

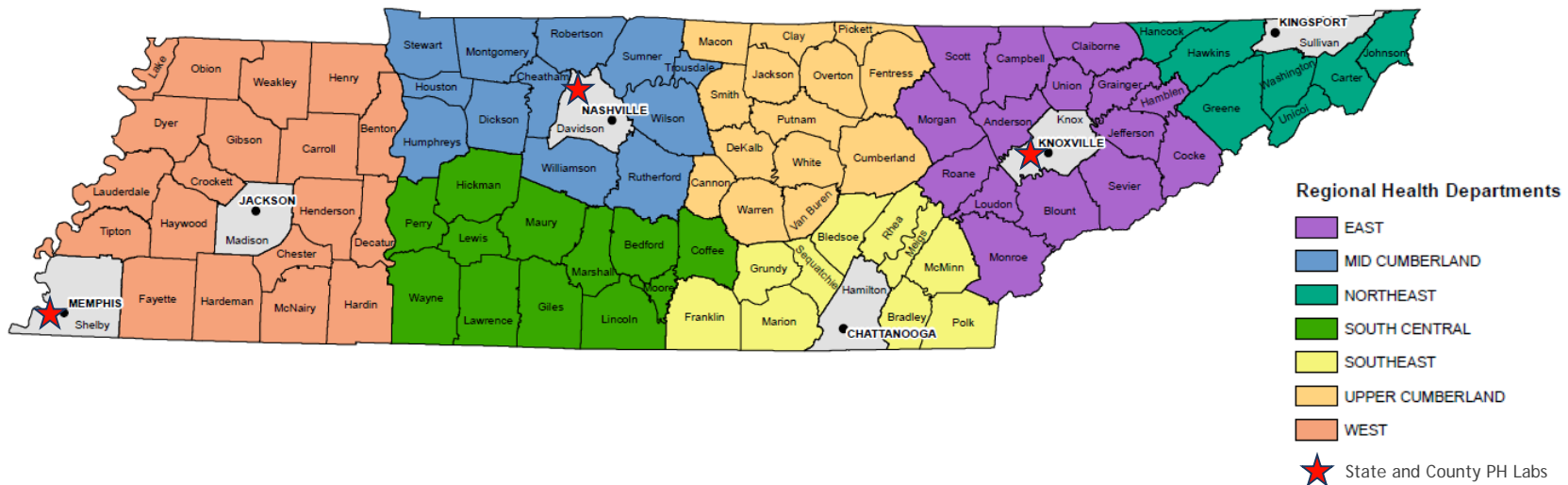


Investigation of a Multi-year *Salmonella* Enteritidis Outbreak Discovered by Whole Genome Sequencing

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About Tennessee

- Population: 6.5 million
- Tennessee Department of Health (TDH)
 - 7 Rural Health Departments
 - 6 Metropolitan Health Departments
 - 2 State Public Health Laboratories
 - 1 County Public Health Laboratory



