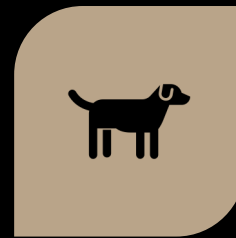# Epidemiological Surveillance of Zoonotic Diseases

MELINDA J. WILKINS, DVM, MPH, PHD

PUBLIC HEALTH VETERINARIAN

VETERINARY POPULATION MEDICINE

UNIVERSITY OF MINNESOTA

Overview

Different types of disease surveillance

Importance of quality surveillance data for evidence-based decision making

Important role of surveillance data for zoonotic disease outbreak investigations.

The necessity of coordination among human and animal regulatory agencies

Surveillance Defined

"The ongoing systematic collection, analysis, and interpretation of outcome-specific data for use in the planning, implementation, and evaluation of public health practice" (Teutsch SM and Churchill RE, 2000)

"The ongoing, systematic collection, analysis, and interpretation of health-related data essential to planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those responsible for prevention and control"

(Adapted from: Thacker SB, Birkhead GS. Surveillance. In: Gregg, MB, ed. Field epidemiology. Oxford, England: Oxford University Press; 2008.)

What is Surveillance? According to US Department of Agriculture

- For the purpose of the National Animal Health Surveillance System (NAHSS), animal health surveillance is defined as the ongoing systematic collection, collation, analysis, and interpretation of data and dissemination of information to those who need to know so that action can be taken.

