Role of PulseNet in Laboratory Based Foodborne Disease Surveillance

Seventh Dubai International Food Safety Conference & IAFP’s First Middle East Symposium on Food Safety
21-23 February 2012

Peter Gerner-Smidt, MD, PhD
Enteric Diseases Laboratory Branch
What is PulseNet?

• A network national and international laboratory networks dedicated to molecular surveillance of bacterial foodborne infections

• Perform standardized molecular subtyping of foodborne disease-causing bacteria by Pulsed-Field Gel Electrophoresis (PFGE) [and other DNA “fingerprinting” methods]
  – High discriminatory subtyping methods enable you to identify bacterial isolates that are related to each other with a high degree of confidence

• Share DNA “fingerprints” electronically

• In United States:
  – > 80 State & local health departments, Federal agencies (USDA, FDA)
  – Dynamic database of DNA “fingerprints” at CDC
  – Database available on-demand to participants
PulseNet Protocols

- Salmonella
- Shigella
- E. coli O157
- Non-O157 STEC (VTEC)
- Listeria monocytogenes
- Vibrio cholerae
- Vibrio parahaemolyticus
- Campylobacter jejuni/coli
- Clostridium perfringens
- Clostridium botulinum
- Yersinia pestis
What is PulseNet?

• A network national and international laboratory networks dedicated to molecular surveillance of bacterial foodborne infections

• Perform standardized molecular subtyping of foodborne disease-causing bacteria by Pulsed-Field Gel Electrophoresis (PFGE) [and other DNA “fingerprinting” methods]
  – High discriminatory subtyping methods enable you to identify bacterial isolates that are related to each other with a high degree of confidence

• Share DNA “fingerprints” electronically
PulseNet Laboratory Network

- Participating Labs
- PFGE Patterns
- PulseNet National Databases (CDC)

Local Databases

Map of the northeastern United States with stars indicating participating labs and a gel image showing PFGE patterns.
What is PulseNet?

• A network national and international laboratory networks dedicated to molecular surveillance of bacterial foodborne infections

• Perform standardized molecular subtyping of foodborne disease-causing bacteria by Pulsed-Field Gel Electrophoresis (PFGE) [and other DNA “fingerprinting” methods]
  – High discriminatory subtyping methods enable you to identify bacterial isolates that are related to each other with a high degree of confidence

• Share DNA “fingerprints” electronically

• In United States:
  – > 80 State & local health departments, Federal agencies (USDA, FDA)
  – Dynamic database of DNA “fingerprints” at CDC
  – Database available on-demand to participants
Tranquility or Trouble? What does PulseNet think?

Data are preliminary and subject to change.
PulseNet Verdict: **Trouble!**

Salmonella Newport

Outbreak with *Salmonella Newport* PulseNet pattern JJPX01.0949

Data are preliminary and subject to change
83 member countries from 7 national and regional PulseNet networks

www.pulsenetinternational.org
Role of PulseNet

• Detect foodborne disease case clusters by PFGE
  – Facilitate early identification of common source outbreaks
• Assist epidemiologists in investigating outbreaks
  – Separate outbreak-associated cases from other sporadic cases
  – Assist in rapidly identifying the source of outbreaks
  – Act as a rapid and effective means of communication between public health laboratories
Integrated Food Safety Surveillance

From “Farm to Fork”

Responsibility of:

Veterinary, National & Local Food Safety Authorities

Public Health Authorities

It is what makes people sick that is the focus of food safety measures in the production chain.
Detecting and Fixing Problems in the Food Supply

Limit ongoing illness

Outbreak investigation
Detecting and Fixing Problems in the Food Supply

- Limit ongoing illness
- Fix underlying problems

Outbreak investigation
## Outbreak Investigations and the role of PulseNet

<table>
<thead>
<tr>
<th></th>
<th>Pathogen-based</th>
<th>Event-based</th>
<th>Individual complaints</th>
<th>Syndromic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speed of outbreak detection</strong></td>
<td>Relatively slow</td>
<td>Fast</td>
<td>Fast</td>
<td>Potentially fast</td>
</tr>
<tr>
<td><strong># cases needed for detection</strong></td>
<td>Very low</td>
<td>Low</td>
<td>Intermediate</td>
<td>High</td>
</tr>
<tr>
<td><strong>Sensitivity for low-level widespread events</strong></td>
<td>Very high</td>
<td>Intermediate</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Signal to noise ratio</strong></td>
<td>High (Very high with PulseNet)</td>
<td>High</td>
<td>Low to moderate</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Types of outbreaks detected</strong></td>
<td>Limited to diseases under surveillance</td>
<td>Any</td>
<td>Any</td>
<td>Limited to syndromes under surveillance</td>
</tr>
<tr>
<td><strong>Role of subtyping - PulseNet</strong></td>
<td>Detection, Delineation, Culture confirmation</td>
<td>Delineation, Culture confirmation</td>
<td>Delineation, Culture confirmation</td>
<td>Delineation, Culture confirmation</td>
</tr>
</tbody>
</table>

