

# Then and Now: The changing landscape of enteric disease surveillance, outbreak detection and response

Where are we going from here?

**November 7, 2017**  
**2017 InFORM Meeting**

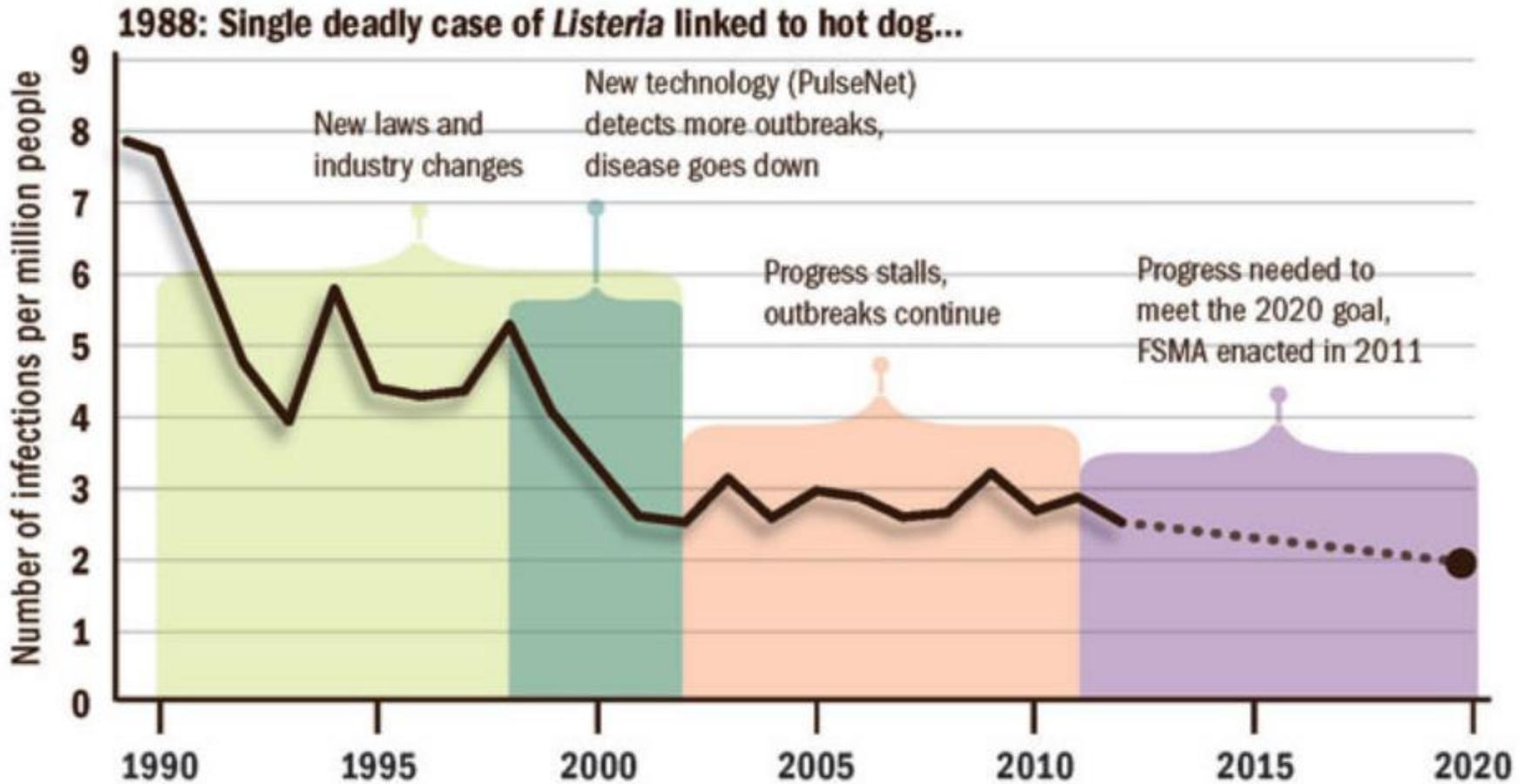
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# Listeria : CDC Vital Signs Report June 2013

