pennsylvania
DEPARTMENT OF HEALTH
Bureau of Epidemiology

Pennsylvania Epi Notes

Winter 2013 Volume 3, Issue 1

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2012 West Nile Virus Activity in Pennsylvania

Formal surveillance for West Nile virus (WNV) has been in place for over a decade in Pennsylvania, and over 450 human cases have been documented statewide through 2012. WNV activity has been largely subdued the past several years, following a peak in 2003. However, WNV activity surged in Pennsylvania in 2012, and surveillance data show the largest number of human cases were reported since 2003.

West Nile is an arbovirus that is most often transmitted by the bite of an infected mosquito. WNV was first recognized as a cause of human disease in 1937 in Uganda and remained isolated to the Eastern Hemisphere for more than 60 years. However, in 1999, the first outbreak of WNV infections in the Western Hemisphere was detected in New York City, and WNV quickly became a household phrase in the United States. Despite initial concerns of a bioterrorist event, the translocation of WNV into the Western Hemisphere is hypothesized to represent a naturally occurring event from migratory birds or from inadvertent transport of infected birds or mosquitoes on an international flight. Due to a large immunologically naïve population of birds and receptive mosquito species, the virus was able to spread coast to coast in North America and invade the Caribbean and Latin America in only four years.

Birds play a critical role in the transmission cycle of WNV, as birds serve as the reservoir for the virus. Once bitten by an infected mosquito, birds become viremic for several days and serve as a source of virus to subsequent host-seeking mosquitoes. The virus introduced to New York City causes overwhelming fatal infections in certain bird species (notably members of the Corvidae family, which includes crows and jays) that has led to sizeable bird die-offs. However, in many smaller bird species the infection is silent. Most mosquitoes that feed on birds are selective feeders and do not feed on humans. Occasionally, though, certain mosquito species (particularly *Culex pipiens*, the common house mosquito) act as a bridge vector and will feed on birds, as well as other species such as humans and horses. However, humans and horses are dead-end hosts for the virus and do not play a role in the virus transmission cycle, except in special circumstances such as blood transfusion, breast feeding or organ transplantation. As a result, screening of the blood supply and organ donors for WNV infection began in 2004. The WNV transmission cycle is depicted in Figure 1.

Figure 1: West Nile virus transmission cycle

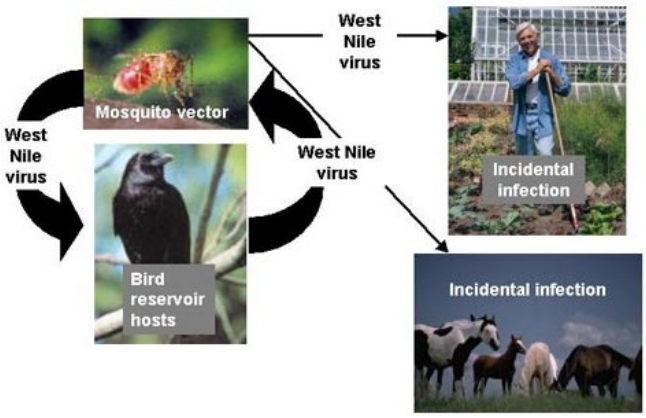


Figure courtesy of CDC (www.cdc.gov/ncidod/dvbid/westnile/cycle.htm)

The clinical spectrum of human WNV infection varies considerably. Most infections (approximately 80 percent) are asymptomatic. The majority of the remaining 20 percent experience a mild illness characterized by fever with headache and fatigue that can last from a few days to several weeks. A small proportion (less than 1 percent) develop a serious infection of the

