Molecular Epidemiology and Disease Surveillance of Clinical 
Salmonella in Taiwan

Chien-Shun Chiou, PhD
Center for Research and Diagnostics
Taiwan CDC
Salmonella

Present number of serovars in each species and subspecies

<table>
<thead>
<tr>
<th>Species</th>
<th>Subspecies</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. enterica</td>
<td>subsp. enterica</td>
<td>1504</td>
</tr>
<tr>
<td></td>
<td>subsp. salamae</td>
<td>502</td>
</tr>
<tr>
<td></td>
<td>subsp. arizonae</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>subsp. diarizonae</td>
<td>333</td>
</tr>
<tr>
<td></td>
<td>subsp. houtenae</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>subsp. indica</td>
<td>13</td>
</tr>
<tr>
<td>S. bongori</td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2541</td>
</tr>
</tbody>
</table>

Salmonellosis in Taiwan

- Disease burden
- Epidemiology
  - Serotype distribution
  - Antimicrobial resistance
- Disease surveillance and control
## Disease Burden

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. cases*</td>
<td>1,412,498</td>
<td>108,000</td>
</tr>
<tr>
<td>No. hospitalizations</td>
<td>15,608</td>
<td>1,200</td>
</tr>
<tr>
<td>No. deaths</td>
<td>553</td>
<td>42</td>
</tr>
<tr>
<td>No. isolates**</td>
<td>42,771</td>
<td>&gt; 10,000</td>
</tr>
</tbody>
</table>


** Average of isolates, 1993-2000
Salmonella Reference Lab

Epidemiological investigation
1. Serotyping
2. Genotyping (PFGE)
3. Antimicrobial susceptibility testing (NHRI)

Service
1. Salmonella identification
2. Providing isolates for research purpose

International disease surveillance
1. Global Foodborne Infections Network (GFN)
   former WHO Global Sal Surv (GSS)
2. PulseNet International
Paper-Bridged Method for *Salmonella* Phase Reversal
脈衝電泳
(Pulsed-Field Gel Electrophoresis)
Automatic Circulator

Lead Biotech (立圓)
leadbiot@ms62.hinet.net
## Salmonella DNA Fingerprint Database

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospitals</strong></td>
<td>20</td>
<td>15</td>
<td>15</td>
<td>44</td>
<td>29</td>
<td>46</td>
</tr>
<tr>
<td><strong>Isolates</strong></td>
<td>2,535</td>
<td>2,332</td>
<td>2,098</td>
<td>3,763</td>
<td>2,335</td>
<td>13,063</td>
</tr>
<tr>
<td><strong>Serotypes</strong></td>
<td>58</td>
<td>61</td>
<td>46</td>
<td>53</td>
<td>50</td>
<td>88</td>
</tr>
<tr>
<td><strong>PFGE patterns</strong></td>
<td>601</td>
<td>557</td>
<td>552</td>
<td>917</td>
<td>629</td>
<td>2,116</td>
</tr>
</tbody>
</table>

2009/7/30

Taiwan CDC
http://www.cdc.gov.tw
## The 10 most common serotypes

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Ratio (%)</th>
<th>2004 (n = 2,535)</th>
<th>2005 (n = 2,332)</th>
<th>2006 (n = 2,098)</th>
<th>2007 (n = 3,763)</th>
<th>2008 (n = 2,335)</th>
<th>Total (n = 13,063)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enteritidis</td>
<td>22.9</td>
<td>24.8</td>
<td>26.6</td>
<td>28.2</td>
<td>25.6</td>
<td>25.8</td>
<td></td>
</tr>
<tr>
<td>Typhimurium</td>
<td>22.3</td>
<td>24.7</td>
<td>20.6</td>
<td>20.3</td>
<td>21.6</td>
<td>21.7</td>
<td></td>
</tr>
<tr>
<td>Stanley</td>
<td>11.3</td>
<td>8.3</td>
<td>11.5</td>
<td>8.8</td>
<td>8.5</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>Newport</td>
<td>5.6</td>
<td>5.9</td>
<td>6.4</td>
<td>7.5</td>
<td>8.4</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Albany</td>
<td>3.4</td>
<td>4.7</td>
<td>4.9</td>
<td>4.0</td>
<td>3.8</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>Agona</td>
<td>3.2</td>
<td>5.1</td>
<td>3.9</td>
<td>4.1</td>
<td>3.8</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Paratyphi B var. Java</td>
<td>2.4</td>
<td>2.6</td>
<td>3.4</td>
<td>3.5</td>
<td>3.8</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Weltevreden</td>
<td>3.7</td>
<td>2.7</td>
<td>2.7</td>
<td>2.6</td>
<td>2.3</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Derby</td>
<td>2.7</td>
<td>2.3</td>
<td>2.1</td>
<td>3.4</td>
<td>2.2</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Braenderup</td>
<td>3.8</td>
<td>2.1</td>
<td>3.1</td>
<td>1.9</td>
<td>1.4</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Choleraesuis</td>
<td>4.4 (5)</td>
<td>3.2 (8)</td>
<td>1.4 (14)</td>
<td>0.7 (18)</td>
<td>1.2 (16)</td>
<td>2.1 (13)</td>
<td></td>
</tr>
</tbody>
</table>

