

Current Thinking on Foodborne Outbreak Investigations: The CDC Perspective

May 15, 2008

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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

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Overview

- How outbreaks of foodborne illness are identified
- Epidemiologic process of linking products to illness
- Intervening in ongoing outbreaks and preventing future ones
- Gaps in the current system
- Vision for the future

Public Health Infrastructure in the United States

- **The county or city health department**
 - The front line of public health
- **The State health department**
 - Epidemiologists
 - Laboratorians
 - Sanitarians
- **The federal agencies:**
 - Risk identification agency: CDC
 - Risk management/regulatory agencies: FDA, USDA, EPA
- **"Tiered response" to emergencies**
 - CDC provides back-up to States: epidemiologists, laboratory support, coordination

Federal Roles

- **CDC:**

- Disease surveillance
- Outbreak detection and investigation
- Education and training of public health staff

Problem identification

Source implication

- **FSIS & FDA:**

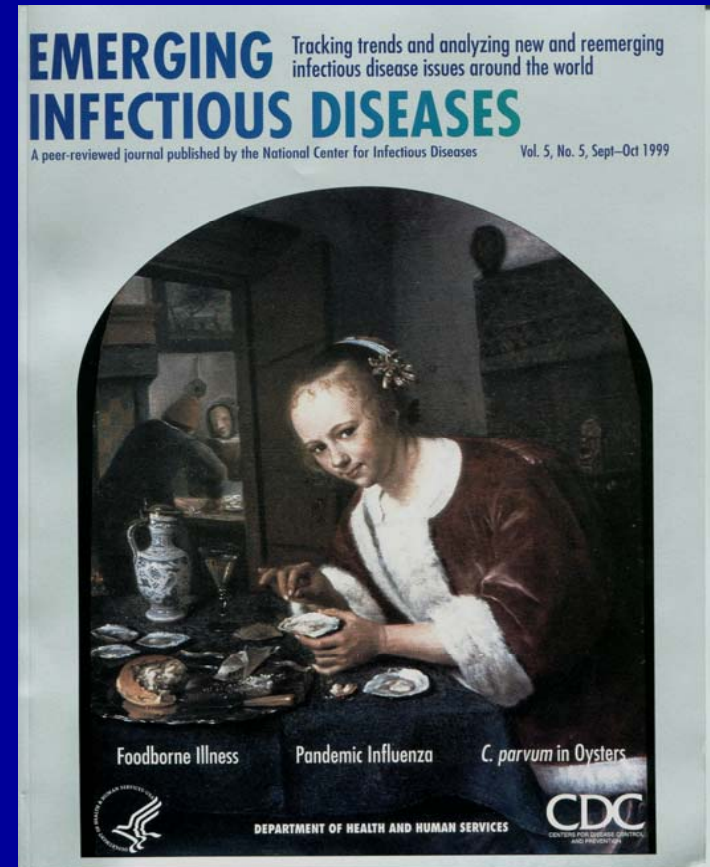
- Food safety policies
- Inspection and enforcement
- Product recall and traceback
- Investigation of farm and production facilities