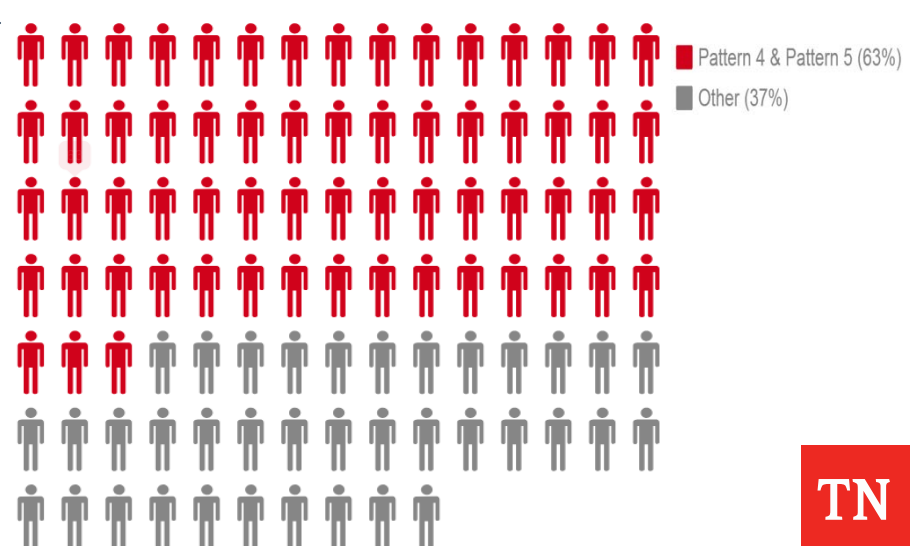
Salmonella in Tennessee

- ~1,000 cases of *Salmonella* identified annually in TN
- 2,500 Serotypes of *Salmonella* - determined by PFGE
- 17% of isolates - *Salmonella* Enteritidis (SE)
- Most common *Salmonella* Enteritidis PFGE Patterns: JEGX01.0004 and JEGX01.0005
- 1 out of every 10 cases = SE Pattern 4 or 5

