1. Surveillance Principles and Concepts

2. Essential Public Health Service #1: Monitor Health Status to Identify and Solve Community Health Problems
3. Objectives

- Define surveillance and list the features of an ideal surveillance system
- Describe the steps involved in the evaluation of a public health surveillance system
- Discuss the application of surveillance systems in human and veterinary medicine, identifying differences between the two
- Evaluate a previously unknown surveillance system in a systematic fashion and make recommendations to improve it
- Know where to go for information about prevention and control plans for arboviral encephalitides

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4. A Word About Surveillance

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5. Surveillance: What It’s Not

![Surveillance: What It’s Not](image1)

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6. Definition of Surveillance

![Definition of Surveillance](image2)

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7. History of Public Health Surveillance

- **1961**: CDC made responsible for MMWR
- **1951**: CDC authorized Council of State and Territorial Epidemiologists (CSTE) to develop case definitions for public health surveillance
- **1990s**: National Electronic Surveillance System (NETSS), followed by Disease Surveillance System (NEDSS)

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8. History of Public Health Surveillance

- **1988**: Guidelines for Evaluating Surveillance Systems
- **2001**: Updated Guidelines for Evaluating Public Health Surveillance Systems
  - Integration of surveillance and health information systems
  - Establishment of data standards
  - Electronic exchange of health data
  - Response to emerging health threats

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9. Definition of Surveillance

Definition of Surveillance

- **Public Health Surveillance** is the ongoing systematic collection, analysis, interpretation and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health.

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10. Public Health Surveillance

- Authorized by legislators
- Carried out by public health officials
- Related to public health information systems but not necessarily the same
- Authority to require reporting resides in state legislatures

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11. Definition of Surveillance

Definition of Surveillance

- Public Health Surveillance is the ongoing systematic collection, analysis, interpretation and dissemination of data regarding a **health-related event** for use in public health action to reduce morbidity and mortality and to improve health.

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12. Health-Related Event

Health-Related Event

- Infectious Disease: Methicillin Resistant S. aureus (MRSA) (antibiotic resistance)
- Chronic Disease: Cancer cases
- Zoonotic Disease: West Nile virus cases
- Injury: Dog bites
- Exposures: Blood Lead levels
- Behaviors: Smoking
- Risk factors: Access to health care; obesity
- Use of health services: Influenza vaccinations

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13. Definition of Surveillance

Definition of Surveillance

- Public Health Surveillance is the ongoing systematic collection, analysis, interpretation and dissemination of data regarding a health-related event for use in **public health action** to reduce morbidity and mortality and to improve health.

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14. Uses of Public Health Surveillance Data

Uses of Public Health Surveillance Data

- **Immediate public health action**
- Program planning and evaluation
- Formulating research hypotheses

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15. Inhalation Anthrax Associated with Dried Animal Hides

Inhalation Anthrax Associated with Dried Animal Hides---Pennsylvania and New York City, 2006

- February 16, patient traveled to PA to perform with his dance troupe, collapsed and was admitted to local hospital
- Blood cultures grew gram+ rods; PCR and susceptibility to lysis by gamma phage confirms *B. anthracis*
- February 21: PDOH reported to NYC and CDC

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16. Public Health Action

Public Health Action

- Environmental and epidemiologic investigation identified likely source of infection
- Postexposure prophylaxis for inhalation anthrax for coworkers
- Enhanced surveillance for additional cases of anthrax
- Risk communication to the public to minimize risk for exposure/infection and alleviate concern

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17. Uses of Public Health Surveillance Data

Uses of Public Health Surveillance Data

- Immediate public health action
- Program planning and evaluation
  - Surveillance for Lyme Disease, West Nile Virus, and Avian Influenza H5N1 have led to increased appropriations for surveillance, a national strategy for pandemic flu planning and research
- Formulating research hypotheses

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West Nile Virus Surveillance, 2001

FIGURE 1. Areas reporting West Nile virus (WNV) activity — United States, 2001

*As of September 16, 2001.
*Kentucky reported WNV activity in a horse but no birds.