Risk assessment and management

Source assessment

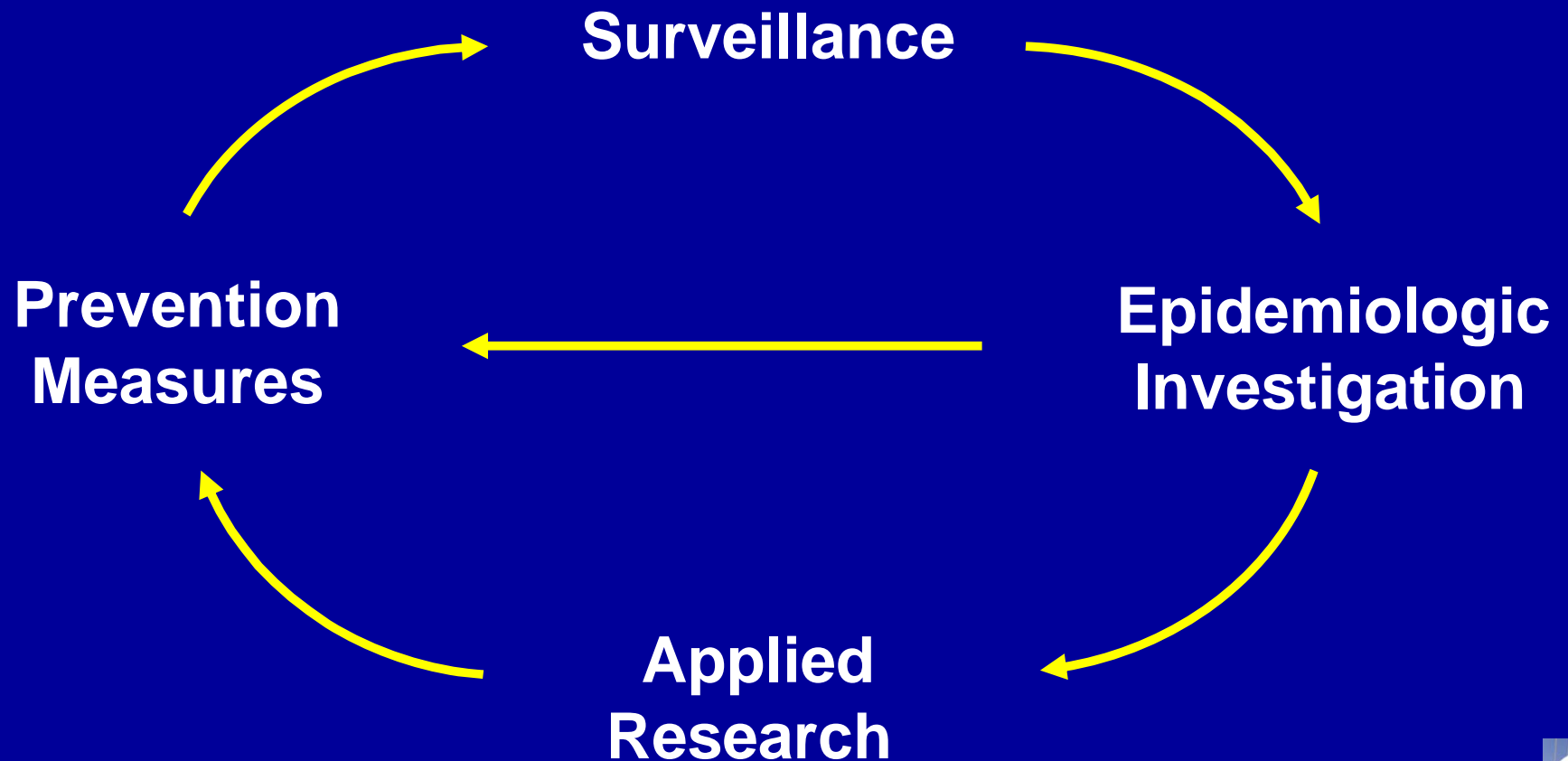
Public Health Burden of Foodborne Disease

- Each year an estimated 76 million cases
 - 1 in four Americans gets a foodborne illness each year
 - 1 in 1000 Americans is hospitalized each year
 - 5,000 deaths
 - \$6.5 billion in medical and other costs
- >1,200 outbreaks (>27,000 illnesses) reported in 2006
- Outbreak epidemiology changing
 - Centralization, industrialization, globalization
 - Number of possible outbreaks detected has grown substantially
- Effective investigations key to reducing burden of foodborne disease
 - Identify food vehicles and factors which lead to outbreaks