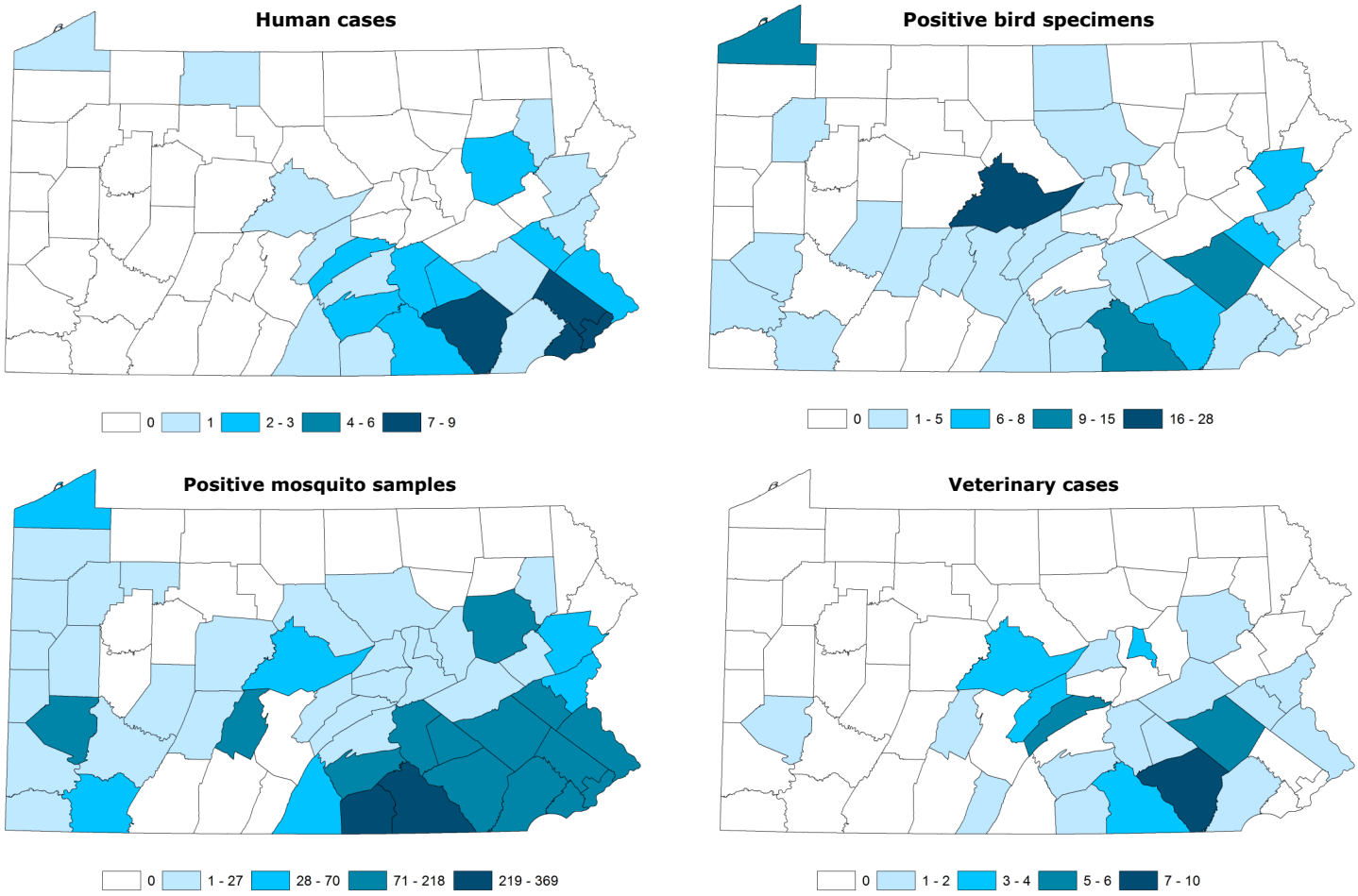
(West Nile Virus continued)

nervous system that manifests as meningitis or encephalitis, referred to as neuroinvasive disease. Neuroinvasive WNV infections can affect persons of any age, but the highest risk is seen among immunosuppressed persons or those over 50 years of age. Sequelae of neuroinvasive disease can be disabling and permanent.

The commonwealth has a comprehensive WNV control program that has been in place since 2000. It is a multi-agency effort coordinated by the Departments of Environmental Protection (DEP), Health (DOH), and Agriculture (PDA). A number of other agencies also work with DEP, DOH and PDA to carry out the program's goal, which is to reduce WNV morbidity and mortality in Pennsylvania. The WNV control program's activities consist of mosquito trapping, testing and monitoring of infection rates; coordinating and/or conducting mosquito control efforts in localities (mostly larval control efforts targeted at catch basins); dead bird collection and testing; surveillance and testing for human infections; surveillance and testing for equine infections; and public awareness and communication.

In 2012, the WNV season in Pennsylvania began in an unusual manner. First, an equine case of WNV was reported on March 29, the earliest in the year that an equine case has been documented in Pennsylvania. Next, a WNV-positive mosquito pool was detected on May 3, the earliest WNV has ever been detected in mosquitoes in Pennsylvania. By late November, 52 of 67 Pennsylvania counties reported some evidence of WNV activity (Figure 2). Although human cases did not appear earlier than usual in 2012, several of the WNV program's surveillance indicators were higher during the 2012 season compared with recent years. For example, there were 60 human WNV cases reported in 2012, the most Pennsylvania had seen in a single year since 2003 (Figure 3). Table 1 summarizes the 2012 results and contrasts them with the highest results from preceding years in Pennsylvania. It is notable that the overall mini-

Figure 2: West Nile virus activity by county, 2012 *



(West Nile Virus continued)

mum infection rate (MIR), an estimated measure of the number of WNV-infected mosquitoes per 1,000 tested, was more than twice what it had been in any previous year (Figure 4). DEP officials corroborated the MIRs observed in Pennsylvania with mosquito control programs from other states, which also reported abnormally elevated MIRs in their jurisdictions during the 2012 season.

DEP reported more than 75,000 mosquito control events in 2012, up 16 percent from 2011 and 25 percent from 2010. Counties with the most control events were Philadelphia, Allegheny, Bucks, Delaware and York. Adult mosquito control (spraying) was conducted on 565 occasions during the 2012 season, with the largest number of events taking place in Cumberland (51), Lancaster (46), Adams (42), Philadelphia (41) and Montgomery (38) Counties. Over 2,000 public mosquito complaints were reported to DEP in 2012, nearly double that of 2011 and driven largely by the expanding range of the aggressive Asian tiger mosquito (*Aedes albopictus*), which has not been found to be a competent vector of WNV. Nonetheless, DEP's extensive mosquito control activities are commendable and played an important role in preventing human WNV infections.