Source: http://www.cdc.gov/ncidod/dvbid/westnile/Mapactivity/survcenter99Maps.htm

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19. West Nile Virus Surveillance, 2004

![West Nile Virus Surveillance, 2004](image1)

20. Uses of Public Health Surveillance Data

![Uses of Public Health Surveillance Data](image2)
21. Surveillance: Slide 21

![Surveillance Chart](image)

22. Uses of Public Health Surveillance Data

**Uses of Public Health Surveillance Data**

- Immediate public health action
- Program planning and evaluation
- **Formulating research hypotheses**
  - Behavioral Risk Factor Surveillance System detected concomitant increase in population prevalence of diabetes and obesity → Is there a relationship?
23. Examples of Public Health Surveillance Systems

Examples of Public Health Surveillance Systems

- National Electronic Disease Surveillance System (NEDSS)
  - Standard data formats, communications infrastructure, agreements on data access, sharing and confidentiality
  - NETSS, HIV/AIDS, TB, ID
- Behavioral Risk Factor Surveillance System (BRFSS)
- Cancer registries: collects reports from all health care providers, institutions, and laboratories
- Provider-Based Sentinel Surveillance Networks
  - Emerging Infections Network (EIN)
  - EMERGEncy ID NET
  - GeoSentinel
  - Border Infectious Disease Surveillance Project (BIDS)

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24. Evaluation of Surveillance Systems

Evaluation of Surveillance Systems

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25. Evaluation of PH Surveillance Systems

Evaluation of PH Surveillance Systems

- Purpose: ensure that problems of public health importance are being monitored efficiently and effectively
- Should be done periodically to ensure that surveillance systems keep up with change
  - Evaluation incorporates recommendations for improvements

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26. Program Evaluation: Application to Surveillance Systems

Program Evaluation: Application to Surveillance Systems

- Engage Stakeholders in the Evaluation
- Describe the System
- Focus the Evaluation Design
- Gather Credible Evidence Regarding the System’s Performance
- Justify and State Conclusions and Make Recommendations
- Ensure Use of Evaluation Findings and Share Lessons Learned

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27. Simplified Flow Chart of a Surveillance System

Example of Public and Population Health Surveillance

Example of Public and Population Health Surveillance
West Nile Virus
29. Situation

- July 1999: crows die near Bronx zoo
- August 23: Infectious disease MD at Queens hospital reports 2 patients with encephalitis to NYC DoH
  - Investigation reveals cluster of 6 patients, 5 with profound muscle weakness; all resided in a 4 mi² area in Queens
  - CDC conducts tests: Capture ELISA for IgM to common North American arboviruses positive for SLE in serum, CSF
- Active surveillance begun 8/30 in NYC, 9/3 in Westchester and Nassau County DoHs
- 9/3: Aerial and ground spraying with mosquito adulticides and larvicides

30. Situation

- September 7-9: deaths of Guanay Cormorant, 3 Chilean flamingos, Asian pheasant and bald eagle
  - Autopsies: severe myocarditis, meningoencephalitis
  - Suspect an equine encephalitis virus (EEE, WEE, SLE)
31. Surveillance: Slide 31

Components in the Transmission and Maintenance of Arboviral Encephalitis

- Vertebrate hosts
- Predators and parasites
- Food/Space resources
- Weather/climate
- Virus
- Immune status
- Dead-end hosts
- Vectors

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32. Ecology: Entomology of Viral Encephalitides

Ecology: Entomology of Viral Encephalitides

- Arboviruses (arthropod-borne viruses)
- Maintained in nature through biological transmission between susceptible vertebrate hosts by blood-feeding arthropods
  - Arthropod vector hosts includes mosquitoes, sand flies, ceratopogonids "no-see-ums" and ticks
  - Primary hosts are nonhuman
  - Humans, domestic animals usually incidental or dead-end hosts (no significant viremia, don’t contribute to the transmission cycle)

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33. Surveillance: Slide 33

34. Burden of SLE in People
35. Burden of EEE in People and Horses

![Map showing cases of EEE and WEE in Horses and Humans, 1997](image)

36. Burden of WEE in People

![Map showing confirmed and probable human cases of Western Equine Encephalitis in the United States (1964-1997)](image)
37. Meanwhile, Back in the Bronx!