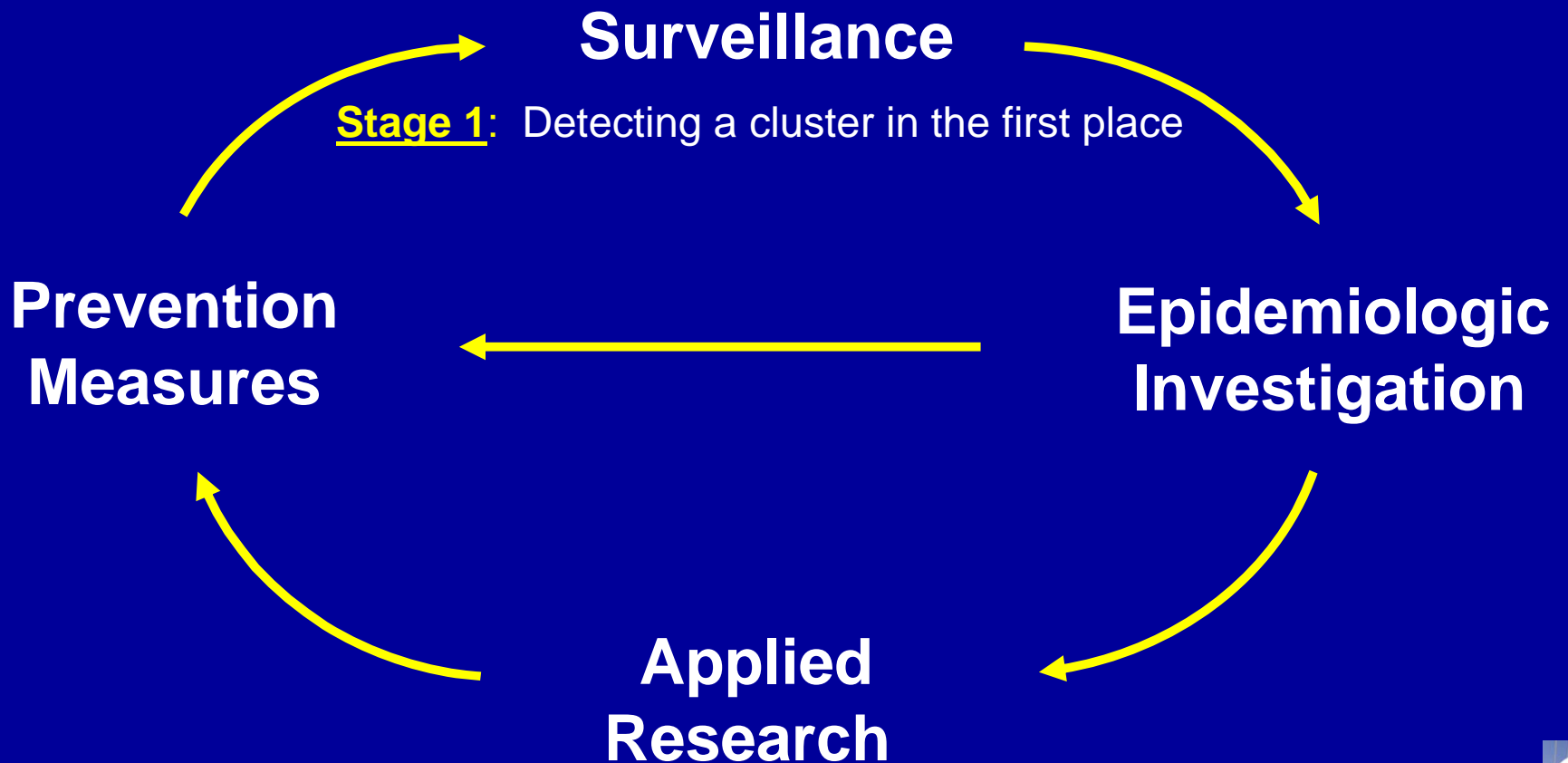


Mead et al. EID 1999

Cycle of Foodborne Disease Control and Prevention



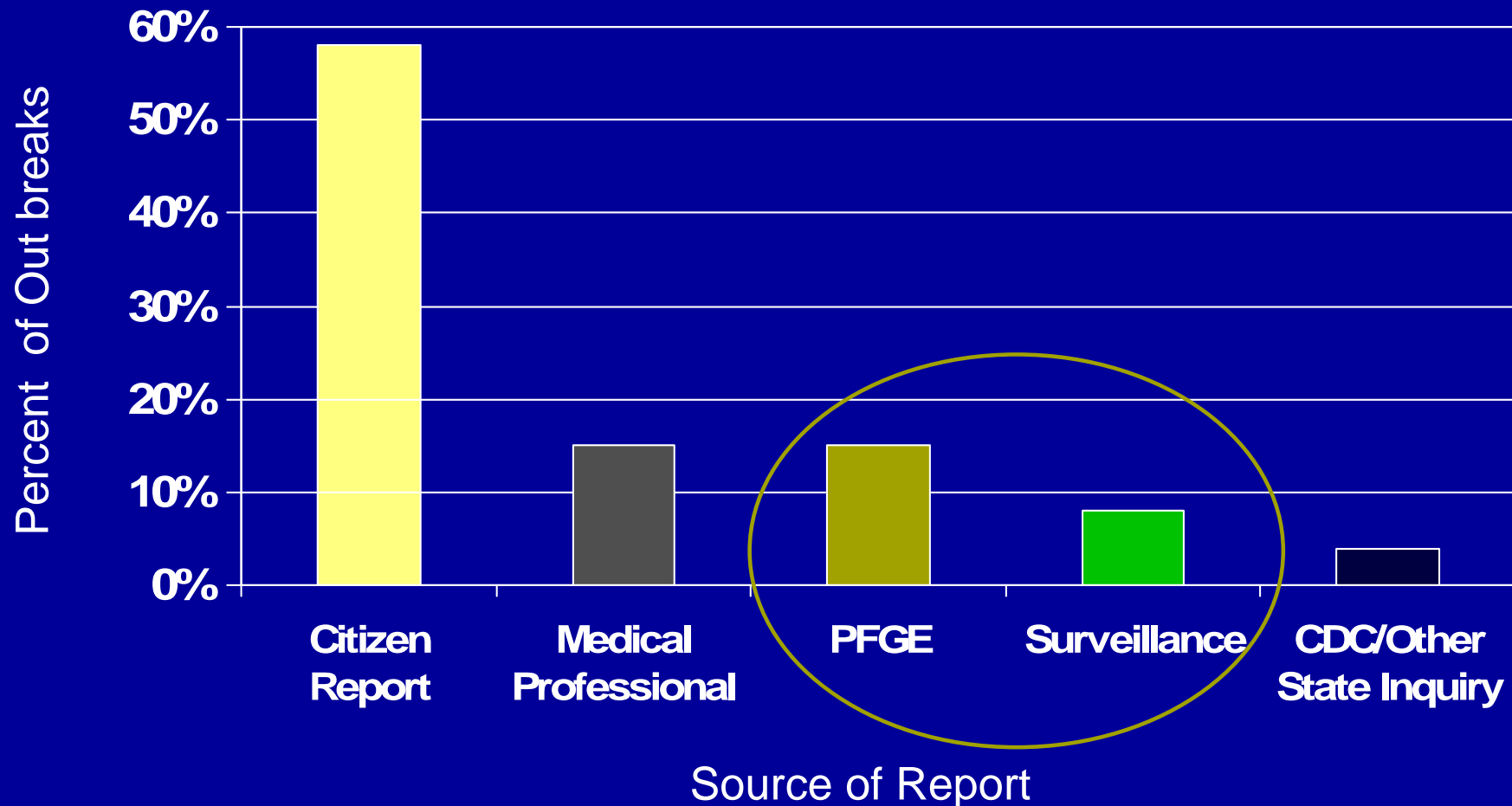
Cycle of Foodborne Disease Control & Prevention: Stages of an Outbreak Investigation



Stage 1: Detecting a cluster in the first place

- Surveillance = the ongoing systematic collection and analysis of data and the provision of information which leads to action being taken to prevent and control a disease
 - Reports of suspected outbreaks by state and local health departments to CDC
 - PulseNet