Health Surveillance Keywords
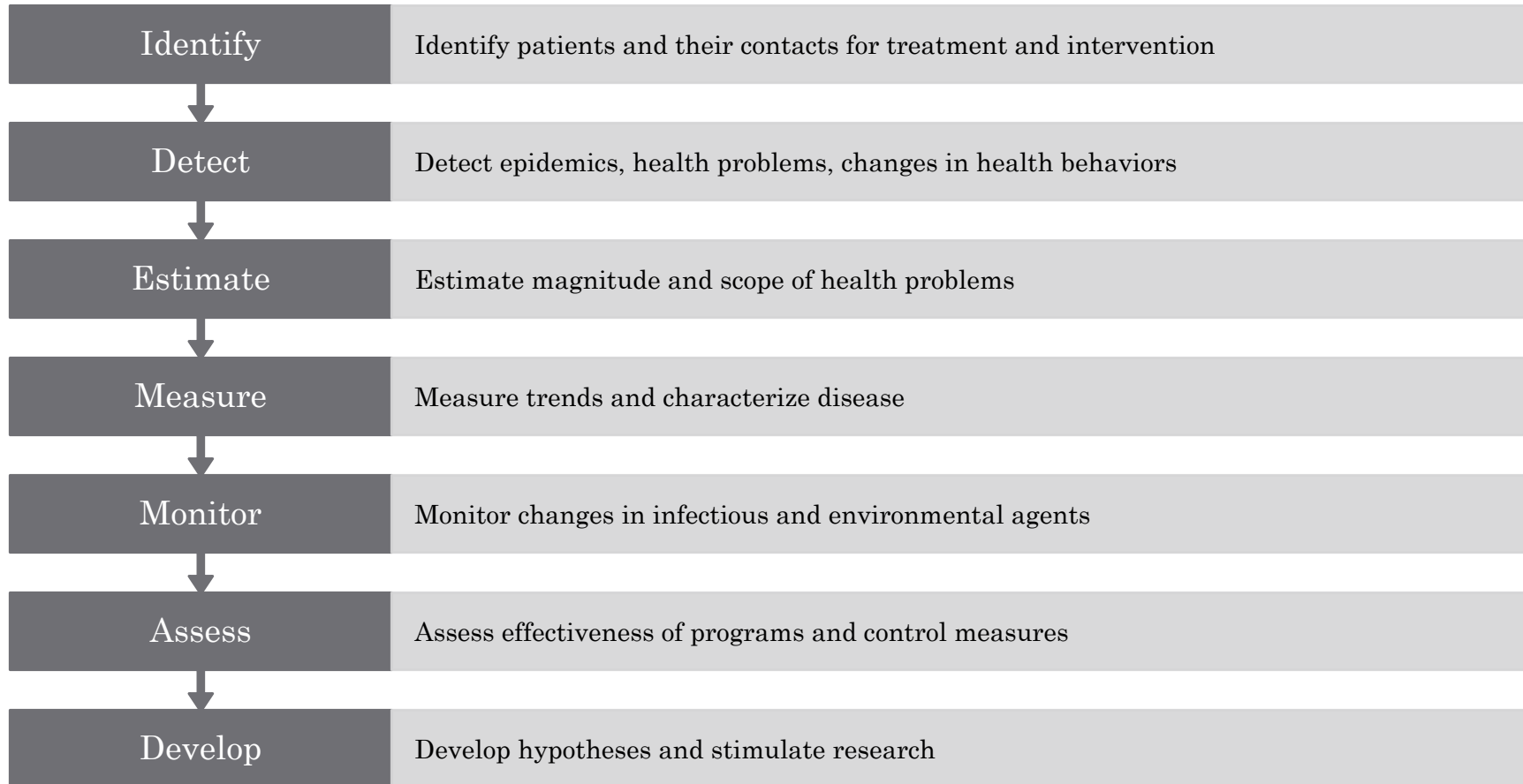
systematic

ongoing

collection

analysis

interpretation

dissemination

health-related data

linked to public health practice (or action)

https://www.cdc.gov/training/publichealth101/surveillance.html

Uses of Public Health Surveillance

Identify	Identify patients and their contacts for treatment and intervention
Detect	Detect epidemics, health problems, changes in health behaviors
Estimate	Estimate magnitude and scope of health problems
Measure	Measure trends and characterize disease
Monitor	Monitor changes in infectious and environmental agents
Assess	Assess effectiveness of programs and control measures
Develop	Develop hypotheses and stimulate research

Types of Public Health Surveillance

Passive Surveillance	Active Surveillance
• Diseases are reported by health care providers or laboratories	• Health agencies contact health providers seeking reports
• Simple and inexpensive	• Ensures more complete reporting of conditions
• Limited by incompleteness of reporting and variability of quality	• Used in conjunction with specific epidemiologic investigation
	• More expensive

Other Types of Public Health Surveillance

Sentinel Surveillance

Reporting of health events by health professionals who are selected to represent a geographic area or a specific reporting group

Can be active or passive

Syndromic Surveillance

Focuses on one or more symptoms rather than a physician-diagnosed or laboratory-confirmed disease

Examples – Harvesting chief complaint data from Emergency Departments, over-the-counter medication sales, poison control or nurse hotlines

Before you build a surveillance system, there are many steps and many things to consider…..
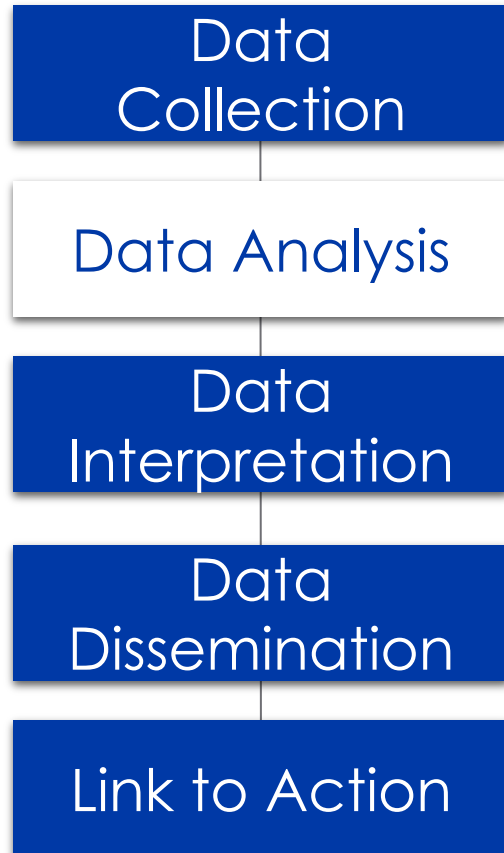
Surveillance Process