Salmonella Serotypes



Salmonella Enteritidis



Whole Genome Sequencing in TN

- Began December 2014

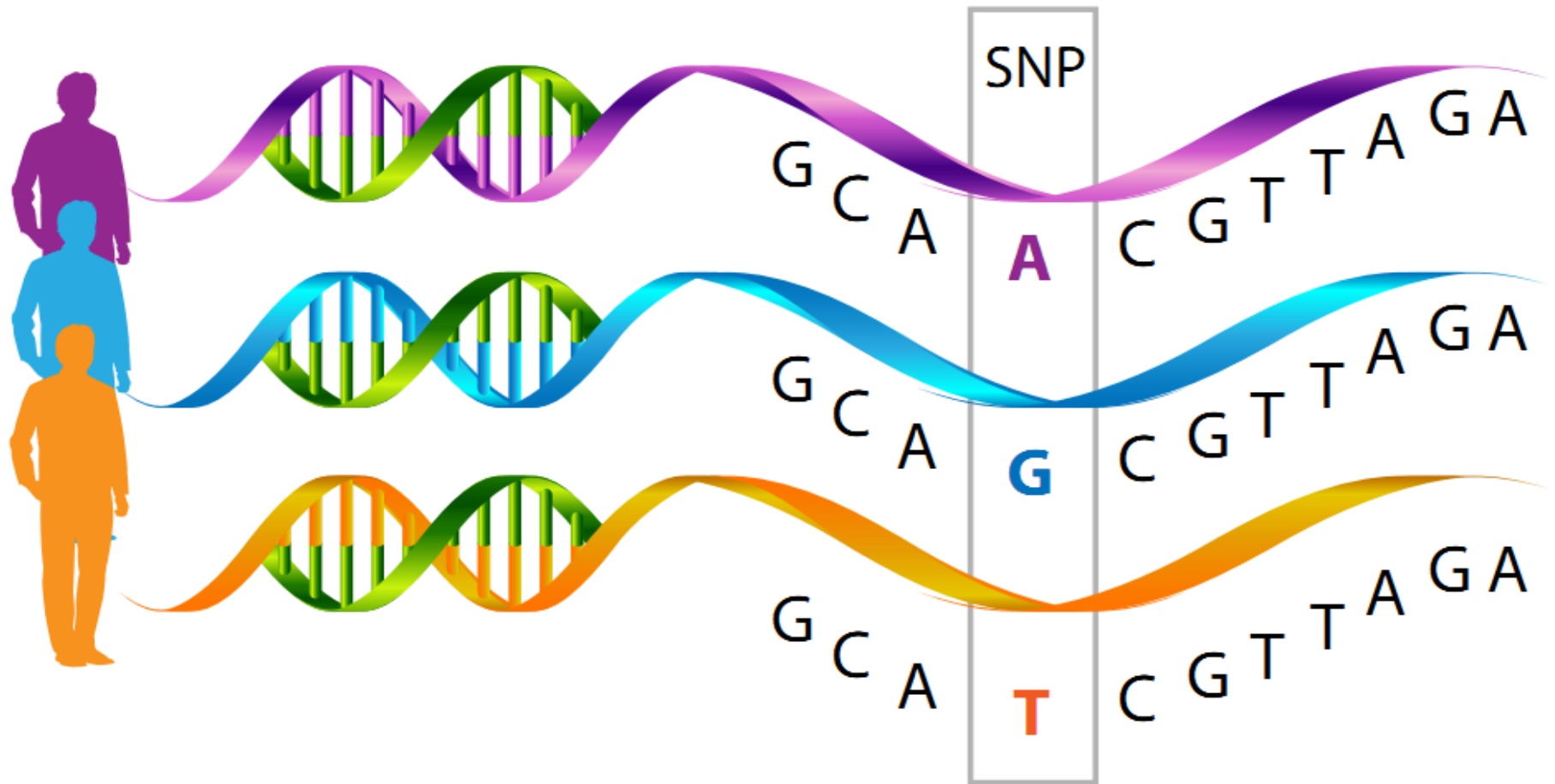
- PFGE: 15-30 Bands



- WGS: A unique DNA sequence composed of millions of bases (A,T,C,G)



Single nucleotide polymorphisms (SNP)



WGS Process



Specimen
received at
SPHL



WGS
Performed



Analysis

- NYS
- CDC

Organisms:

Real Time

- *Listeria*
- *STEC O157*
- *STEC Non-O157*
- *Salmonella*
- *Gonorrhea*
- *Campylobacter*
- *Shigella*