Foodborne Disease Outbreaks by Reporting Source Connecticut, 2004-2006

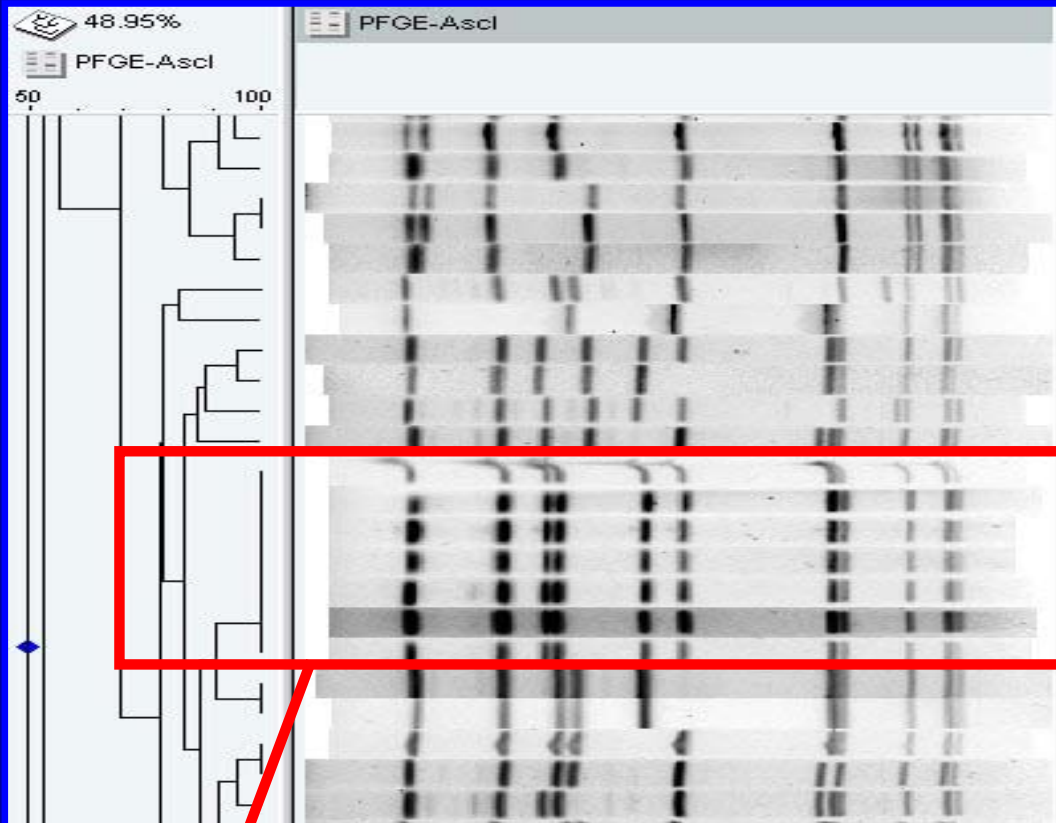


What is PulseNet USA?



- National network of >75 public health and regulatory laboratories
- Perform molecular typing of foodborne disease-causing bacteria
 - **Current method is pulsed-field gel electrophoresis (PFGE)**
 - **Create DNA “fingerprints”**
- Share DNA “fingerprints” electronically
- DNA “fingerprints” are kept in dynamic database at CDC
 - **available on-demand to participants**

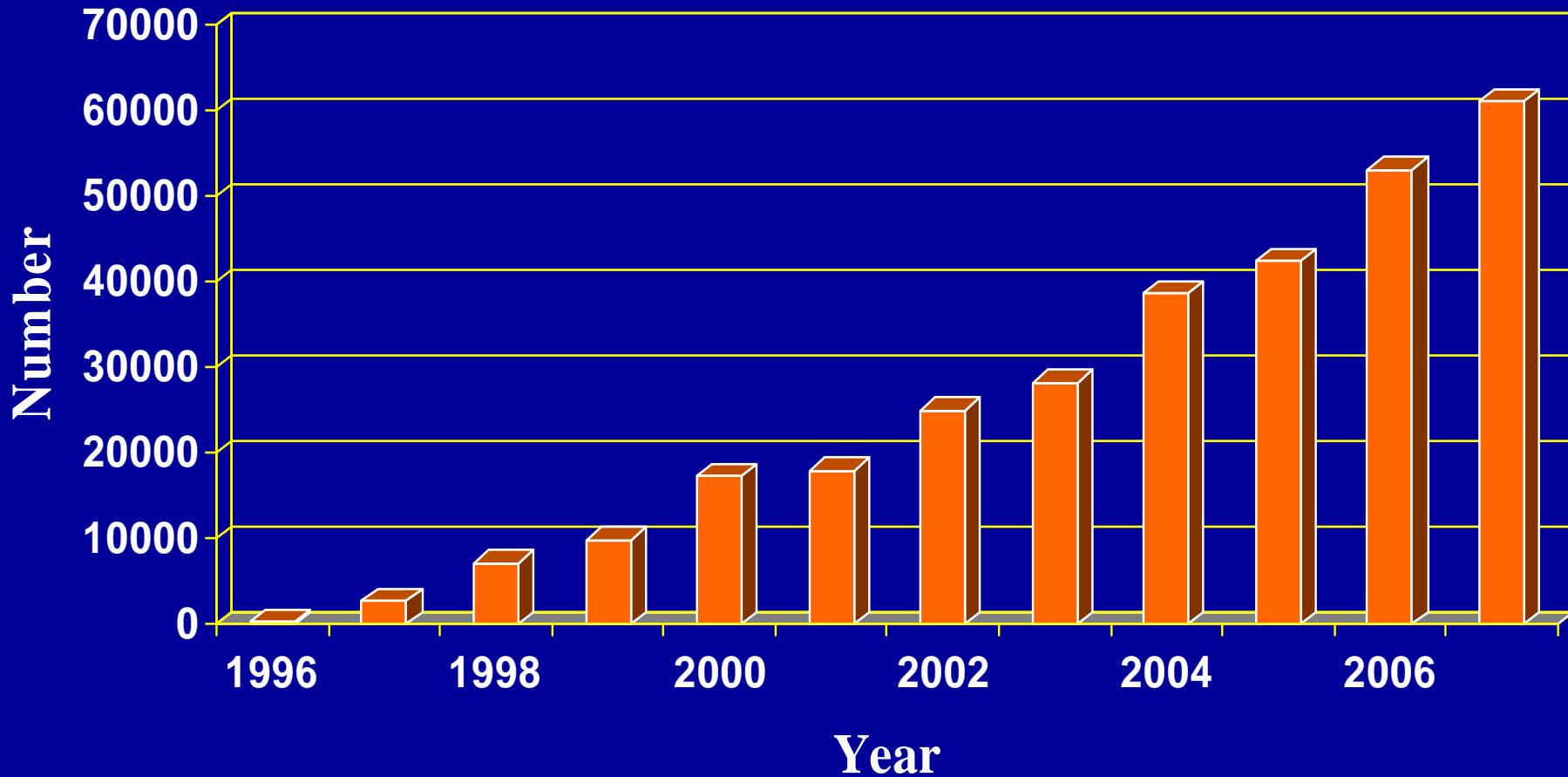
PulseNet Data Analysis: Searching for Clusters