2009/7/30
**Figure 2.** Proportion of most common serotypes of reported human *Salmonella* isolates by region, 2002. (Source: EID 2006 12:381)
Figure 2. Proportion of most common serotypes of reported human *Salmonella* isolates by region, 2002. (From EID 2006 12:381)
Figure 2. Yearly reports of *Salmonella* isolation from human sources at prefectural and municipal public health institutes, 1980-2005, Japan

(Infectious Agents Surveillance Report: Data based on the reports received before June 15, 2006)
Distribution of *Salmonella* PFGE genotypes, 2004-2008

**Enteritidis (n = 3372)**
- G1: 49%
- G2: 16%
- G3: 8%
- Others: 27%

**Typhimurium (n = 2840)**
- G1: 32%
- G2: 8%
- G3: 3%
- Others: 57%

**Stanley (n = 1252)**
- G1: 64%
- G2: 13%
- G3: 5%
- Others: 18%

**Newport (n = 895)**
- G1: 23%
- G2: 11%
- G3: 6%
- Others: 74%

**Albany (n = 539)**
- G1: 12%
- G2: 9%
- G3: 5%
- Others: 74%

**Agona (n = 524)**
- G1: 24%
- G2: 10%
- G3: 16%
- Others: 50%
## MLVA Subtyping of S. Typhimurium

<table>
<thead>
<tr>
<th>PFGE type</th>
<th>No. isolates</th>
<th>No. MLVA type*</th>
<th>No. MLVA type**</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPX.0001</td>
<td>40</td>
<td>33</td>
<td>31</td>
</tr>
<tr>
<td>JPX.0010</td>
<td>10</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>JPX.0013</td>
<td>23</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>JPX.0049</td>
<td>17</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>JPX.0077</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>98</strong></td>
<td><strong>81</strong></td>
<td><strong>78</strong></td>
</tr>
</tbody>
</table>

* by all (16) VNTR loci  
** by 5 VNTR loci (STTR3, STTR5, STTR6, STTR9, STTR10)
Distribution of S. Enteritidis TWJEGX01.0003 Strain in 2004
Foodborne Disease
Surveillance and Control
From farm to table (fork)
From farm to flash
PulseNet
The National Molecular Subtyping Network for Foodborne Disease Surveillance
The 1993 Western States *E. coli* O157 Outbreak

Actual cases in 1993 = 726

Outbreak detected

Meat recall

Number of Cases

Day of Outbreak
If the Western States outbreak had occurred in 1999, and the number of cases required to detect the outbreak had been 1/3 the actual number in 1993 (60 instead of 180)
Predicted curve had the outbreak occurred in 1999

predicted number of cases in 1999 = 235

predicted date of outbreak detection

predicted date of meat recall
1993 Western States *E. coli* O157 Outbreak

- 726 cases
- 4 deaths
- outbreak detected 1993
- 39 d

2002 Colorado *E. coli* O157 Outbreak

- Initial recall of 354,200 pounds of ground beef
- Expanded to 18.6 million pounds
- 38 cases from 11 states,
  - 17 hospitalizations,
  - one death