Upon Request & Special Projects

- *Salmonella*
- *Campylobacter*
- *Hepatitis C*

Future Activities

- ARLN
 - *CRE*

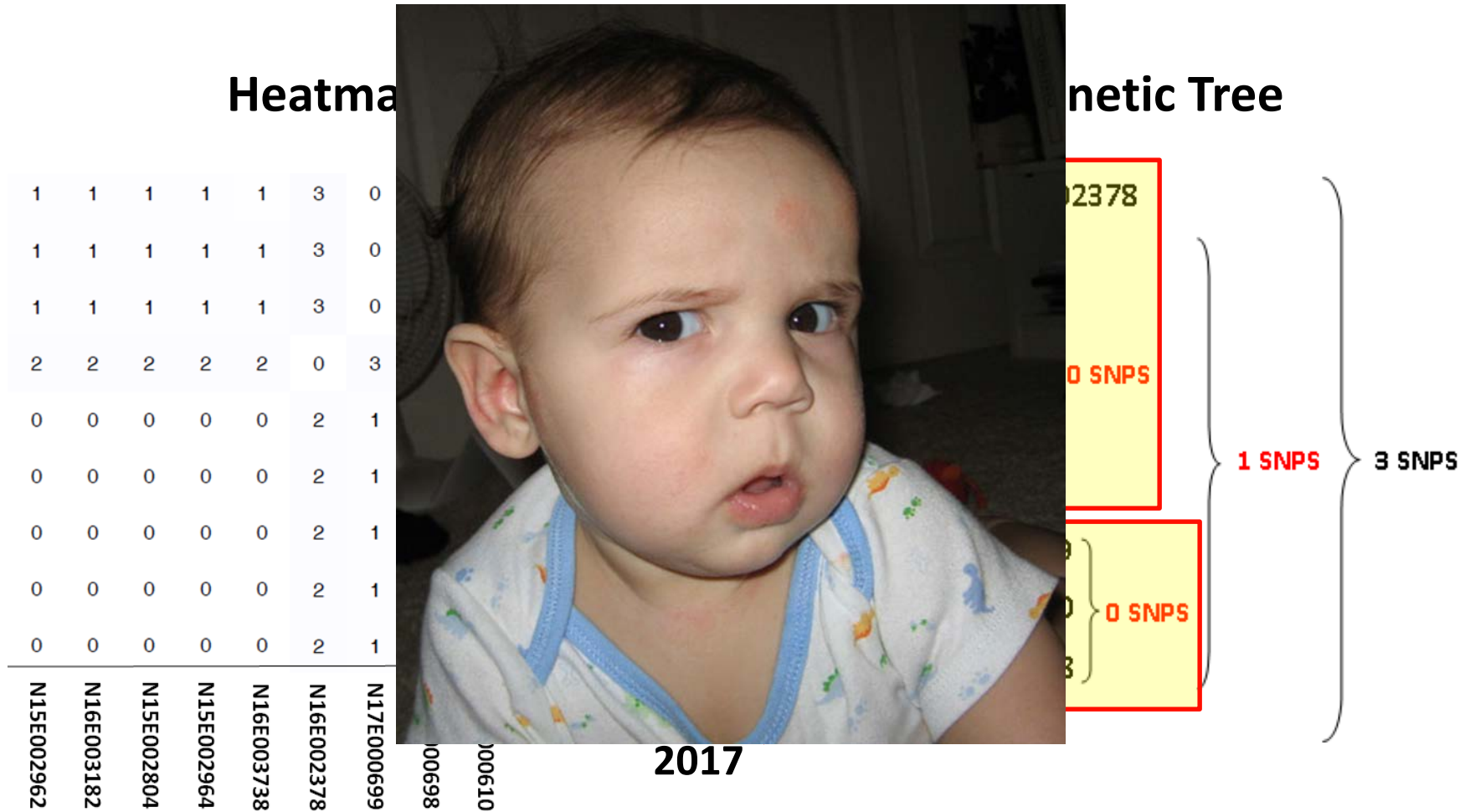
Outbreak Detection

- March 8, 2017 - TDH identified an increase of Salmonella Enteritidis (SE) Pattern JEGX01.0004 isolates on the weekly PFGE cluster report
- March 31, 2017 – WGS results available

PFGE Salmonella Cluster Report — March 8, 2017

SPHL #	PFGE- Xba1 Pattern #	Serotype	County	Collection Date	Recy'd Date	Age	Gender	Source	Outbreak	Investigator
N17E000377	JEGX01.0004	Enteritidis	Loudon	2017-01-16	2017-02-01	82	FEMALE	Blood		
N17E000440	JEGX01.0004	Enteritidis	Williamson	2017-01-27	2017-02-07	10	MALE	Stool		
N17E000455	JEGX01.0004	Enteritidis	Shelby	2017-01-26	2017-02-07	75	MALE	Stool		
N17E000456	JEGX01.0004	Enteritidis	Shelby	2017-01-23	2017-02-07	66	MALE	Serum		
N17E000458	JEGX01.0004	Enteritidis	Shelby	2017-01-21	2017-02-07	78	MALE	Serum		
N17E000610	JEGX01.0004	Enteritidis	Shelby	2017-02-10	2017-02-22	35	FEMALE	Stool	} ← 0 SNPs	
N17E000698		Serotype pending	Shelby	2017-02-10	2017-03-02	58	FEMALE	Stool		
N17E000699		Serotype pending	Shelby	2017-02-13	2017-03-03	23	FEMALE	Stool		
N17E000457	JEGX01.0021	Enteritidis	Shelby	2017-01-28	2017-02-07	45	MALE	Stool		
N17E000513	JEGX01.0021	Enteritidis	Shelby	2017-01-14	2017-02-10	0-4	MALE	Tissue		
N17E000580	JEGX01.0005	Typhimurium	Rutherford	2017-02-09	2017-02-16	1	MALE	Stool		
N17E000238	JEGX01.0004	Enteritidis	Hamilton	2017-01-05	2017-01-24	57	MALE	Stool		