38. The Emus Were OK!
39. Unusual Findings

- WNV usually produces asymptomatic infection or mild febrile disease
  - No documented epizootics in birds
  - Crows with antibodies to WNV are common, suggests asymptomatic or mild infection
  - SLE usually not virulent in birds
- This epizootic unusual because of high mortality in crows, other birds

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40. Timeline, continued

- September 7-9: 2 more flamingos die
- 9/10: Dr. McNamara sent samples to National Veterinary Services Laboratory (NVSL-USDA), USAMRIID (Fort Detrick, MD)
  - USDA rules out common bird viruses and equine encephalitis viruses
  - Isolated unknown virus, sent to NCID/CDC
- 9/23: CDC tests isolates by PCR, sequences virus
  - Repeated IgM ELISA to WNV and got higher positive/negative ratios than to SLE antigen
- 9/24: CDC identifies as West Nile Virus
  - Human autopsy specimens positive, got identical genome sequence to virus in birds

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Before and concurrent with this outbreak, local health officials observed increased fatalities among New York City birds, especially crows. During September 7-9, officials of the Bronx Zoo noted the deaths of a cormorant, two captive-Bred Chilean flamingoes, and an Asian pheasant. Necropsies performed on these birds at the zoo revealed varying degree of meningoencephalitis and severe myocarditis. Tissue specimens from these birds were sent to The U.S. Department of Agriculture National Veterinary Services Laboratories (NVSL) in Ames, Iowa, on September 10 to be tested for common avian pathogens and the equine encephalitis viruses; all tests were negative. NVSL isolated viruses from the birds' tissues and forwarded them to CDC On September 20 for identification and characterization.
43. WNV

- **Family Flaviviridae, Genus Flavivirus**
  - JE Antigenic Complex
  - Includes JE, Kunjin, Murray Valley, SLE, WNV, Yaounde virus and several others
  - All in family are similar: 40-60 nm, enveloped, icosahedral nucleocapsid, positive sense single-stranded RNA, 10-11k bases long

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44. Electron Microscopic Images of West Nile Virus

- **Electron Microscopic Images of West Nile Virus in Crow Brain Tissue**
  - ncidid/dvbid/westnile/virus.htm

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45. Previous WNV Outbreaks

- Uganda, 1937: West Nile District
- Israel, 1950 – 1954 and 1957: first outbreaks, recognized as cause of severe meningitis, encephalitis among elderly patients
- France, 1962
- South Africa, 1974 (largest epidemic recorded)
- Romania, 1996

46. WNV in Animals

- Morocco, 1996: epizootic in horses
- Italy, 1998
- US, 1999-2001
- France, 2000
Skinner and Gubler

- Gubler: “This is exciting. We prefer it didn’t occur, but it is interesting. What we are seeing in the waning years of the late 20th century is the transport and movement of these viruses in new areas. And you get a virus moving into a new area, the entire mosquito population is susceptible.”
- Skinner: “The important message to get across is that all the public health and responsive measures implemented are the same.”