Data
Collection

Data Analysis

Data
Interpretation

Data
Dissemination

Link to Action

Before collecting data, decide
on the overarching goal
of the system

https://www.cdc.gov/training/publichealth101/surveillance.html

Surveillance Data Analysis

Data
Collection

Data Analysis

Data
Interpretation

Data
Dissemination

Link to Action

- Who will analyze the data?
- What methodology will they use?
- How often will they analyze the data?

https://www.cdc.gov/training/publichealth101/surveillance.html

Surveillance Data Interpretation

Data
Collection

Data Analysis

Data
Interpretation

Data
Dissemination

Link to Action
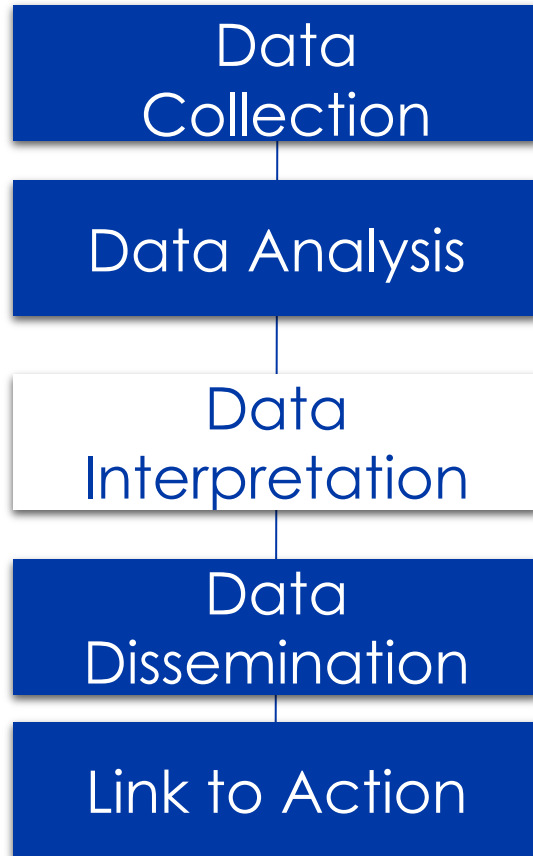
Data interpretation is closely
coupled with data analysis

https://www.cdc.gov/training/publichealth101/surveillance.html

Data Dissemination

Data Collection
Data Analysis
Data Interpretation
Data Dissemination
Link to Action
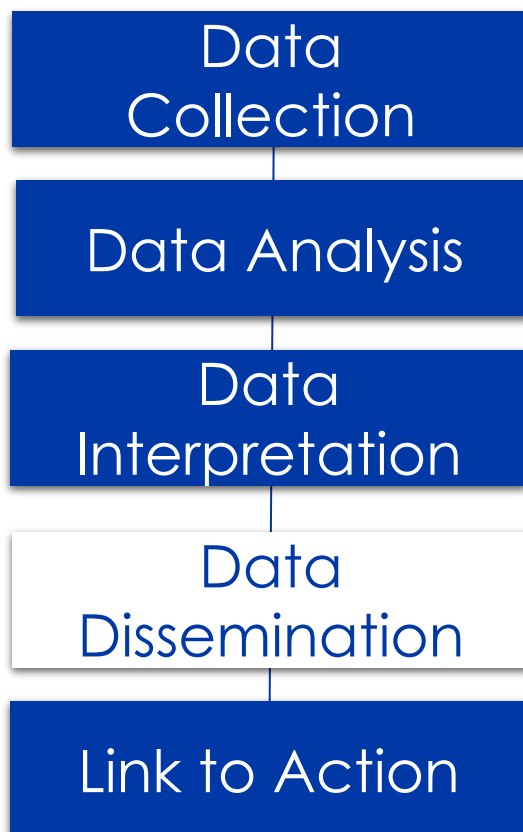
- Health agency newsletters, bulletins, or alerts