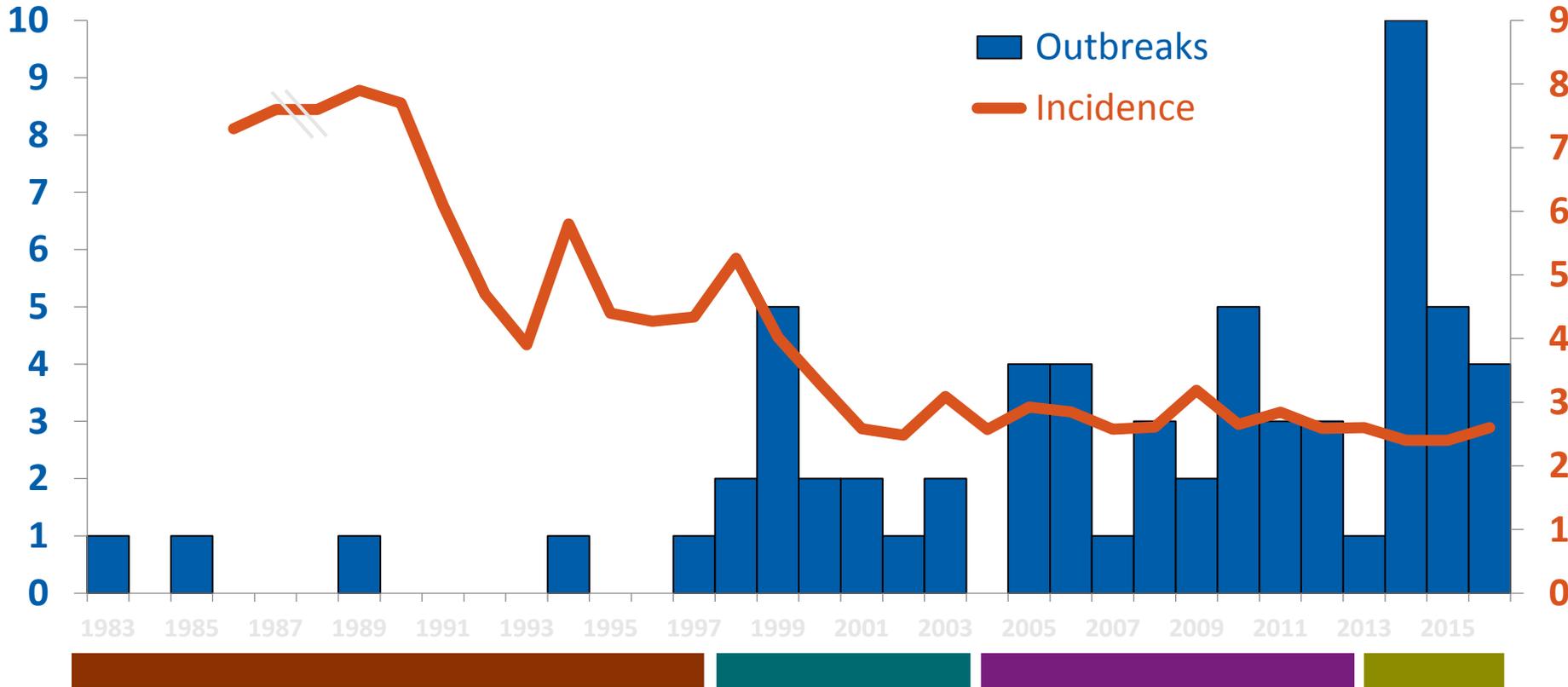


SOURCES: JAMA, 1995; CDC, 2012

# Listeriosis Outbreaks and Incidence\*, 1983-2016

No. outbreaks

Incidence (per million pop)



**Era**

**Pre-PulseNet**

**Early PulseNet**

**Listeria Initiative**

**WGS**

Outbreaks per year

0.3

2.3

2.6

6.3

Median cases per outbreak

69

11

5.5

4

\*2016 incidence rate preliminary data from FoodNet

# Foods implicated in listeriosis outbreaks since 2013 in the United States (in the WGS era)

## ➤ Expected foods:

- Raw milk
- Soft cheeses
- Mung bean sprouts
- (Not processed meats)

Found as a result of multi-state investigations

Contamination often occurred at the packing shed or processing facility

## ➤ Novel foods:

- Caramel-dipped apples
- Ice cream
- Packaged leafy green salads
- Stone fruits (nectarines)
- Frozen raw vegetables