Although not hit nearly as hard as states such as Texas, 2012 was a notable year for WNV in Pennsylvania. Like most of the

Figure 3: Human WNV cases and deaths by year, 2001-2012 *

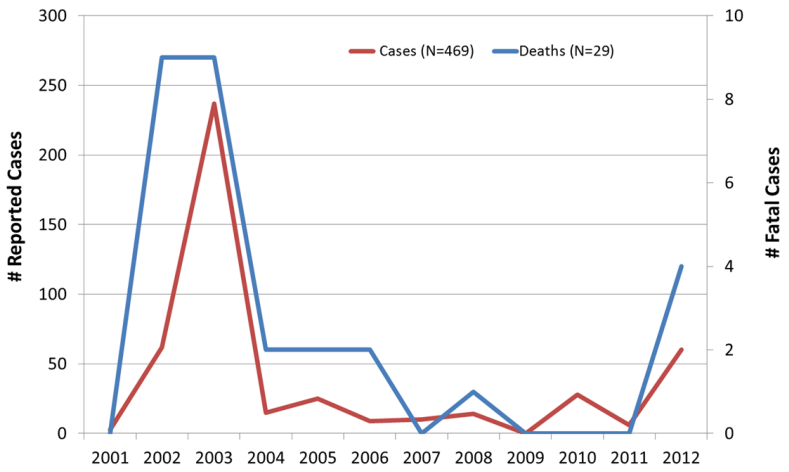
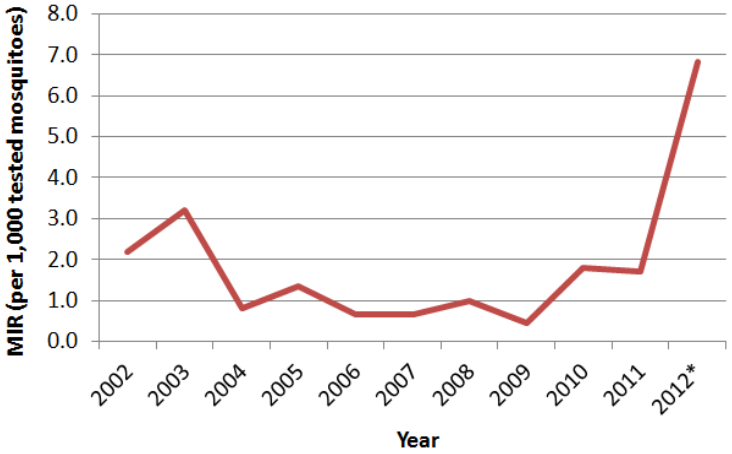


Figure 4: WNV minimum infection rate (MIR) by year, 2002-2012 *



Minimum infection rate = estimated measure of the number of WNV-infected mosquitoes per 1,000 tested

Table 1: 2012 WNV surveillance data and comparison to previous years *

Surveillance indicator	2012 results	Counties with highest numbers in 2012	Most recent year with
Human cases	60	Philadelphia (9), Lancaster (8), Delaware (7)	2003 (237)
Human deaths	4	Philadelphia (2), Berks (1), Luzerne (1)	2003 (9)
Veterinary cases	50	Lancaster (10), Berks (6), Juniata (5)	2003 (653)
Positive birds	135	Centre (28), Erie (15), Berks (14)	2004 (546)
Positive mosquito samples	3,410	York (369), Adams (345), Delaware (218)	N/A (surpassed previous
Minimum infection rate (MIR) per 1,000 mosquitoes	6.8	N/A (statewide)	N/A (surpassed previous record of 3.4 in 2003)

* 2012 data are provisional and subject to change.

(West Nile Virus continued)

United States, the increase in Pennsylvania was likely due to a combination of factors. First and foremost, arboviruses like WNV tend to be cyclical in nature, and periodic large outbreaks are expected yet very difficult to predict. Second, an abnormally mild winter and spring extended the usual mosquito breeding season. Furthermore, the record-setting hot summer sped up the mosquito life cycle, thus resulting in more mosquitoes in less time. Additionally, elevated temperatures increased the rate of WNV replication, which means mosquitoes infected with WNV were more infectious than usual. And lastly, WNV mutations have occurred in the past, and it is plausible that further, yet-to-be detected viral evolution may have driven the severity of the 2012 season. Thankfully, winter arrived, suppressing the mosquito population and giving public health officials time to analyze the 2012 WNV surveillance data and prepare for the 2013 season.

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2012 Pertussis Activity in Pennsylvania

Background

Pertussis, also known as "whooping cough," is a vaccine-preventable respiratory disease caused by the bacteria *Bordetella pertussis*. Pertussis is characterized by violent, uncontrollable coughing. In typical cases, coughing paroxysms end with an inspiratory whoop and can be followed by vomiting. In children, adolescents and adults who were previously vaccinated, the illness can be milder and the characteristic "whoop" absent. After paroxysms subside, a nonparoxysmal cough can continue for two to six weeks or longer. Pertussis is more common in children than in adults and can be fatal, especially in infants.[1]

Pertussis begins with cold-like symptoms, a mild cough and a fever. After a week or two, the coughing fits begin. The fits are violent and "whoops" may be emitted when the infected person gasps for air. Vomiting may occur after coughing fits. The coughing fits may last up to 10 weeks. More than half of children under 1 year of age infected with pertussis are admitted to the hospital. Symptoms in older children and adults may be less severe. The recovery period can take months and an infected person may occasionally experience coughing fits during this recovery period.[2]