Adapted from CIFOR guidelines, chapter 4 (http://www.cifor.us/)
Detect - Investigate – Confirm
outbreaks of foodborne infections
The decade's 10 biggest food-borne illness outbreaks

By Jacque Wilson, CNN
updated 11:04 AM EST, Fri September
A large outbreak in one place may be obvious
PulseNet in a local outbreak investigation

*E. coli* O157:H7 Outbreak Minnesota, 2000

PulseNet separates patients that are part of the outbreak from patients that are unrelated to the outbreak.

Data are preliminary and subject to change.
PulseNet strengthens the association to the source in an outbreak investigation

Hamburger Brand X; 2000

PulseNet removes patients that are not related to the outbreak from the investigation

Data are preliminary and subject to change

Without PFGE

OR = 1.93; p = 0.31

-NOT significant-

With PFGE

OR = 17.1; p = 0.005

-SIGNIFICANT-

Courtesy J. Besser Minnesota DoH
Linking patients in many places to the same outbreak may be difficult without PulseNet.
Outbreak of Shiga toxin-producing *E. coli* O145 2010

- **April 16**
  - 16 persons diarrhea with link to University dining halls in Michigan
  - On site inspection does not reveal any food preparation errors
  - **PulseNet** *PFGE* available on one patient
    - Indistinguishable from old unrelated isolate of STEC O145

Data are preliminary and subject to change
Outbreak of Shiga toxin-producing *E. coli* O145 2010

- **April 22**
  - 4 persons with non-O157 illness in Ohio with link to college dining hall
  - **PulseNet** PFGE matching MI cases
    - Likely a common vehicle of both outbreaks

Data are preliminary and subject to change
Outbreak of Shiga toxin-producing *E. coli* O145 2010

- **April 26**
  - 12 persons with bloody diarrhea in New York also associated with college
  - PulseNet PFGE matching MI and OH cases

- **April 28**
  - Epi-investigation indicates vehicle to be romaine lettuce from supplier A
Outbreak of Shiga toxin-producing *E. coli* O145 2010

- **May 20**
  - 26 confirmed cases in 5 states (3 HUS)
  - Outbreak traced back to one batch of lettuce from supplier A originating from a single farm in Arizona
  - Culture confirmed by **PulseNet**
    - The outbreaks in MI, OH and NY would not have been linked without PulseNet
    - The cases in Tennessee and Pennsylvania would not have been recognized as being part of an outbreak without PulseNet

Data are preliminary and subject to change
Papaya recalled over salmonella fears: What you must know to stay safe

(CBS/AP) Papayas are a popular summertime treat. But the FDA is warning that they could be responsible for a multi-state outbreak of salmonella.

PICTURES: 10 common mistakes

Agromod Produce, based in Mexico, is recalling several varieties of papayas linked to 97 reported illnesses nationwide. The company says it has been closed down temporarily but is expected to reopen soon.

The food safety agency advises consumers to avoid those brands and to wash their hands after handling anything related to papayas.

The list of states impacted includes California, New York, and Texas.

(Credit: Flickr (janineong))
PulseNet in another outbreak related to imported food

Salmonella typhi Linked to Mamey Fruit,

By Deborah Mitchell on August 24, 2010 - 12:31pm

It seems that problems with Salmonella have emerged in another food item, although this time the number of affected individuals is vastly fewer. The Food and Drug Administration (FDA) and two food companies have announced a recall of mamey fruit pulp because of an outbreak of Salmonella enterica typhi.
14 New Vehicles in Outbreaks in the United States, 2006 - 2011

Data Sources: PulseNet, OutbreakNet, Foodborne Disease Outbreak Surveillance System

- Bagged spinach
- Carrot juice
- Peanut butter
- Broccoli powder on a snack food
- Dog food
- Pot pies
- Canned chili sauce
- Hot peppers
- White pepper
- Raw cookie dough
- Whole, raw papaya
- Mamey fruit
- Hazelnuts
- Pine nuts