Slide courtesy to Bala Swaminathan, CDC, Atlanta, GA
Public health impact of PulseNet

- Prior to PulseNet, the average number of cases in *E. coli* O157:H7 outbreaks reported to CDC was 27

- By 1998, average number of cases was 9
  - Smaller outbreaks detected
  - Outbreaks detected earlier, preventing additional cases
PulseNet USA

- Celebrating 10\textsuperscript{th} anniversary
- Began building PulseNet in 1996
- Inaugurated by the Vice-President of the United States at the White House in 1998
- Recognized as one of 10 most innovative government programs in 1998 and as one of 15 most innovative government programs in 15 years
- PulseNet is now recognized as a critical component of foodborne disease outbreak detection and investigation in the USA
Key
IsolatDate
Serotype
PFGE-XbaI-pattern

E. Coli O157:H7
EXHX01.1171

Similarity: 100.00%
Dice (Opt:0.50%) (Tol 1.5%-1.5%) (H>0.0% S>0.0%) [0.0%-98.3%]
Unmatched bands: 0
E. coli 9 March: Nationwide outbreak of *Salmonella enterica* serotype Agona infections in infants in France, linked to infant milk formula, investigations ongoing

Emanuelle Espié 1(e.espie@invs.sante.fr), François-Xavier Weiö1, Cécile Brouard1,2, Isabelle Lepidi1,2,3

1 Institut de Veille Santé, Et Maure, France
2 Centre National de Référence des *Salmonella*, Institut Pasteur, Paris, France
3 Programme de formation d’épidémiologie de terrain (PROFET), France
4 Département des Affaires Sanitaires et Sociales, Seine Maritime, France

In January and February 2005, the Centre National de Référence des *Salmonella* (French Reference Centre) received 76 strains from 11 French regions, which is four times more than the median number of isolates sent to the NRC-Salm during the previous four years.

We defined a case as an infant with clinical symptoms compatible with a *salmonella* infection. The cases were all aged between 1 and 7 months and live in 14 different departments that reported feeding their infants milk made with different types of the Picot brand of infant powder or powdered drinks containing fennel. Twenty-one healthy infants aged between 1 and 7 months of this brand milk formula.

These preliminary results strongly suggest that milk formula prepared by this company is the source of the human isolates.

**Figure 1.** Geographical distribution of infant cases of *Salmonella* Agona infection, France, 2005.
Dear Dr Chiou,

Please find as attached file the XbaI PFGE results of French Agona strains. The running conditions were similar to the Pulsenet protocol and the molecular size marker was Braenderup H9812.
Profile X1 was observed in most of the cases who where fed "Picot" or "Bledilait" milk and in all strains recovered in the baby milk factory. Interestingly, other more or less closely related profiles X2, X9-X10 were also seen in babies who consumed either "Picot" or "Bledilait" milk.
Four unrelated strains displayed four different profiles (X4-X7).
It seems that the profile of your Agona strain is indistinguishable of our X1.
Don't hesitate to contact me again if you have some difficulties in opening the figures.
Best regards,
FX
--
François-Xavier WEILL, MD.
Co-director
French National Reference Centre for Salmonella
WHO Collaborating Centre for Salmonella
Unité de Biodiversité des Bactéries Pathogènes émergentes
Institut Pasteur
28 rue du Docteur Roux
75724 Paris cedex 15
France
Tel : 33-(0)1 45 68 83 45
Fax : 33-(0)1 45 68 88 37
Foodborne disease surveillance by PulseNet USA
AL has detected a small cluster of S.tennessee from 4 patients. The key numbers and collection dates are listed below. Please see the pattern of interest in the attached bundle file.

AL-8002774-06 09/06/2005
AL-8008342-06 10/11/2005
AL-8002349-06 10/11/2005
AL-8002382-06 10-17-2005

For questions regarding this cluster, please contact Chris Sellers at (334)206-3845.