WGS Analysis: Heatmap and Phylogenetic Tree



WGS Identifies a 2 year outbreak

Epidemiologic Investigation

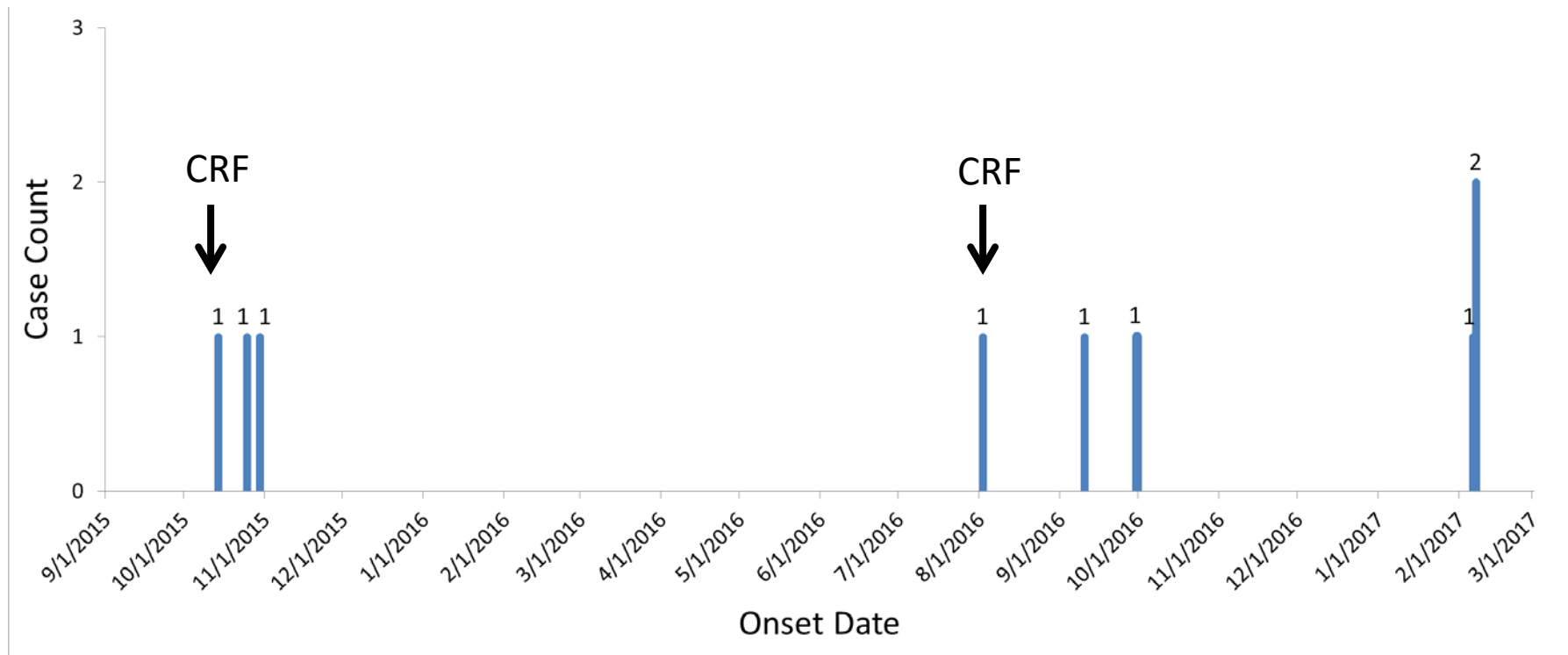
- 9 confirmed SE cases
 - 0-3 SNPs difference
- Collection dates: October 15, 2015 to February 13, 2017



- 89% Female
- All cases resided in or visited Shelby County, TN

Epidemic Curve

Cases of Salmonella Enteritidis by Date of Onset



To interview or not to interview?

