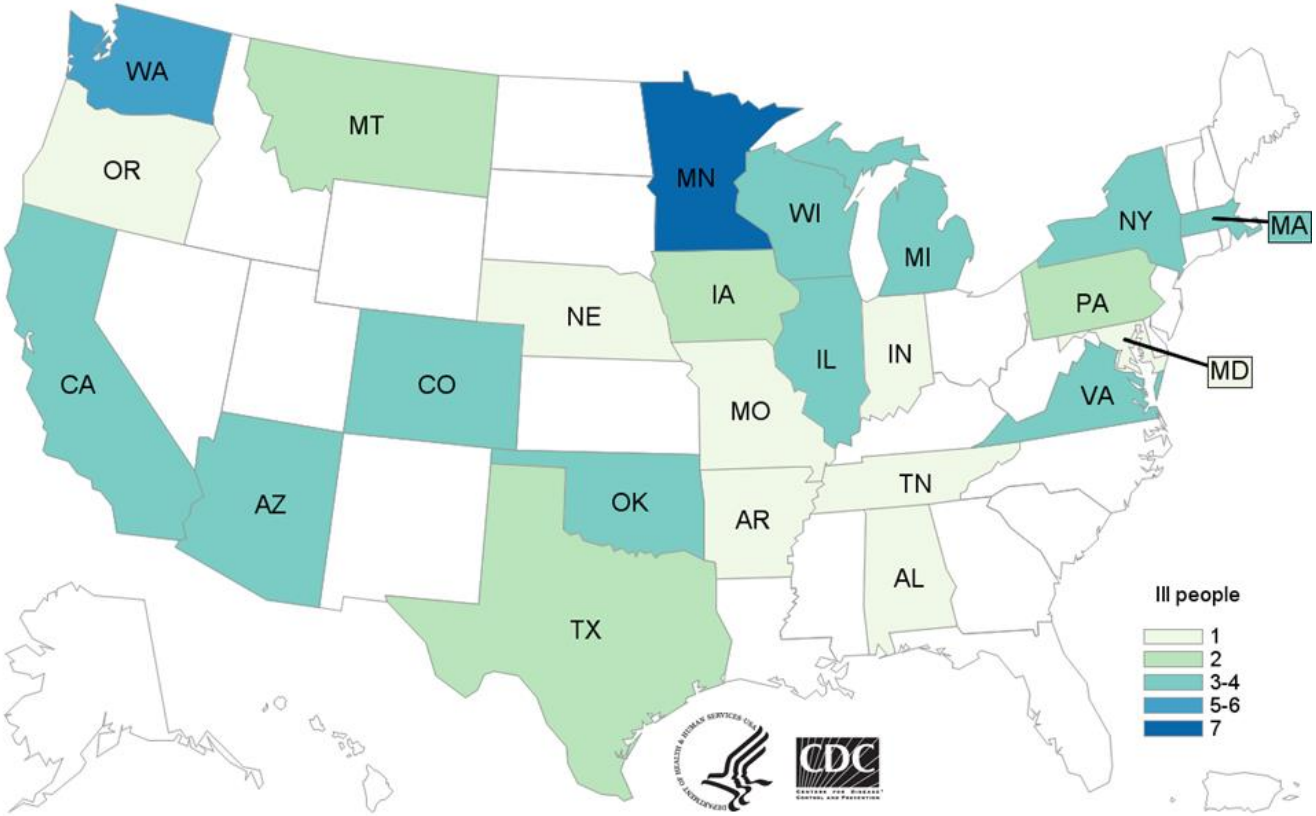
Additional Recalls

- General Mills issued recall expansions on July 1 and July 25 to include additional production dates