- Surveillance summaries and reports

- Medical and epidemiologic journal articles
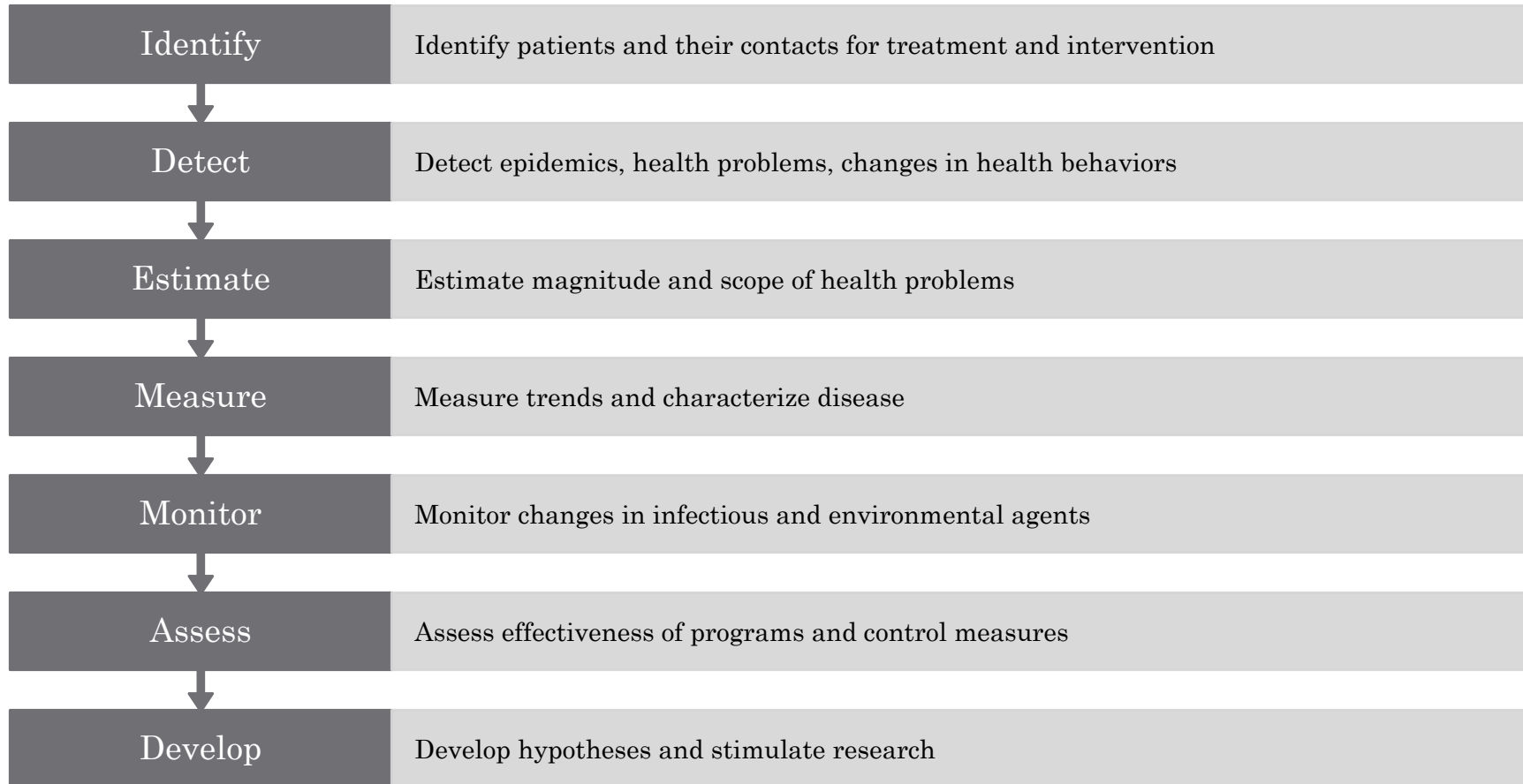
- Press releases and social media