Most investigations started with ill people. A few started with finding *Listeria* in a food, that matched strains from patients who ate that food

***New efforts in food industry now to reduce contamination with listeriosis***

# Improving our ability to detect, solve and stop outbreaks

- Routine whole genome sequencing is swiftly becoming part of routine public health surveillance
- Now placing WGS capacity in state and city health departments
  - Starting with *Listeria*
  - Expanding to STEC, *Salmonella*, *Campylobacter*, *Shigella*...
  - Likely to start finding more clusters
- Expanding investigative capacity in states as well

***Anticipate using WGS as main subtyping method in 2019***



# Evolving paradigm for surveillance and investigation

- Testing all strains with standard molecular subtyping
- Interviewing all patients with standard questionnaire
- Reviewing strains from foods or food production environments also in PulseNet
- Multi-dimensional cluster detection – for similar
  - Molecular pattern/sequence type
  - Time/space
  - Demographic/ethnic grouping
- Analyze epi data as soon as cluster identified
- With sequence, can predict antimicrobial resistance as soon as cluster identified, use to prioritize

# The impact of finding more multi-jurisdiction clusters

- Finding more clusters that are
  - Multi-county
  - Multi-state
  - Multi-national
- Importance of standardized, harmonized approaches
  - IFORC (Interagency Foodborne Outbreak Response Collaboration)
  - Gen-FS (Interagency Collaboration on Genomics and Food Safety )
  - PulseNet International
  - CIFOR, and other collaborative groups

*Making collaborative investigations a new norm*

# The impact of finding smaller clusters

- Increased subtyping precision mean more confidence
- Finding clusters that are too small for traditional measures of statistical significance
- Growing potential of “rapid precision traceback”
  - Patient interviews including source of food
  - Loyalty card permissions
  - Retail logistic records
  - Blockchain

*Need great care in communicating results*

# The impact of finding smaller clusters – cont'd

- Blurring the boundary between outbreaks and sporadic cases
- Changing interpretation of “baseline”
- With PFGE, often defined background rate, and subtracted it from outbreak, assuming some cases in cluster represented unrelated background
- With WGS, may look at cases in background, and wonder how they are related to current cluster
- Are there sustained points of harborage or reservoirs where a strain may be maintained for years, blooming periodically?
- Can identifying and controlling them prevent future disease?

*Chipping away at the baseline*

# Vive la France

- Santé Publique France has been in the forefront
- Ran WGS (cgMLST) with PFGE for 2015-2016
- Now switched to WGS for *Listeria*, and applying to *Salmonella* and others pathogens.
- Changed their cluster definition for listeriosis:
  - $\geq 2$  isolates of same cgMLST type in 2 years, of which
  - $\geq 1$  is from a human
- Routinely sample suspect foods in
  - Refrigerators of patients with *Listeria* meningitis
  - Hospital kitchens of hospital-associated cases

# What is next?

- WGS depends on
  - Isolating a pure culture in a clinical laboratory
  - Shipping it to the public health laboratory
  - Sequencing and interpreting
  - *Can take weeks*
- To make surveillance faster, public health will need more advanced molecular diagnostic tools for direct use on a clinical specimen to
  - Provide species identification
  - Predict serotype, subtype virulence, antimicrobial resistance
  - Report results in hours, rather than days
- Exploratory work
  - Amplifying around key gene targets, like Shiga toxin-coding phage genes
  - Using metagenomic approaches with long-read sequencing
  - Single cell sorting and sequencing

*The next generation of methods*

## Future foodborne outbreaks more likely to be

- Dispersed in space: Multi-state, multi-national
- Dispersed in time: Multi-year
- Detected by sequence-based surveillance
- Detected as contaminated product first
  
- Associated with
  - fresh and minimally processed foods
  - imported foods
  - novel food vehicles
  - novel routes and pathways of contamination