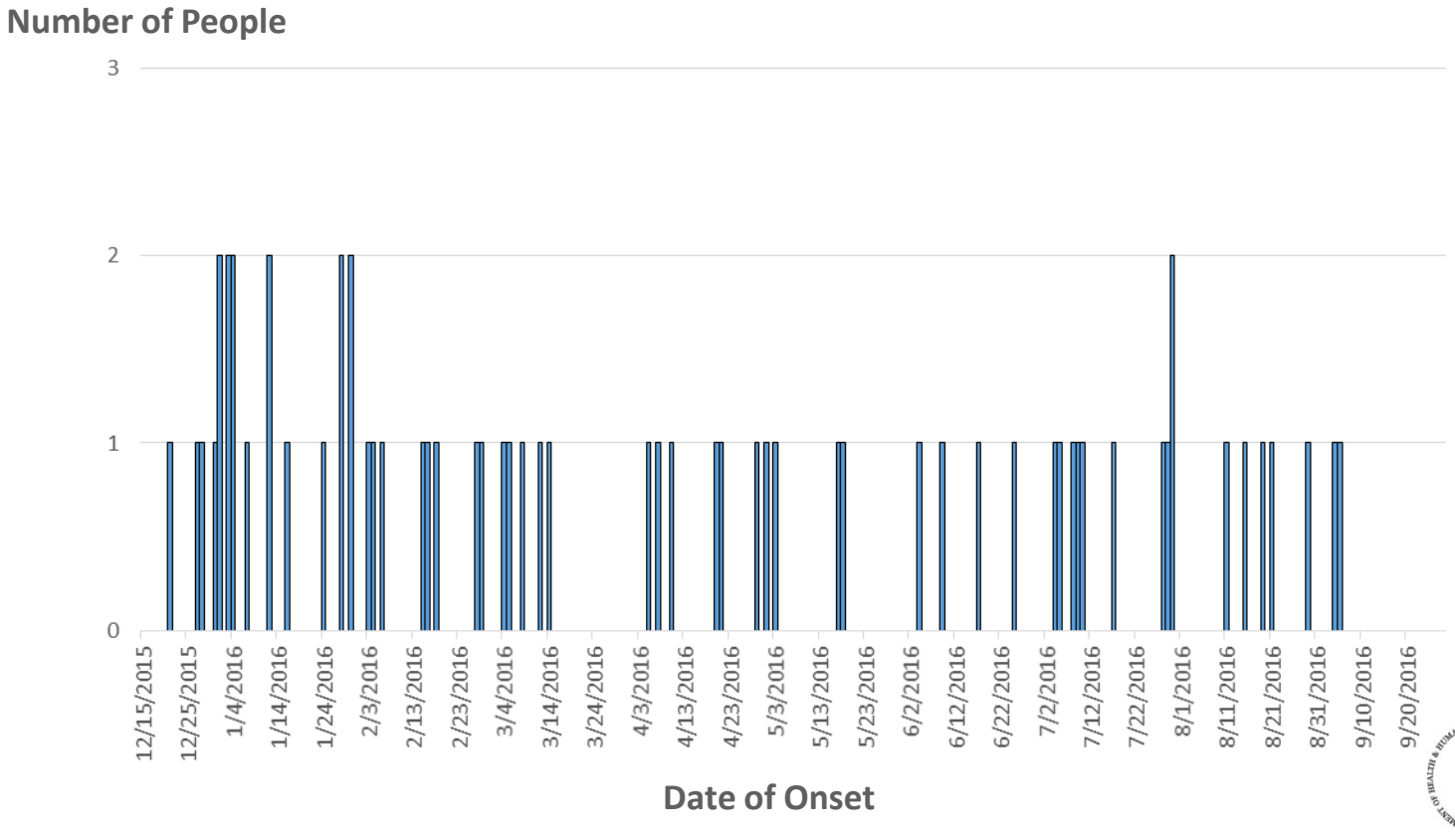
- Downstream product recalls issued by companies that had used recalled flour to make their own products
  - Various baking mixes
  - Frozen entrees and snacks

- In total, over 200 products across ~30 brands recalled

People infected with the outbreak strains of *E. coli* O121 or *E. coli* O26, by state of residence, as of September 28, 2016 (n=63)



People infected with the outbreak strains of *E. coli* O121 or *E. coli* O26, by date of illness onset, September 28, 2016 (n=63)



Public Health Messaging

- It is not safe to taste or eat raw dough or batter
  - Flour or other ingredients used to make raw dough or batter can be contaminated
  - Always bake items made with raw dough or batter before eating them
  - Do not taste raw dough or batter
- Do not give playdough made with raw flour to children
- Restaurants and retailers should not serve raw dough to customers or provide raw dough for children and other guests to play with

Outbreak Summary

- Epidemiologic, traceback, and laboratory investigations linked this outbreak of *E.coli* O121 infections to flour produced at a single facility
- First time flour has been definitively implicated in any STEC outbreak
- Highlights the risks of consuming or handling raw dough
- Collaborative efforts of state, local, and federal public health and regulatory efforts key to successful investigation

Acknowledgements

State and Local Health Departments and Regulatory Agencies

Alabama
Arkansas
Arizona
California
Colorado
Iowa
Illinois
Indiana
Massachusetts
Maryland
Michigan
Minnesota
Missouri
Montana
Nebraska
New York
Oklahoma
Oregon
Pennsylvania
Tennessee
Texas
Virginia
Washington
Wisconsin

Federal Partners

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- Core Response Team 3
- Pacific Regional Laboratory NW
- District Offices

CDC Enteric Diseases Laboratory Branch

CDC Outbreak Response and Prevention Branch
- Lyndsay Bottichio
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- Sam Crowe
- Ian Williams
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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Questions?

Words of wisdom

“Relationships are the key:

With good relationships and a bad surveillance system you can still accomplish a lot.

However, with a very sophisticated system, but poor relationships you can still have bad surveillance data.”

Paraphrased-Dr. Gueneal Rodier, WHO, March 2004