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Response

- NYC Mayor’s Office of Emergency Management: no comment on CDC report
- Vector control (9/3)
  - Host-seeking adult Culex pipiens population decreased (had program in place)
  - Detection of WNV in Culex, Aedes vexans mosquitoes
  - Instituted surveillance of wild birds and/or sentinel chickens to assess WNV distribution
  - Concern for Succoth
- Emergency hotlines
- DEET cans distributed citywide
- Leaflets, Public Service Announcements distributed

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Outbreak of West Nile-Like Viral Encephalitis – New York, 1999

Reported by MDs in Flushing hospital, acute care hospitals and microbiology laboratories, Vet at Wildlife Conservation Society, NYC Outbreak Investigation Team, NYC DOH officials, Mayor’s Office of Emergency Management, Westchester and Nassau County DoHs, Dept. of Environmental Conservation, State Epidemiologists in NJ, NY State, CT, EID Lab University of CA, NVSL/APHIS/USDA, and CDC – EPO, DVRD and DVBID/NCID, and EIS Officers

FIGURE 1. Seropositive cases of West Nile-like virus, by week of onset — New York, 1999

Source: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4934a1.htm

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As of 9/28: 17 confirmed, 20 probable cases with 4 deaths
As of 10/5: 50 lab positive (27 confirmed, 23 probable), 5 deaths
- Initiated intensive retrospective case finding

CDC, State Wildlife veterinarians, other federal agencies using deaths in crows as sentinel events to define geographic distribution of mosquitoes and infected birds
- As of 10/5: 41 positive avian tissue specimens from NYC, Nassau, Suffolk, Rockland, West counties in NY, Fairfield County CT, Bergen, Union, Middlesex and Essex Counties in NJ
- Culex pools positive for WNLV by rt-PCR
53. MMWR (2)

- Cooperative federal working group formed, with state and local health departments, to define distribution of WNLV in mosquito and bird populations outside the Northeast
- CDC guidelines for enhanced human surveillance sent to state epidemiologist and lab directors
  - Includes early warning tools for surveillance in nature, such as mosquito trapping for virus isolation and avian serology (neutralizing antibodies or virus)

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54. MMWR 10/22

- Most birds have been crows but also other native species (blue jay, rock dove, sandhill crane, laughing gull, mallard, American robin, red-tailed hawk, others)
  - Extension northward and southward
- Antigenic mapping of isolates performed using E (envelope) - glycoprotein specific monoclonal antibodies, which ddx WNV, Kunjin virus, SLE

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55. MMWR 10/22

- Serum samples from resident or migrant birds will be collected from NY, NJ, MD, VA, NC, SC, GA, FL from university ornithologists, state wildlife biologists, and health departments
- Wildlife and health officials alerted to investigate reports of unusual clusters of dead birds
- Training to institute programs for arbovirus and mosquito vector surveillance will be offered to states w/o programs starting with Atlantic states
- IDSA EIN (Inf Ds Soc Am Emerg Infx Sentinel Networks) and Int'l Soc of Travel Med (GeoSentinel) assisting with case-finding

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56. MMWR, 10/22/2000: The End of the Outbreak

![Figure 1: Number of seropositive cases of West Nile virus, by week of onset — New York, 1999.](https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4641a9.htm)
57. Guidelines for Surveillance: Rationale

Guidelines for Surveillance: Rationale

- In many local and state health departments, vector-borne disease capacity has diminished.
  - Concern that disease will spread - dormant over winter
- Surveillance
  - Enhanced surveillance in states affected and those with potential to be infected (MA to TX)
  - Mosquitoes - Active surveillance in southern states throughout year, early spring in northern states
  - Wild and sentinel birds, especially crows
  - Enhanced passive veterinary surveillance for neurologic illness in animals, emphasize horses as backup outside mosquito-bird cycle
  - Enhanced passive human surveillance for viral encephalitis and aseptic meningitis

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58. Guidelines for Surveillance (2)

Guidelines for Surveillance (2)

- Lab diagnosis
  - CDC and USDA protocols and reagents, IgM and IgG ELISAs for WNV in all state public health and veterinary labs for initial testing of humans and animals
  - State health, veterinary and reference labs with BSL-3 capability should conduct neutralization test for flavivirus-specific abs
  - BSL-3 labs to isolate and identify virus
  - Other BSL-3 labs to do RT-PCR for viral RNA

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Guidelines for Surveillance (3)