13

https://www.cdc.gov/training/publichealth101/surveillance.html

Surveillance Link to Action

Data
Collection

Data Analysis

Data
Interpretation

Data
Dissemination

Link to Action

Public health surveillance should always have a
link to action

https://www.cdc.gov/training/publichealth101/surveillance.html

Uses of Public Health Surveillance

Identify	Identify patients and their contacts for treatment and intervention
Detect	Detect epidemics, health problems, changes in health behaviors
Estimate	Estimate magnitude and scope of health problems
Measure	Measure trends and characterize disease
Monitor	Monitor changes in infectious and environmental agents
Assess	Assess effectiveness of programs and control measures
Develop	Develop hypotheses and stimulate research

How do you know if a surveillance system is working and effective?

- You evaluate it!

- Updated Guidelines for Evaluating Public Health Surveillance Systems - provided by CDC/Working Group Link

- 10 Main attributes

- Relate back to the original goal

- Is it worth the resources?

Surveillance System Attributes

Attribute	Question It Answers
Usefulness	How useful is the system in accomplishing its objectives?
Data quality	How reliable are the available data? How complete and accurate are data fields in the reports received by the system?
Timeliness	How quickly are reports received?
Flexibility	How quickly can the system adapt to changes?
Simplicity	How easy is the system's operation?

Surveillance System Attributes

Attribute	Question It Answers
Stability	Does the surveillance system work well? Does it break down often?
Sensitivity	How well does it capture the intended cases?
Predictive value positive	How many of the reported cases meet the case definition?
Representativeness	How good is the system at representing the population under surveillance?
Acceptability	How easy is the system's operation?

Goals of Health Surveillance

Public Health

- Provide information that can be used for health action by public health personnel, government leaders, and the public to guide public health policy and programs.

Animal Health

- The purposes of surveillance are rapid detection of introduced diseases and emerging issues, monitoring and providing actionable information for endemic diseases, and measuring regional prevalence of trade-significant diseases.

Smith PF, Hadler JL, Stanbury M, et al. Blueprint version 2.0: updating public health surveillance for the 21st century. J Public Health Manag Pract 2013;19:231–9.

Importance of Quality Surveillance Data

Garbage In → [Surveillance System] → Garbage Out

Surveillance System

Roadmap of Epidemiologic Reasoning
"The Big Picture"

You are here!

Frequency
(What is going on?)

Distribution
(Who, where, when?)

Determinants
(Why?)

Evaluate for Validity
(Is there a significant association?)

Evaluate for causal relationship
(Is there a cause and effect relationship?)

Yes

Yes

GOAL
Intervention
and/or
Prevention

Descriptive Epi (Hypothesis Generation)	Analytic Epi (Hypothesis Testing)	Analytic Epi Evaluate Validity	Assess for Causal Relationship:
Study types Correlational/ ecologic Case study/series Cross sectional	**Study types** Case control Cohort Experimental	**Assess role of:** Chance Bias Confounding Effect modification	Statistical assoc. Biologic plausibility Temporal association Consistency of findings Dose-response relationship