Data are preliminary and subject to change
• The most deadly outbreak of foodborne illness in the United States for more than a decade
  
  o 146 case patients
  o 30 deaths
  o 1 miscarriage
Listeria outbreak 1109COGX6-1 (Cantaloupe 2011)

- Detected by the Colorado Department of Public Health and Environment after 7 listeriosis illnesses had been notified during the last week of August 2011
  - Not detected by PulseNet

- PulseNet reports 4 PFGE pattern combinations among the 7 isolates and starts looking for case patients in other states:

<table>
<thead>
<tr>
<th>PFGE-Ascl</th>
<th>PFGE-Apal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kb</td>
<td>Kb</td>
</tr>
</tbody>
</table>

Data are preliminary and subject to change
Listeria outbreak 1109COGX6-1 (Cantaloupe 2011)

- PulseNet identifies case patients in 28 other states infected with strains with one of the outbreak PFGE patterns
  - It would not be possible to link all these patients without PulseNet
Listeria isolates matching all outbreak patterns eventually cultured from the implicated cantaloupes produced on a single farm in Colorado

- Culture confirms the vehicle of the outbreak

Data are preliminary and subject to change
Non-human isolates in the PulseNet database may provide clues to the source of an outbreak

2002 Colorado *E. coli* O157 Outbreak

- Outbreak detected 2002
- 44 ill, no deaths
- 18 d

- When the 2002 Colorado *E. coli* O157 outbreak was detected by PulseNet, the PFGE pattern of isolates obtained by USDA/FSIS during regulatory sampling from the vehicle, ground beef, had been submitted a couple of weeks before

- **Simple outbreak investigation**

- Expanded recall of ~ 18 million pounds of beef contained the outbreak
Outbreak investigations lead to improved food safety practices in the industry

FoodNet-estimated Incidence of STEC O157 Infection ~ % FSIS Positive Ground Beef Samples 2001-2006

W. Lanier, Thesis 2008
Outbreaks motivates producers to focus on food safety

Turkey meat producer announces a second recall
By Tom Watkins, CNN
September 12, 2011 7:28 p.m. EDT

"It is frustrating but it strengthens our resolve to also do more to find additional methods and measures that are going to further reduce the potential for pathogens that can cause food-borne illnesses."

The latest recall, of 185,000 pounds of ground turkey meat, was announced Sunday for products produced August 23 and 24, and 30 and 31 from the company's establishment in Springdale, Arkansas.
Incidence of reported cases and outbreaks of listeriosis, 1978—2010, United States*

- Average size of outbreak = 53.8 cases
- Food implicated in 5/5 outbreaks

- Average size of outbreak = 46.7 cases
- Food implicated in 11/13 outbreaks

PulseNet/Listeria Initiative (2004-2010)
- Average size of outbreak = 6.45 cases
- Food implicated in 14/20 outbreaks

*Data from the Foodborne Diseases Active Surveillance Network (FoodNet) and the Foodborne Disease Outbreak Surveillance System (FDOSS); FDOSS and FoodNet data current as of June, 2010.
Examples of international PulseNet Investigations

International Outbreaks of shigellosis in Denmark and Australia in 2007 associated with imported baby corn from Thailand

By author name and date

Two outbreaks of Shigella sonnei infections simultaneously detected in Denmark and Australia were found to be linked to the same baby corn packing house in Thailand. PulseNet played a key role in confirming this link when

International outbreak of E. coli O157 infections linked to ground beef patties of a particular brand

CDC, October 26, 2007

International outbreak of Salmonella Senftenberg infection in 2007 associated with consumption of fresh basil imported from Israel

Multiple authors, Eurosurveillance, Volume 12, Issue 24, 14 June 2007

PFGE analysis performed according to the PulseNet Salmonella protocol by researchers in Europe and the United States, and shared through the PulseNet International network and the former European Enter-net, was instrumental in delineating this outbreak caused by Salmonella Senftenberg and confirming its source: fresh basil from Israel. Read original

http://pulsenetinternational.org/
Established in December 2006

Coordinator:
- Dr. Suleiman Al-Busaidy, Central Public Health Laboratory, Muscat, Oman

Training/Quality assurance program coordination:
- NAMRU-3, Cairo

March 25-29 training and strategic planning meeting in Amman, Jordan
  - Participants from 16 countries
Conclusions

PulseNet is an indispensable tool for the

• Fast and efficient Detection
• Fast and efficient Investigation
• Culture confirmation

of bacterial foodborne outbreaks
Disclaimer:
The findings and conclusions in this presentation are those of the author and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

For more information please contact Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA 30333
Telephone, 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov Web: www.cdc.gov