Pertussis can be treated with antibiotics. Treatment with antibiotics within the first three weeks of illness may prevent the spread of disease to others, but treatment is not recommended after three weeks because the bacteria have usually been eradicated from the body by that time. It is important to note that treatment will not diminish symptoms nor reduce the duration of illness. More severe cases may need to be hospitalized for treatment.[3]

Pertussis Vaccine

Prior to the 1990s, the DTP vaccine was administered to children in the United States. DTP contained vaccines for diphtheria and tetanus, plus a pertussis vaccine made with whole cells. Concerns about adverse reactions associated with the whole cell component[4] led to the licensure and use of DTaP, which contains diphtheria, tetanus and acellular pertussis vaccines. The Centers for Disease Control and

(Pertussis continued)

Prevention (CDC) recommends administering the DTaP vaccine at ages 2 months, 4 months, 6 months, 15-18 months, and 4-6 years. In Pennsylvania, around 85 percent of children have received four or more doses of DTaP by 3 years of age.[5]

Tdap, which is the formulation of tetanus, diphtheria, and pertussis vaccine for adolescents and adults, is recommended for everyone at 11-12 years of age. For those who were not vaccinated with Tdap at that age, a single dose is recommended as soon as possible afterwards. In addition, to prevent spreading pertussis to vulnerable infants, the CDC's Advisory Committee on Immunization Practices recently released a provisional recommendation that Tdap vaccine be given to all pregnant women with every pregnancy, irrespective of previous Tdap history. Also, adults who have frequent contact with an infant under 1 year of age, including parents, grandparents, childcare providers and healthcare workers, should receive a single dose of Tdap.[6,7]

Figure 1: Pertussis disease progression

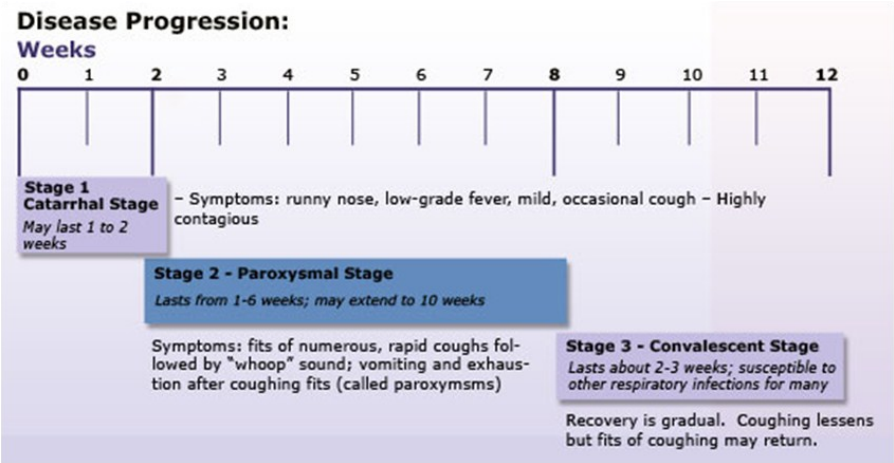


Figure courtesy of CDC (www.cdc.gov/pertussis/about/signs-symptoms.html)

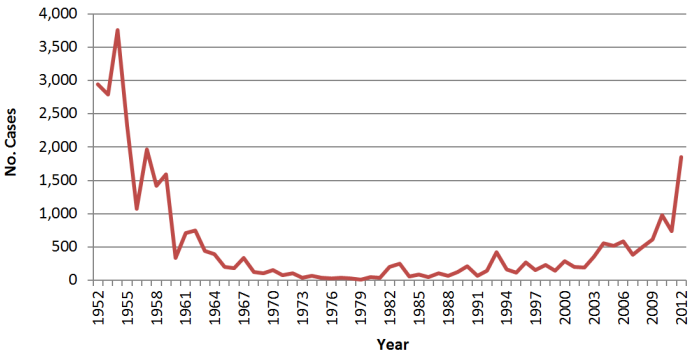
Vaccination against pertussis confers strong immunity against the disease in the short term. However, immunity to pertussis decreases over time, making it important to adhere to the recommended vaccination schedule.[8]

Pertussis Surveillance

Pertussis increased dramatically in both Pennsylvania and the rest of the country in 2012. There were 1,853* cases reported in Pennsylvania and 41,000 cases nationally.[9] This is the highest number of cases reported since the late 1950s (Figure 2).[10,11] Although pertussis generally peaks every three to five years, there has been an overall upward trend in the last decade.

The age distribution of pertussis cases has also shifted in recent years. Traditionally, pertussis has been reported most frequently in infants (1 year of age and under). However, in 2012, pertussis was most frequently reported among children aged 10 to 12 years (Figure 3). This shift does not appear to be related to changes in vaccination status, as overall pertussis vaccine coverage in the Pennsylvania population has been relatively constant since 2000. In 2012, approximately 80 to 85 percent of pertussis cases had been appropriately vaccinated.