Bedrock - Surveillance

Note: you do not have to go through every step before you can begin intervention but this graphic provides a general overview of the "big picture" of epidemiologic reasoning – M. Wilkins
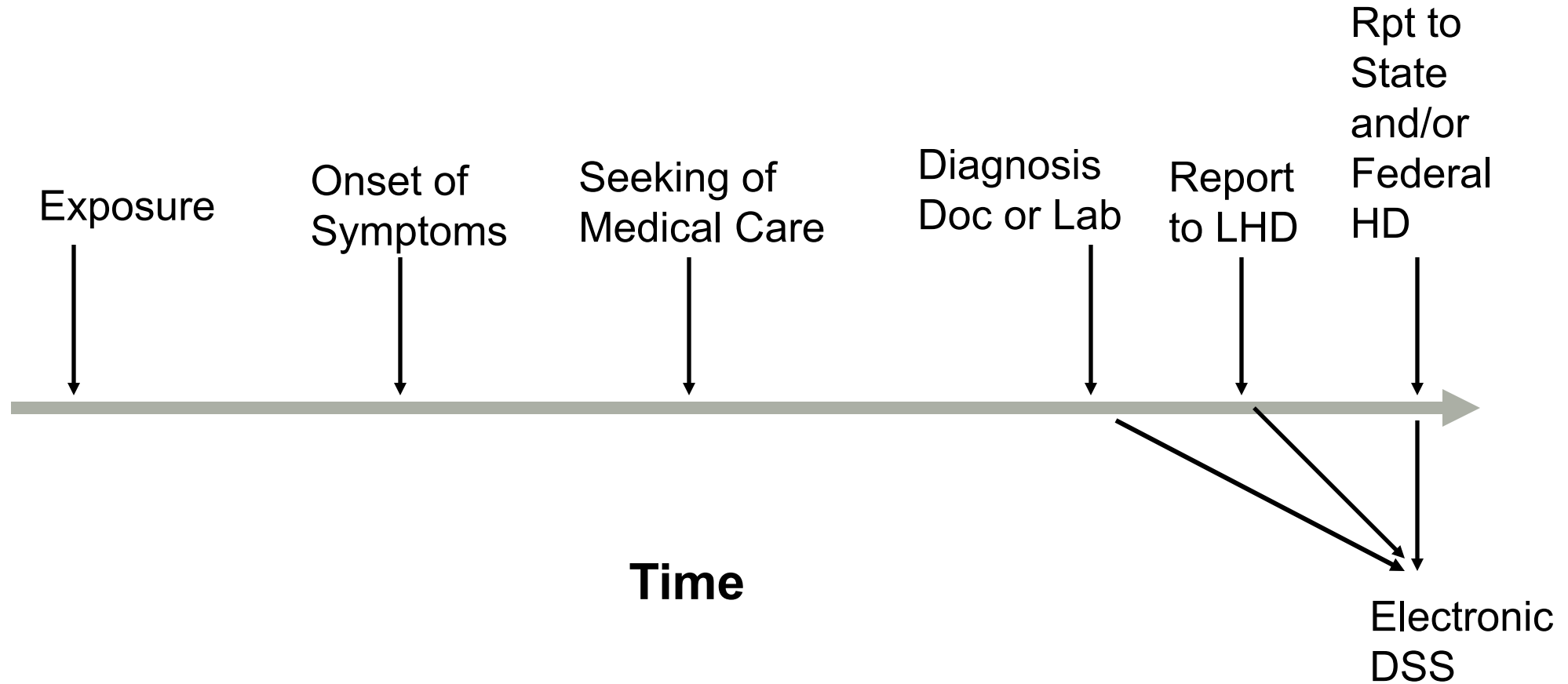
<--------------------------Tool - Biostatistics------------------ >

Cases reported to public health surveillance

~5 to 20% of all cases (depending on severity of illness) actually end up in the reporting system