*More dispersed and smaller: “low and slow”*

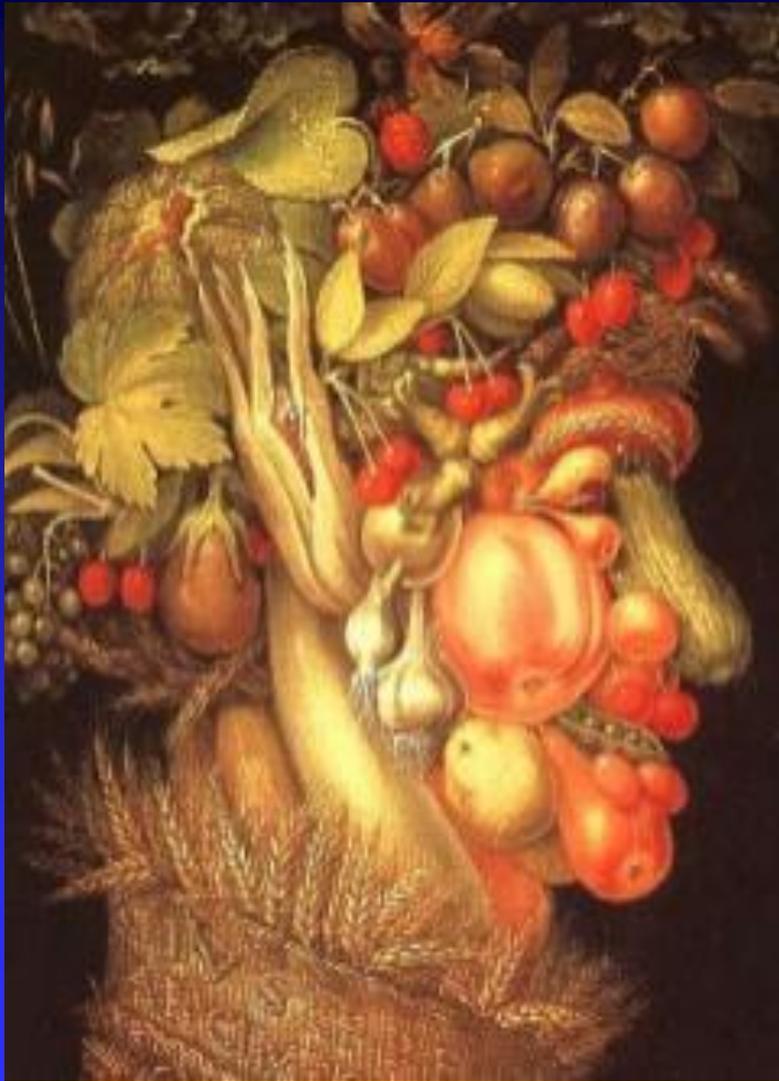
# Foodborne diseases in the 21<sup>st</sup> century: A rapidly evolving public health approach

- Foodborne outbreak investigations are an important driver for improving food safety
- Whole genome sequence-based surveillance is a major evolutionary step forward in outbreak detection and investigation
- Combined with enhanced patient interviews and better traceback
- Improvement in subtype-based surveillance mean more outbreaks are detected and stopped while they are smaller, and more food safety gaps are identified and corrected
- Collaborative partnerships are vital to
  - Detect and investigate cross-border events
  - Focus improved control measures around the world
  - Reduce the number of foodborne infections, hospitalizations and deaths



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# Thank you

*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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# Our websites

**E. coli:**

[www.cdc.gov/ecoli](http://www.cdc.gov/ecoli)

**Salmonella:**

[www.cdc.gov/salmonella](http://www.cdc.gov/salmonella)

**Listeria:**

[www.cdc.gov/listeria](http://www.cdc.gov/listeria)

**FoodNet:**

[www.cdc.gov/foodnet](http://www.cdc.gov/foodnet)

And a May 25, 2017 Webcast

“How Deadly Burgers Made Food Safer –  
The Impact of the 1993 *E. coli* O157 Outbreak”

**PulseNet:**

[www.cdc.gov/pulsenet](http://www.cdc.gov/pulsenet)

<https://www.cdc.gov/od/science/wewerethere/>

**Foodborne outbreak surveillance:**

[www.cdc.gov/outbreaknet](http://www.cdc.gov/outbreaknet)

**Foodborne burden of illness:**

[www.cdc.gov/foodborneburden](http://www.cdc.gov/foodborneburden)

**General Information About Foodborne Diseases:**

[www.foodsafety.gov](http://www.foodsafety.gov)

<http://www.cdc.gov/vitalsigns/foodsafety/>



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