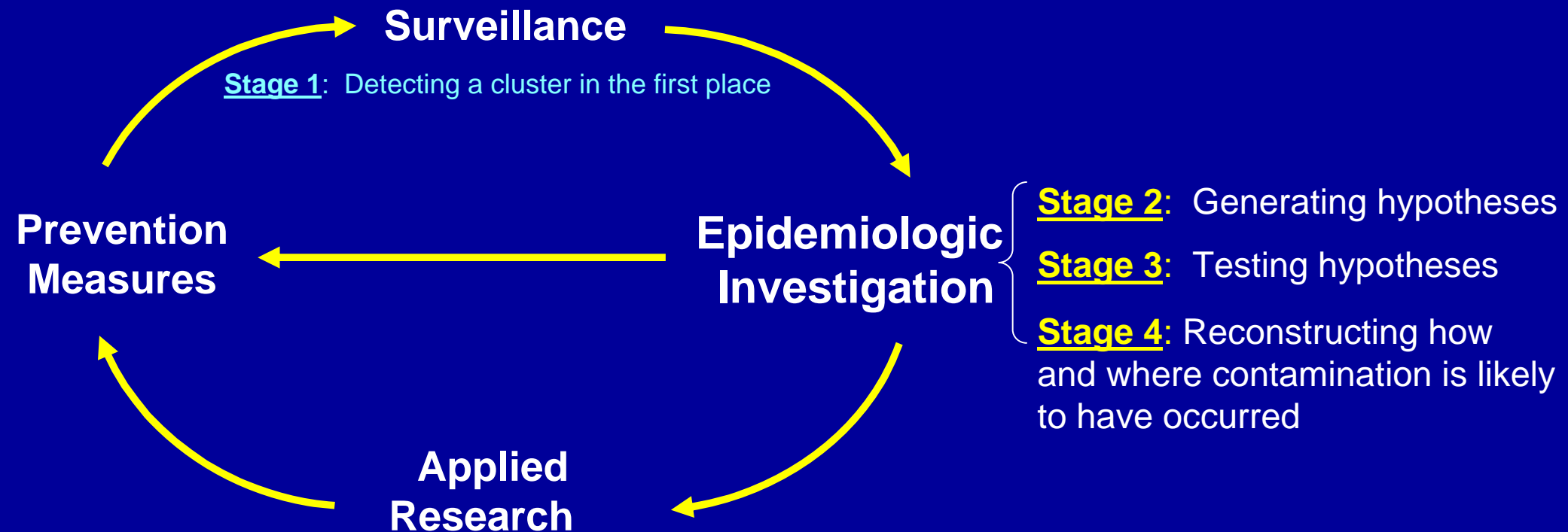
Cluster of indistinguishable patterns

- State health depts submit patterns electronically
- CDC searches for similar patterns in past 2-4 months
- CDC compares patterns visually
- When cluster identified, PulseNet contacts epidemiologists

PFGE Patterns Submitted to PulseNet Databases, 1996 - 2007



Cycle of Foodborne Disease Control & Prevention: Stages of an Outbreak Investigation



Stage 2: Generating Hypotheses

- If we know the pathogen:
 - Reservoir
 - Biology
 - History of previous outbreaks
- Look at reported series of outbreaks in the electronic Foodborne Outbreak Reporting System (eFORS)
- Look at case-control studies of sporadic cases
- Look at isolates from animals and foods
- Look at food recall history from UDSA and FDA
- Orient cases with respect to person, place, and time

Hypothesis Generating Interviews

- Strategies include:
 - Interviews with structured questionnaire with many food items on it: “trolling, trawling, or shotgun”
 - Intensive open-ended interviews about everything that went into patient’s mouth in the last 5 days
 - In-depth interview with people in their homes, including refrigerator, pantry
 - Some combination of the two
 - All must be done the same way
- A food product is not the source of all outbreaks!