- Exposure data collected from completed Salmonella Case Report Forms (CRFs)
 - Only 2 CRFs available (1 - 2015, 1 - 2016)
- Interview 2017 cases?
 - Interviews conducted with 3 most recent 2017 cases (NHGQ)
- Interview 2015 and 2016 cases?
- Common Exposures (>50%)
 - Grocery Store K
 - Chicken, Seafood, Pineapple, HATE tomatoes
 - Dogs
 - 6/9 ate at Restaurant A
 - 7th case had catered meals delivered to office

Causes of Long Term Outbreaks

- Ill food worker
- Contaminated source
- Processes and practices
 - Using raw/undercooked ingredients
 - Cross-contamination by hands or utensils
 - Improper cleaning and sanitation

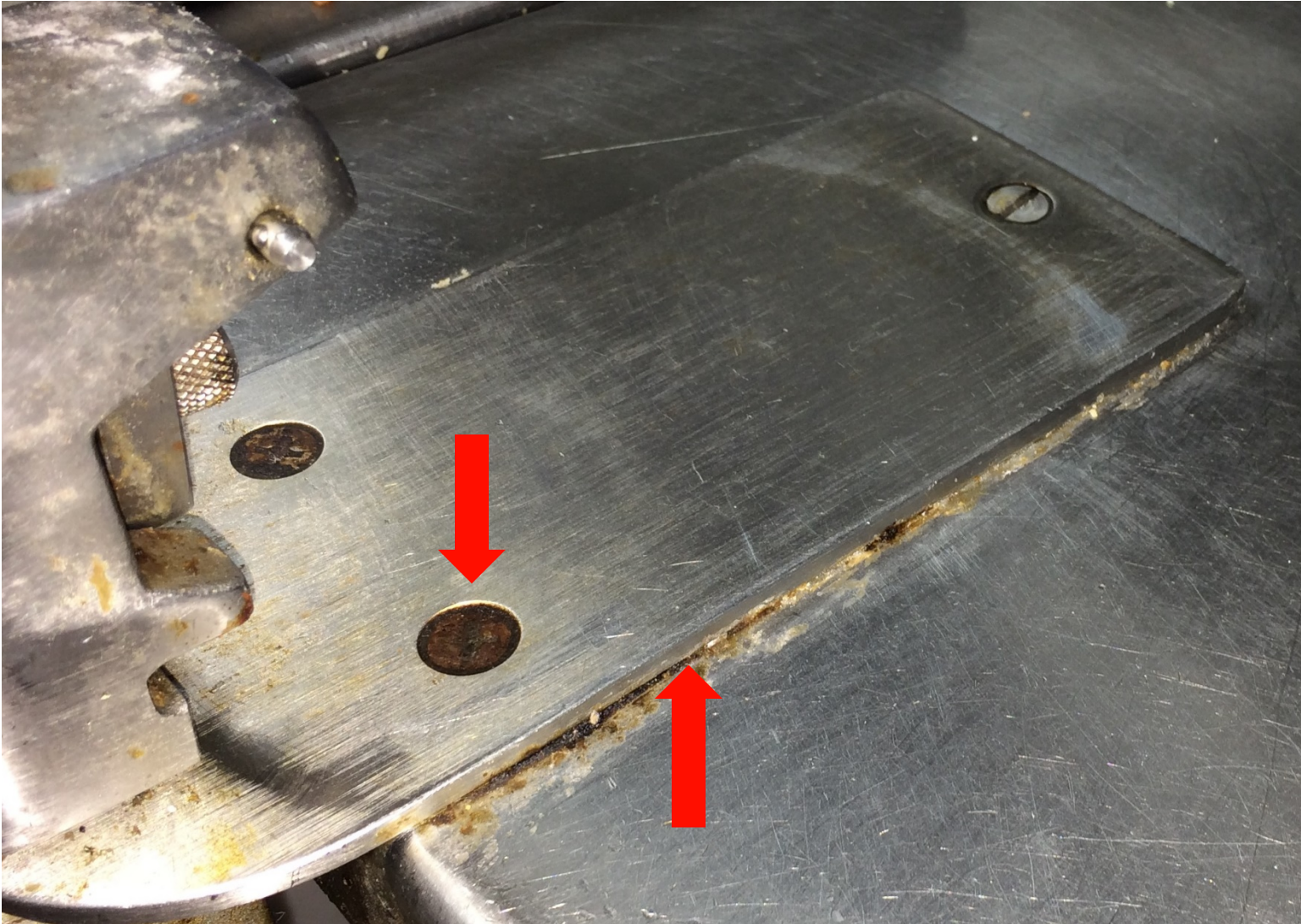
Environmental Health Investigation

- Local region contacted
- Recommendations
 - Restaurant assessment
 - Environmental swabbing
 - Stool collection of restaurant workers
- May 9, 2017 - Region met with the restaurant
 - Locally sourced items
 - Beef
 - Seafood
 - Eggs

Preparation Table Maintenance



Equipment Design

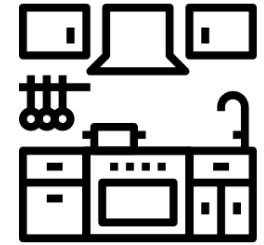


Equipment cleaning and sanitization



Environmental Findings

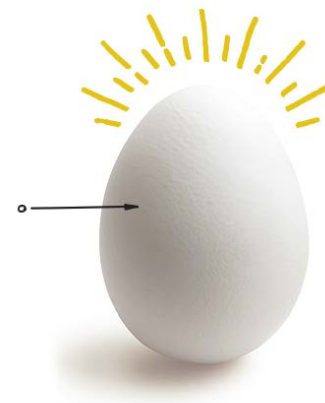
- Equipment
 - Inadequate preparation space
 - Facility design opportunities
- Processes
 - Cross-contamination
 - Inadequate sanitization
- People
 - Inadequate training
 - Lack of management oversight
- May 12, 2017 – Environmental swabbing performed
 - All swabs negative