Figure 2: Pertussis Cases, Pennsylvania, 1952-2012 *



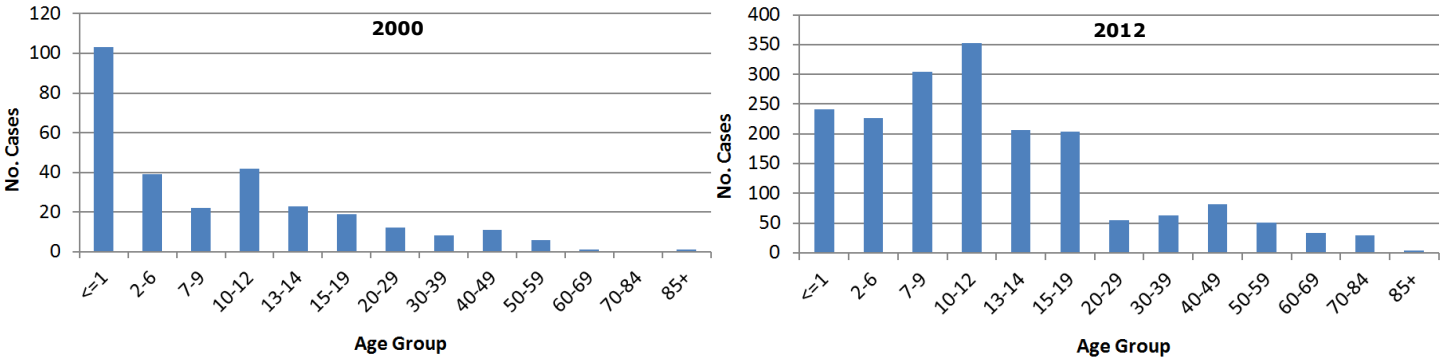
Discussion

The causes behind the national increase in pertussis are not fully understood, although several factors may play a role. Increased awareness of pertussis in older age groups and faster and easier testing methods may have led to more cases being diagnosed and reported.[12]

Furthermore, there is evidence that the immune response produced by the acellular pertussis vaccine, adopted in the 1990s, wanes more quickly than that resulting from the whole cell vaccine. If immunity wanes with time, one would expect to see an increase in cases among children approaching 11 to 12 years of age, the age at which the Tdap booster is administered. In fact, increasing pertussis in children aged 7 to 10 years of age has been observed nationally[13] and in Pennsylvania (Figure 3). These findings

(Pertussis continued)

Figure 3. Pertussis Cases by Age Group, Pennsylvania, 2000 and 2012 *



are fueling a re-examination of recommended vaccine schedules and make-up of the pertussis vaccine.

It should be noted that an increase in pertussis diagnosis may also be due to false positive test results when using polymerase chain reaction (PCR) testing. PCR testing for pertussis diagnosis has become more frequent since 1997. However, PCR is not as specific and is more likely to produce a false positive result than pertussis culture, which is considered the gold standard for pertussis testing. Therefore, persons with other respiratory illnesses may be erroneously diagnosed with pertussis.[14] The CDC provides best practices on the use of PCR in pertussis testing.

* 2012 data are provisional and subject to change.

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The Role of Pulsed-field Gel Electrophoresis in the Detection of Foodborne Outbreaks

Foodborne outbreaks occur when people become sick after ingesting a food or beverage contaminated by a pathogen (e.g., bacteria, virus, parasite) or toxin. The Pennsylvania Department of Health (DOH) and local health departments make every effort to find the source of suspected foodborne outbreaks impacting the citizens of the commonwealth. The goal is to stop the outbreak, prevent additional people from becoming sick and prevent future similar outbreaks from occurring.

Foods or beverages can be contaminated with pathogens or toxins at any point in the food production process (see Figure 1). Sometimes outbreak investigations lead to the identification of new pathogens, new food vehicles or unrecognized issues in the food safety system. Ultimately, these investigations lead to better understanding of foodborne outbreaks, improved regulations and enforcement by regulatory agencies such as FDA and USDA, and increased consumer knowledge.

Figure 1: Food production chain

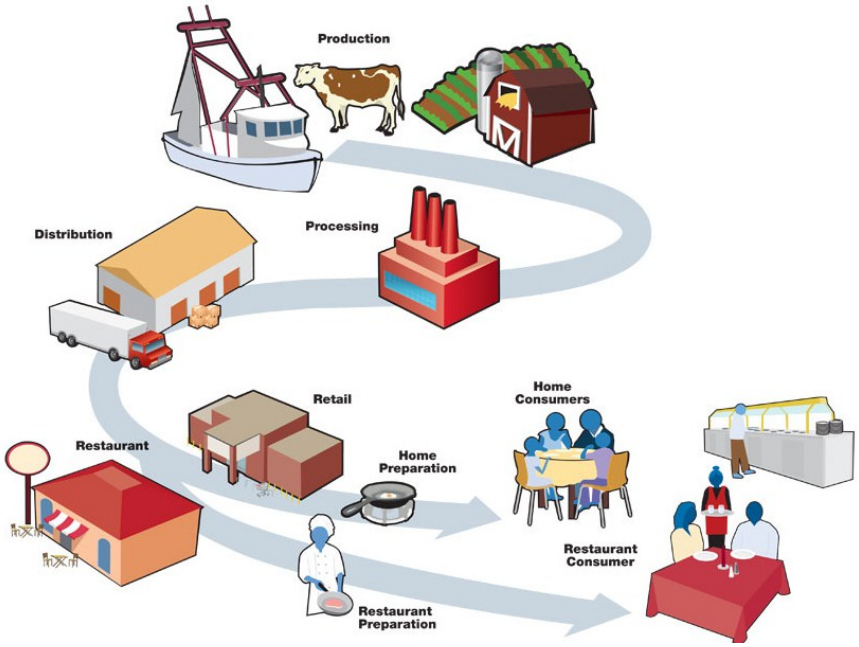


Figure courtesy of CDC (www.cdc.gov/outbreaknet/investigations/figure_food_production.html)

How do we detect foodborne outbreaks?