Stage 3: Testing Hypotheses

- Systematically compare exposures of ill and those who remained well
 - Two structures of investigation
 - Illness in a defined group (cohort) after an event: interview whole group about exposures and subsequent illness
 - Illness in cases and controls: interview the ill people and comparable healthy persons (controls) about preceding exposures.
 - Measure statistical association of illness with each exposure
 - Direction of association
 - Probability of chance alone (Should be positive)
 - Strength of association (No fixed rule)
 - Dose-response relationship (Supports if present)
- Plausibility of association
- Repeat process as necessary

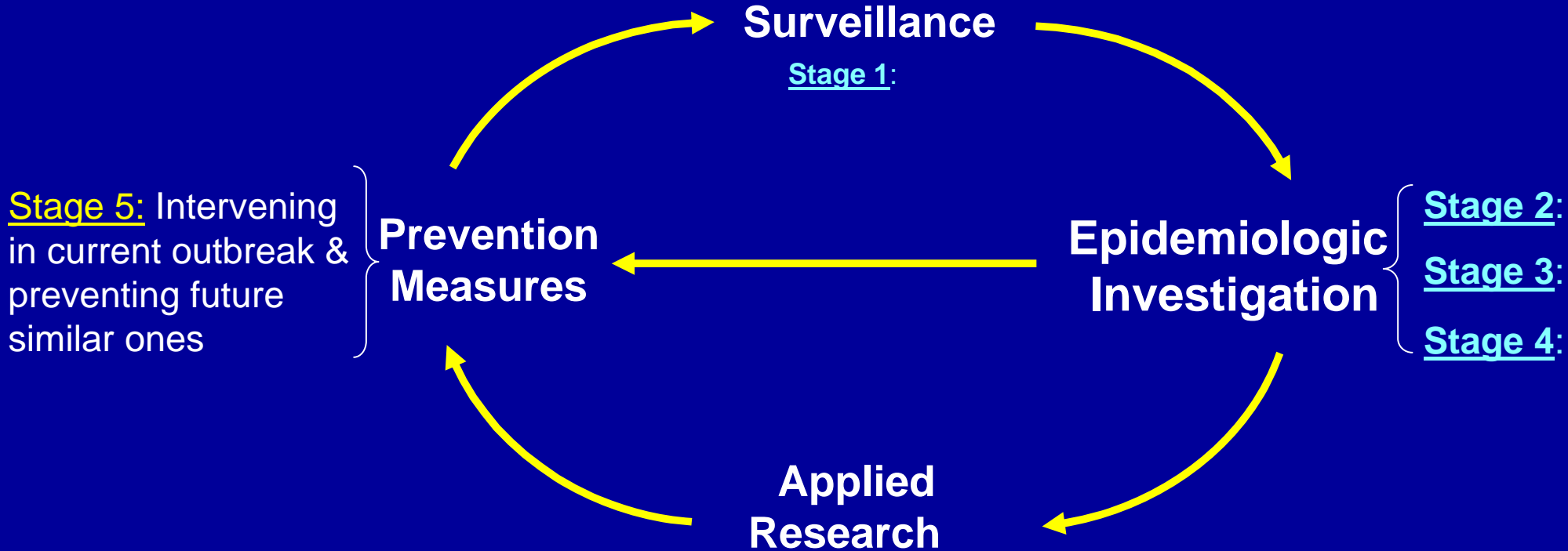
Stage 4: Reconstructing How and Where Contamination is Likely to Have Occurred

- Details of implicated food needed:
 - When and where was it prepared?
 - Details on purchase, brand, lot number of the food
 - Judgment needed: Contamination in final kitchen or before?
- If contamination earlier in distribution is likely, trace the food item back through distribution to point where they converge
 - Precision of traceback depends on invoices, company records and cooperation, and probability
 - Accurate exposure history critical
 - If data converge, does trace forward from point of convergence explain other cases?