- Prevention and Control
  - Mosquito abatement – larval source reduction through local programs
  - Public outreach
- Public health infrastructure
  - Trained personnel for surveillance and response, lab support
- Interjurisdictional data sharing between federal, state and local agencies including DoH, Agriculture, Wildlife
  - Secure e-mail list servers, WWW sites
- Research priorities

Guidelines for Surveillance (4)

- Find out about cases in horses too
- Identified need to enhance state and local surveillance programs for vector borne diseases
- 12/99: CDC announced avail of FY 2000 supplemental funds for cooperative WNV surveillance, prevention and control
  - 19 state and local health departments eligible
61. **WNV 2001**

![WNV 2001 Map]


62. **WNV in Horses and Birds, 2001**

![WNV in Horses and Birds, 2001 Map]

Data reported through ArboNet
January 1 – August 15, 2006
26 states – 388 cases of human illness reported to CDC
  – 56% males
  – Onset 1/1 to 8/10
  – 123 fatal
  – 68 presumptive viremic blood donors (PVD) in 2006, 10 had West Nile fever

1033 dead corvids, 199 other birds in 30 states
  – Horses in 18 states, one squirrel in KS
WNV seroconversions in 237 sentinel chicken flocks in 8 states, 5 seropositive sentinel horses in MT
3456 WNV positive mosquito pools from 30 states
65. **WNV in Mammals**

- **Birds**
  - Detected in 138 species; crows and jays can become ill and or die but most infected birds survive
  - Handle live/dead suspects with gloves
- **Dogs and cats**
  - Single report of WNV in a dog in Botswana 1982, single dead cat 1999
  - Serosurvey in NYC 1999 – dogs frequently infected w/o clinical disease
- **Horses**
  - Cases documented by virus isolation, detection of viral neutralizing antibodies
  - 40% of cases die
  - Vaccination against EEE, WEE, and VEE doesn’t protect
  - Vaccine recently licensed, effectiveness ?
- **Bats, chipmunk, skunk, squirrel and domestic rabbit**

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66. **CDC Organization with Responsibility for Arboviruses**

- **CDC**
  - Coordinating Center for Infectious Diseases
    - **National Center for Infectious Diseases**
      - Division of Vector-Borne Infectious Disease (DVBID)
      - West Nile Virus Program

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67. MDPH Organization with Responsibility for Arboviruses

MDPH Organization with
Responsibility for Arboviruses

- Department of Health and Human
  Services
  - MDPH
    - Communicable Disease Control
      - Division of Epidemiology and Immunization
        - Epidemiology Program: WNV

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68. West Nile Virus Surveillance in MA

West Nile Virus Surveillance in MA

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69. Other surveillance systems

Other surveillance systems

◆ **NEDSS** promotes use of data and information system standards to advance the development of efficient, integrated and interoperable surveillance systems at federal, state and local levels
◆ **Goal in ongoing, automatic capture and analysis of data that are available electronically**

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70. NEDSS

NEDSS

◆ **Serve needs**
  - Monitor and assess disease trends
  - Guide prevention and intervention programs
  - Inform public health policy and policy makers
  - Identify issues needing public health research
  - Provide information for community and program planning
  - Protect confidentiality while providing information to those who need to know
◆ **Integrate and replace NETSS, HIV/AIDS, vaccine-preventable diseases, TB, ID**

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71. Provider-based Sentinel Networks

- IDSA EIN (Infectious Disease Society of America Emerging Infectious Disease Network)
- EMERGEncy ID Network (EMERGE-ID)
- GeoSentinel Network

72. EIN

- CDC cooperative agreement to Infectious Disease Society of America
- 900 ID specialists worldwide
- Purpose/functions
  - Detection of new/unusual events
  - Case identification
  - Acquisition of knowledge
  - Research collaboration
  - Communication and education
73. Others

- National Antimicrobial Resistance Monitoring System (NARMS)
- FoodNet
- PulseNet
- And many more