DOH becomes aware of a possible outbreak in a number of ways:

- An ill person or their friend or family member may call DOH (877-PA-HEALTH) or their local health department to report an outbreak.
- Pennsylvania state regulations require that healthcare providers report all outbreaks and/or unusual occurrences of disease, even if the etiology is unknown. A phone call from a healthcare provider who is aware of multiple people with the same disease may alert us to an outbreak.
- State regulations also require that healthcare providers report certain conditions to the state reportable disease system, PA-NEDSS. Public health staff review reports daily and may notice a higher-than-usual number of reports of a particular disease.
- While interviewing cases or reviewing surveillance information, public health staff may notice a common risk factor reported by recent cases, e.g., multiple people ate at a common restaurant before becoming ill.
- The public health laboratory (DOH Bureau of Laboratories [BOL]) may notice an increased number of submissions of specimens with the same pathogen.

Different pathogens require different types and levels of information in order to determine if an outbreak is occurring. For relatively uncommon pathogens, such as *Listeria*, the detection of the pathogen itself is enough to raise a red flag. For relatively common pathogens, like *Salmonella*, it is necessary to know the serotype and, in many cases, the PFGE pattern or "DNA fingerprint," in order to know if two or more cases may be related.

What is PFGE?

PFGE stands for pulsed-field gel electrophoresis and is a molecular technique sometimes referred to as "DNA fingerprinting." It is currently the standard method for subtyping bacterial pathogens, including *Salmonella* and shiga toxin-producing *E. coli* (see Table 1).

(PFGE and outbreaks continued)

Table 1: Foodborne bacterial pathogens subtyped by PFGE by BOL

Routine	Only when suspected of being outbreak-related	By special request
E. coli O157:H7 and other Shiga toxin-producing *E. coli*	*Campylobacter jejuni*	*Yersinia enterocolitica* *
Listeria monocytogenes	*Clostridium perfringens*	
Salmonella	*Clostridium botulinum*	
Shigella	*Vibrio cholerae*	
	Vibrio parahaemolyticus	

* PulseNet does not maintain a database for this organism.

Figure 2: PFGE example

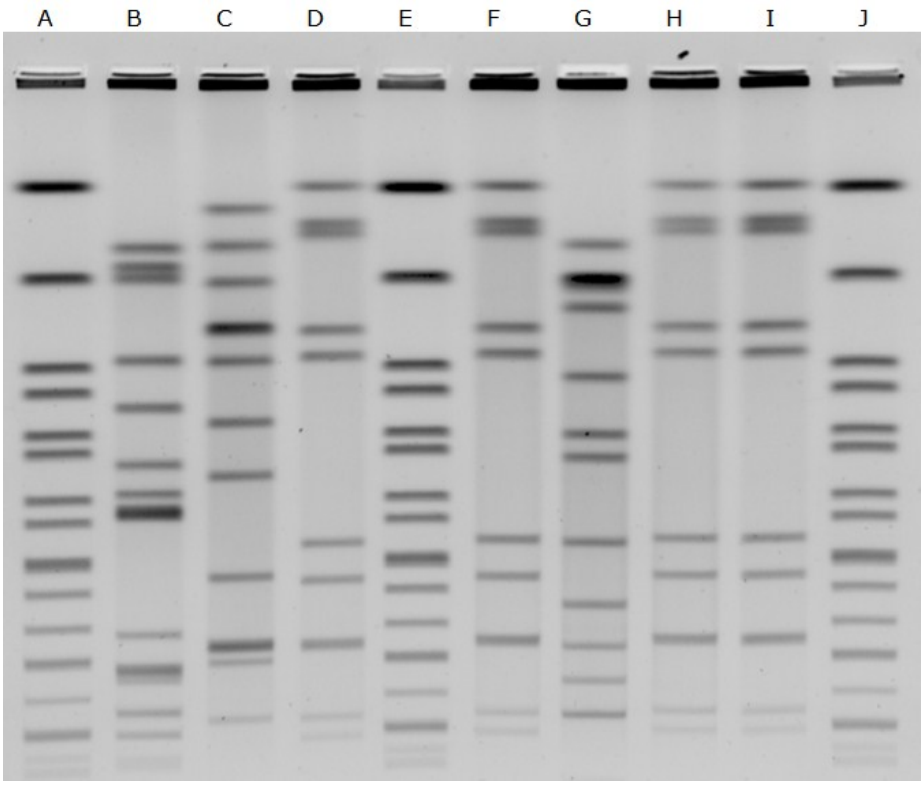


Figure courtesy of BOL. Each vertical column corresponds to one patient specimen. Matching patterns (e.g. columns D, F, H, and I) indicate a possible common source of the bacteria.