CDC's OutbreakNet Team

- **Supports a national network of epidemiologists and other public health officials who investigate outbreaks of foodborne, waterborne, and other enteric illnesses in the United States**
- **Collaboration between CDC and**
 - U.S. State and local health departments
 - U.S. Department of Agriculture (USDA)
 - U.S. Food and Drug Administration (FDA)
- **Works in close partnership with PulseNet**
 - The national molecular subtyping network for foodborne disease surveillance
- **Helps ensure**
 - Rapid, coordinated detection & response to multi-state enteric disease outbreaks
 - Promotes comprehensive outbreak surveillance

Cycle of Foodborne Disease Control & Prevention: Stages of an Outbreak Investigation



Stage 5: Intervening in the Current Outbreak & Preventing Future Ones

- Current Outbreak:
 - Remove implicated food from the marketplace
- Future outbreaks:
 - How frequently do similar events happen?
 - What critical scientific questions remain unanswered?
 - What technological, behavioral or regulatory changes would prevent similar outbreaks?
 - What education or training is needed?
 - Once implemented, do they work?
 - Do similar outbreaks or cases of illness still occur?
 - Does the frequency of contamination in the food change?
- Involves public health investigators, regulators, food scientists, industry and consumers

Limitations of the Epidemiological Method

- Depends on information a person knows – if they are not aware of exposure they cannot report it
- Needs sufficient number of cases and controls to achieve statistical power
- If the correct hypothesis is not considered, it may not be found – may need to repeat the process
 - Partial traceback may be required to test hypotheses
- Implicates the food actually eaten – not necessarily the original source
- Spurious associations are possible:
 - By chance alone, (probability) or
 - Because the implicated food is connected to the unrecognized true source (confounding)

Laboratory Testing of Food in an Outbreak Investigation

- Can be very useful as demonstration that a particular food was contaminated
- Can be critical if the number of patients is very small, and statistical power of epidemiology is low
- Occasionally can provide the critical break information
- May not identify the pathogen in the implicated product because:
 - The actual food that caused the outbreak was already consumed, and thus not collected
 - The food that caused the outbreak was overlooked when samples were collected
 - Contamination may be variable within a food
 - The pathogen may not survive long in the food
 - The test may be insensitive or unverified, the lab may be unqualified
 - There may be no assay at all for that pathogen
 - Laboratory error

A Gap in Multistate Outbreak Investigation Methods

- Limited resources for health departments to conduct interviews
 - “Sporadic” illnesses (some may later be shown to be part of outbreaks)
 - in many jurisdictions, patients are not routinely interviewed to collect information on exposures
 - Cluster and outbreak illnesses
 - Interviews to probe possible sources may be delayed by other priorities
 - Re-interviews to collect product information may be delayed
 - Questionnaires often not standardized among states
 - Information from questionnaires not put into standard database at all States
 - Information on exposures usually not transmitted electronically to CDC

Contrast with PulseNet, in which lab information on every isolate is stored in a standard database at States, is rapidly transmitted to a national database at CDC, and summary information is available to all participants

Our Vision:

A National Multistate Foodborne Investigation Network

- Facilitate collection of exposure data from ill and well persons to help local, State, and federal epidemiologists more rapidly develop hypotheses and implicate vehicles
- Facilitate collection of specific product information (e.g., lot numbers) for traceback investigations
- More rapidly collate and analyze epidemiologic and product information from multiple states
- Routinely join epidemiologic and PulseNet data
- Improve the quality and speed of product data provided to regulatory agencies for traceback

Shorten the time to pinpoint how and where contamination occurred

Salmonella

[Salmonella](#) > [Salmonella Outbreak Investigations](#) > Investigation of Outbreak of Infections Caused by Salmonella Agona

Investigation of Outbreak of Infections Caused by *Salmonella* Agona

Information as of April 22, 2008

[Click Here for Advice to Consumers](#)

CDC is collaborating with public health officials in multiple states across the United States and with the U.S. Food and Drug Administration (FDA) to investigate a multi-state outbreak of *Salmonella* Agona infections. An investigation that includes interviews of persons with *Salmonella* Agona infections and comparison of the DNA fingerprints suggests that cereal from Malt-O-Meal unsweetened Puffed Rice Cereals and unsweetened Puffed Wheat Cereals is likely related to these illnesses.

As of April 22, 2008, state and city health departments from 12 states have identified 21 ill persons infected with same genetic fingerprint of *Salmonella* Agona. Ill persons with the outbreak strain have been identified from Colorado (1), Delaware (1), Maine (2), Massachusetts (2), Minnesota (1), North Dakota (1), New Hampshire (2), New Jersey (4),

Persons infected with the outbreak strain of *Salmonella* Agona, United States, by state, January 1 to April 22, 2008. (N=21)



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Division of Foodborne, Bacterial, and Mycotic Diseases

<http://www.cdc.gov/foodborneoutbreaks/>

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