An Egg-cellent Source of Illness

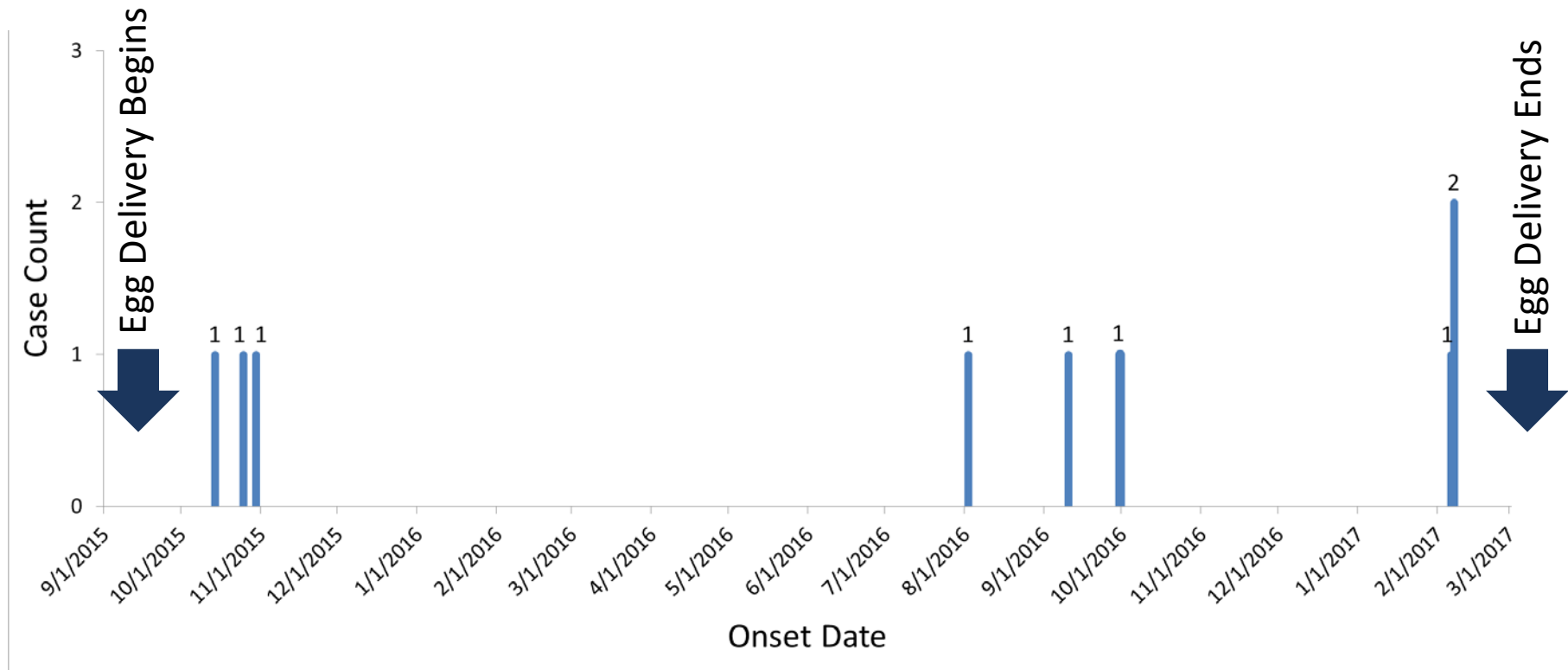
- Salmonella Enteritidis historically linked to eggs
- 2015 - Nationwide eggs shortage due to Avian influenza outbreak
- Restaurant A changed their eggs source from a commercial producer to local Farm W
- Farm W stopped delivering eggs to all restaurants in April 2017

Salmonella



Epidemic Curve with Egg Delivery Schedule

Cases of Salmonella by Date of Onset



Investigation of Farm W

- May 15, 2017 - Tennessee Department of Agriculture and FDA visited Farm W
 - Farm W has no laying hens
 - All eggs sourced from Farm K in Kentucky
 - Eggs are distributed to multiple locations in TN and GA
- May 19, 2017 – FDA visited Farm K
 - 1500 Laying hens = Below regulatory limits of the egg rule
- Why are cases only in one TN county?



★ Distribution city
○ Location of cases

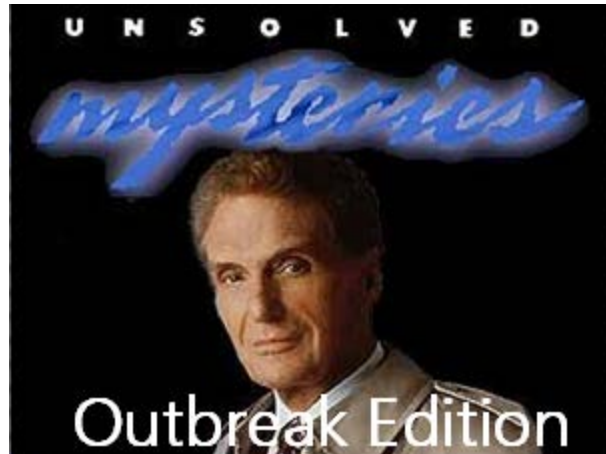
Successes

- WGS is powerful
 - Differentiation between sporadic vs linked cases
 - Identification of meaningful long-term cluster
 - Process improvements: communication, analysis, and interpretation
- Successful case interviews
- Single restaurant identified
 - Food safety deficiencies addressed
- No additional cases



Considerations

- Extend cluster definitions?
- Unable to confirm eggs as true source of illness



Acknowledgements

- Tennessee Department of Health
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- Tennessee Department of Agriculture / FDA

Questions?