PFGE produces a visual pattern that appears like a bar code and is made up of different fragments of the organism's genetic material (see Figure 2). Patterns from different patients' specimens can be compared; if they match, it suggests (but does not prove) that the pathogens infecting the patients came from the same source. When rare patterns are detected, it is even more likely that the matching isolates originated at the same source. To facilitate comparison with patterns from patients around the United States, PFGE patterns are submitted to PulseNet by participating laboratories.

What is PulseNet?

PulseNet is a national molecular subtyping network that conducts surveillance for foodborne disease outbreaks. It was created in 1996 and is coordinated by the Centers for Disease Control and Prevention (CDC) and the Association of Public Health Laboratories. Participants in PulseNet include state and local public health departments, federal food regulatory agency labs, agriculture labs, and veterinary labs. Currently, 87 labs participate, with at least one per state. Participating labs use standardized protocols and equipment to do PFGE; once PFGE is completed on a specimen, the pattern is submitted to PulseNet for comparison.

CDC does routine searches on the national database to look for common patterns, but participating labs can also do searches on their local PulseNet databases (i.e., BOL can search Pennsylvania data). Suspected outbreaks are reported to local and CDC epidemiologists, reporting labs and the PulseNet SharePoint website, and an outbreak investigation begins.

Since its inception, PulseNet has detected many outbreaks, and has proven particularly useful in identifying multistate outbreaks in which cases are widely dispersed geographically, with small numbers of cases in different jurisdictions. The number of patterns submitted to PulseNet over the past 16 years has increased dramatically (see Table 2), leading to a large increase in the number of outbreaks detected.

(PFGE and outbreaks continued)

With expanding international trade and travel, foodborne outbreaks can spread around the world. To detect those types of outbreaks, there is now PulseNet International. In addition to the network in the United States, there are PulseNet networks in Africa, Asia Pacific, Canada, Europe, Latin America and the Caribbean, as well as the Middle East.

Table 2: Increase in number of specimens submitted to PulseNet from 1996 to 2011

	Human isolates	Non-human isolates *
1996	254	5
2011	55,111	4,617

* Non-human = food, animal, or environment

Recent outbreaks detected by PFGE and PulseNet

A good portion of multistate foodborne outbreaks are detected by PFGE. To learn about some of these recent outbreaks, visit CDC's Multistate Foodborne Outbreak Investigations page, or follow some of the links listed below.

Multistate Outbreak of Human *Salmonella* Typhimurium Infections Linked to Hedgehogs

Multistate Outbreak of *Salmonella* Serotype Bovismorbificans Infections Associated with Hummus and Tahini - United States, 2011

Multistate Outbreak of Shiga Toxin-producing *Escherichia coli* O157:H7 Infections Linked to Organic Spinach and Spring Mix Blend

Multistate Outbreak of Listeriosis Linked to Imported Frescolina Marte Brand Ricotta Salata Cheese

Multistate Outbreak of *Salmonella* Bredeney Infections Linked to Peanut Butter Manufactured By Sunland, Inc.

Why are PFGE and PulseNet important?

The food industry is more global than it has ever been. It is not uncommon for one farm or company to distribute their food all over the country or internationally. When cases of a foodborne disease are widespread with only a small number of cases in each jurisdiction, it's difficult, if not impossible, for local public health staff to recognize an outbreak. Outbreaks identified by PFGE have uncovered problems in food production and distribution industries, including the beef, produce, tree nut, peanut, egg and spice industries. As a result, some industrial processes have been changed to increase food safety.

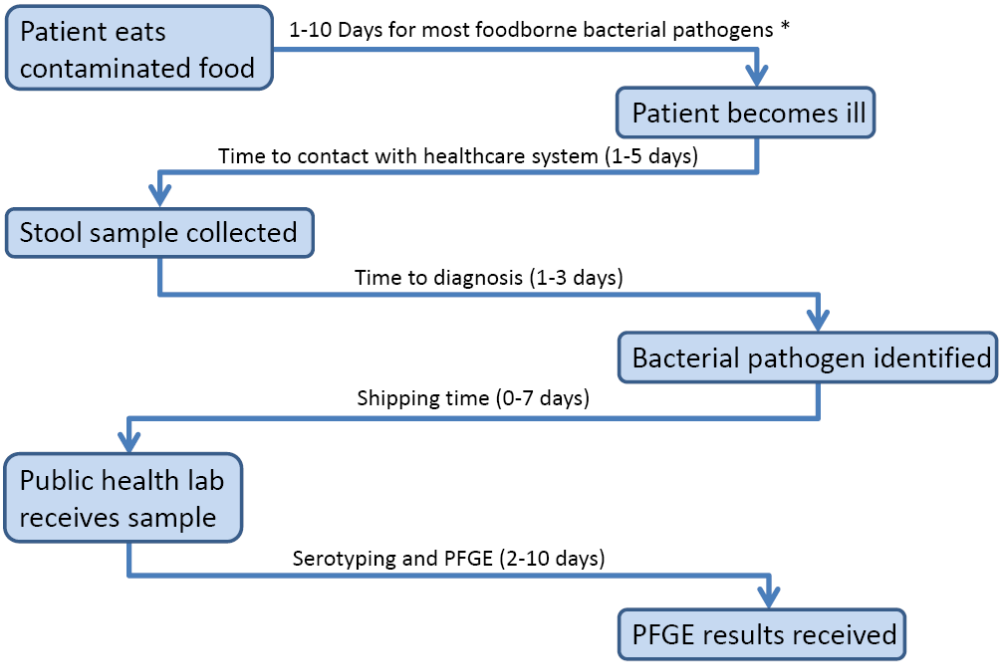
Future of PFGE in outbreak detection

There are three main areas for improvement with regard to PFGE and the detection of outbreaks:

1. PFGE does not have sufficient discriminatory power for some pathogens.
   Some pathogens (e.g. *Salmonella* Enteritidis), have very little heterogeneity in their PFGE patterns, making it difficult to distinguish outbreak-related specimens from those not related to an outbreak. Fortunately, another molecular technique, MLVA (multiple locus variable number tandem repeat analysis), is increasingly being used in combination with PFGE. MLVA provides an additional level of discrimination that helps link outbreak-related specimens.
2. Receipt of PFGE results usually happens two to three weeks after illness onset, so patients may not have good recall of their exposures in the days before they became ill.
   Once a person becomes ill, it can be two to three weeks before their PFGE pattern is submitted to PulseNet (see Figure 3). This means that an outbreak may not be detected until it has been underway for a few weeks. When cases are interviewed at that point, it is usually hard for them to remember what they ate in the days before illness onset, thereby hindering the investigation. Outbreak detection and investigation could be improved by decreasing the time between illness onset and receipt of PFGE results.

(PFGE and outbreaks continued)

Figure 3: Timeline for reporting of cases to health department and receipt of PFGE results



Total: 5-35 days

* Incubation period varies by pathogen; median incubation period for *Listeria* is three weeks but can be up to 10 weeks.

3. A decreasing number of clinical laboratories are providing isolates to public health laboratories for PFGE.
   Clinical laboratories are increasingly using nonculture based methods to diagnose infections. While that is generally sufficient for clinical purposes, it means that there is no cultured organism to provide to a public health laboratory for further characterization, including PFGE. Unless new methods for direct subtyping are developed, the ability to characterize bacterial pathogens will diminish, making it less likely that outbreaks will be detected.

In the absence of a speedy method for "fingerprinting" patient specimens and identifying outbreak-related cases, healthcare providers can help by promptly submitting specimens for testing when a food-borne illness is suspected. Patients can be helpful by participating in interviews conducted by public health staff, referring to calendars and credit card transactions to remember where and what they ate, and providing grocery store loyalty card numbers if requested. Outbreak investigations are multifaceted and outbreaks are only solved with participation from patients, healthcare providers, laboratories, and public health investigators.

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Cases of select notifiable diseases in Pennsylvania *

(as of 2/18/2013)

	Total cases reported for previous 5 years				
	2012 †	2011	2010	2009	2008
Chlamydia	55,112	52,884	47,518	43,068	42,233
Gonorrhea	15,371	13,770	12,883	10,138	11,071
Campylobacteriosis	1,717	1,762	1,622	1,542	1,554
Salmonellosis	1,635	1,844	1,802	1,701	1,721
Pertussis (whooping cough)	1,607	547	762	468	368
Giardiasis	636	792	783	837	873
Legionellosis	293	502	324	383	408
Varicella (chicken pox)	289	337	403	461	853
Cryptosporidiosis	282	457	484	465	326
Shigellosis	121	121	634	1,201	248

* Confirmed cases only
† Case counts for 2012 are provisional and subject to change. Counts for earlier years are for complete years.

Disease Reporting

Healthcare practitioners, healthcare facilities and clinical laboratories are required to report certain diseases to the Pennsylvania Department of Health. In addition to the diseases on the list, all disease outbreaks and/or unusual occurrences of disease are reportable within the commonwealth. In most cases, reporting must be done electronically via Pennsylvania's version of the National Electronic Disease Surveillance System (PA-NEDSS). To request a PA-NEDSS account, healthcare providers may email PA-NEDSS@pa.gov; please include your contact information and the name and address of the facility for which you will be reporting.

Employment Opportunities

The State Civil Service Commission is currently accepting applications for the following Pennsylvania Department of Health positions:

Epidemiologist
Epidemiology Program Specialist
Epidemiology Research Associate
Public Health Physician

To apply, click on the links above or visit the Pennsylvania State Civil Service Commission website and click on Job Seekers.

Complete a civil service application for each position for which you are interested. Some positions also require an application supplement. The commission will send you the results of your examination or rating. If you meet the minimum requirements, your name will be placed on the list of eligible candidates (eligible list) for that job title according to your score. Positions in the merit system are filled from this pool of eligible candidates. When a job vacancy occurs, the hiring agency requests an eligible list from which to interview for that job title. If you are ranked high enough on the eligible list, you will be contacted for a job interview. See How to Get a Civil Service Job for more information.

Pennsylvania Epi Notes

Editors:
Leah Lind, MPH
Chandra Marriott, MPH

Authors:
Leah Lind, MPH
Jonah Long, MPH
Chandra Marriott, MPH

This newsletter is published quarterly at
www.health.state.pa.us/epinotes.
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epinotes@pa.gov.

Pennsylvania Department of Health
Bureau of Epidemiology
Health and Welfare Building, Room 933
625 Forster St.
Harrisburg, PA 17108
Phone: 717-787-3350
For inquiries, call 877-PA-HEALTH
www.health.state.pa.us