Sherricka Simington, Microbiologist
ADPH-Bureau of Clinical Laboratories
P.O. Box 244018-8140 AUM Drive
Montgomery, AL 36124-4018
Phone: (334)260-3400 Fax:(334)274-9805
Email:sherrickasimington@adph.state.al.us
FOR IMMEDIATE RELEASE
P07-21
February 14, 2007

FDA Warns Consumers Not to Eat Certain Jars of Peter Pan Peanut Butter and Great Value Peanut Butter
Product May be Contaminated With Salmonella

The Food and Drug Administration (FDA) is warning consumers not to eat certain jars of Peter Pan peanut butter or Great Value peanut butter due to risk of contamination with Salmonella Tennessee (a bacterium that causes foodborne illness). The affected jars of Peter Pan and Great Value peanut butter have a product code located on the lid of the jar that begins with the number ‘2111.’ Both the Peter Pan and Great Value brands are manufactured in a single facility in Georgia by ConAgra. Great Value peanut butter is labelled as Great Value Original or Great Value Crunchy.
FOR IMMEDIATE RELEASE
P07-32
March 1, 2007

FDA Update on Peanut Butter Recall

Salmonella found in the ConAgra Plant

As a follow-up to the recent Salmonella outbreak linked to peanut butter, the U.S. Food and Drug Administration (FDA) is conducting an extensive inspection of ConAgra's Sylvester, Georgia processing plant. Samples collected by the FDA revealed the presence of Salmonella. The fact that FDA found Salmonella in the plant environment further suggests that the contamination likely took place prior to the product reaching consumers. Last week, tests by several states identified Salmonella in many open jars of Peter Pan and Great Value peanut butter recovered from consumers. In these instances, the Salmonella found in the plant and in the open jars matched the outbreak strain recovered from consumers who became ill.

Peanut Butter Toppings Part of Recall

FDA has learned that the ConAgra plant in Sylvester, GA, sent bulk Peter Pan peanut butter to its plant in Humboldt, TN. The three brands described below are part of the original Peter Pan recall. These brands have been recalled and are no longer being sold. However, some consumers may still have these products in their home.

Consumers who have any of the products listed below should discard them. Individuals who are not sure if the purchased product contains the recalled peanut butter topping should contact the store where the product was purchased.
Released March 7, 2007

NOTE: This is the last planned web update on this outbreak.

Public health officials in multiple states, with the assistance of the Centers for Disease Control and Prevention (CDC) and the U.S. Food and Drug Administration (FDA), are investigating a large multistate outbreak of Salmonella serotype Tennessee infections. An epidemiologic study comparing foods that ill and well persons said they ate showed that consumption of Peter Pan peanut butter and Great Value peanut butter were both statistically associated with illness and therefore the likely source of the

View larger outbreak map
Hello Everyone!

There are two *Salmonella Tennessee* clusters ongoing in the USA. The first cluster is 0611ALJNX-1c with pattern JNX01.0011 and the second cluster is 0701MEJN1 with pattern JNX01.0026. Please see the attached bundle file (S. Tennessee (2007-01-16PN.BDL) and corresponding tiffs).

The lane numbers and corresponding lane information is below:

VA07008: Xbal lane 2 and Brl lane 8
VT0514: Xbal lane 2 and Brl lane 3

Please review the attached information and compare to your database. We are very interested in knowing if you have ever seen either one of these patterns and also sources associated with them.

If you have any questions or concerns, please contact PulseNet USA using the information below.

Thank you,

PulseNet USA National Database Team

Centers for Disease Control and Prevention
1600 Clifton Rd., MS C03
Atlanta, GA 30333
USA

PulseNet: (404) 639-4558
Fax: (404) 639-3333
New Rules To Beat Food Terrorism

WASHINGTON, Dec. 6, 2004

(AP) The government announced new rules Monday aimed at helping trace the source of food contamination, particularly in the event of a bioterror attack on the food supply.

Food manufacturers and others who work in the nation’s human and animal food supply will have to keep records showing where they received food and where they shipped it next.

The idea behind the rules, announced by the Food and Drug Administration, is to help investigators figure out where in a long chain of supply a particular item of food may have been tainted.

The regulations implement part of a law, signed in February 2004, with provisions allowing the government to close food facilities that are unlikely to be able to respond to a national emergency.

"For the life of me, I cannot understand why the terrorists have not attacked our food supply because it is so easy to do."

Tommy Thompson, HHS Secretary
Thank you!!

Thank you!! Thank you!! Thank you!!