Laboratory confirmed case

Laboratory tests for pathogen

Specimen obtained

Person seeks medical care

Person becomes ill
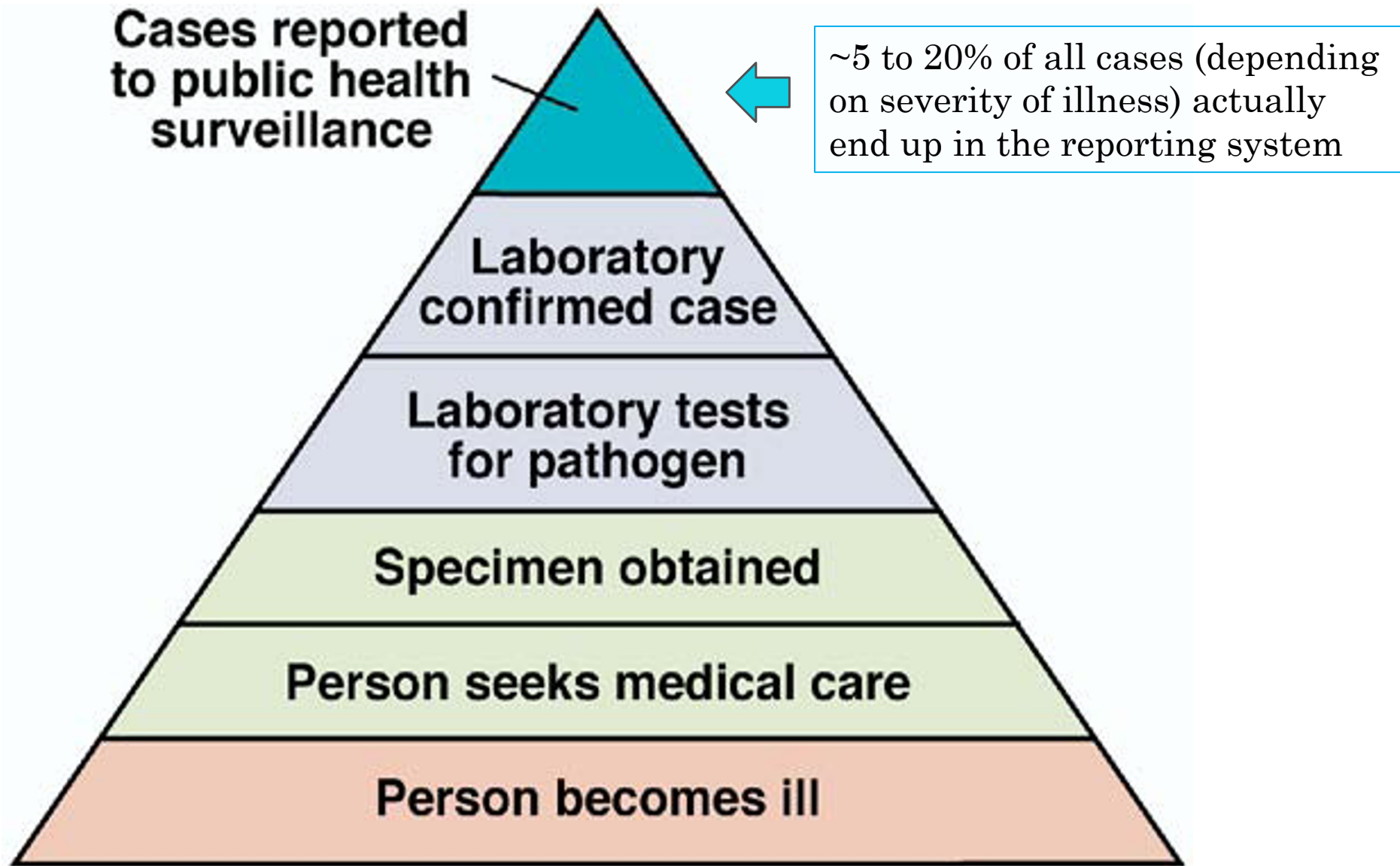
Source: adapted from CDC, http://www.cdc.gov/foodnet/surveillance_pages/burden_pyramid.htm, accessed Sept 4, 2008

Exposure/Disease Detection Timeline

Exposure

Onset of Symptoms

Seeking of Medical Care

Diagnosis Doc or Lab

Cases reported to public health surveillance

Person becomes ill

Person seeks medical care

Specimen obtained

Laboratory tests for pathogen

Laboratory confirmed case

Report to Local HD

Report to State and/or Federal HD

Time

Exposure/Disease Detection Timeline

Exposure

Onset of Symptoms

Seeking of Medical Care

Diagnosis Doc or Lab

Report to LHD

Rpt to State and/or Federal HD

Time

Electronic DSS

Salmonella for example - Can take 2-4 weeks from exposure to reporting to State Health Department

Disease Surveillance – Reasons to Report

- To identify outbreaks and epidemics.
- To enable provision of preventive treatment and/or education.
- To help target prevention programs, identify care needs and use scarce prevention resources efficiently.
- To evaluate the success of long-term control efforts.
- To facilitate epidemiologic research to uncover a preventable cause.
- To assist with national and international disease surveillance efforts.
- Mandated by Law (in some countries)
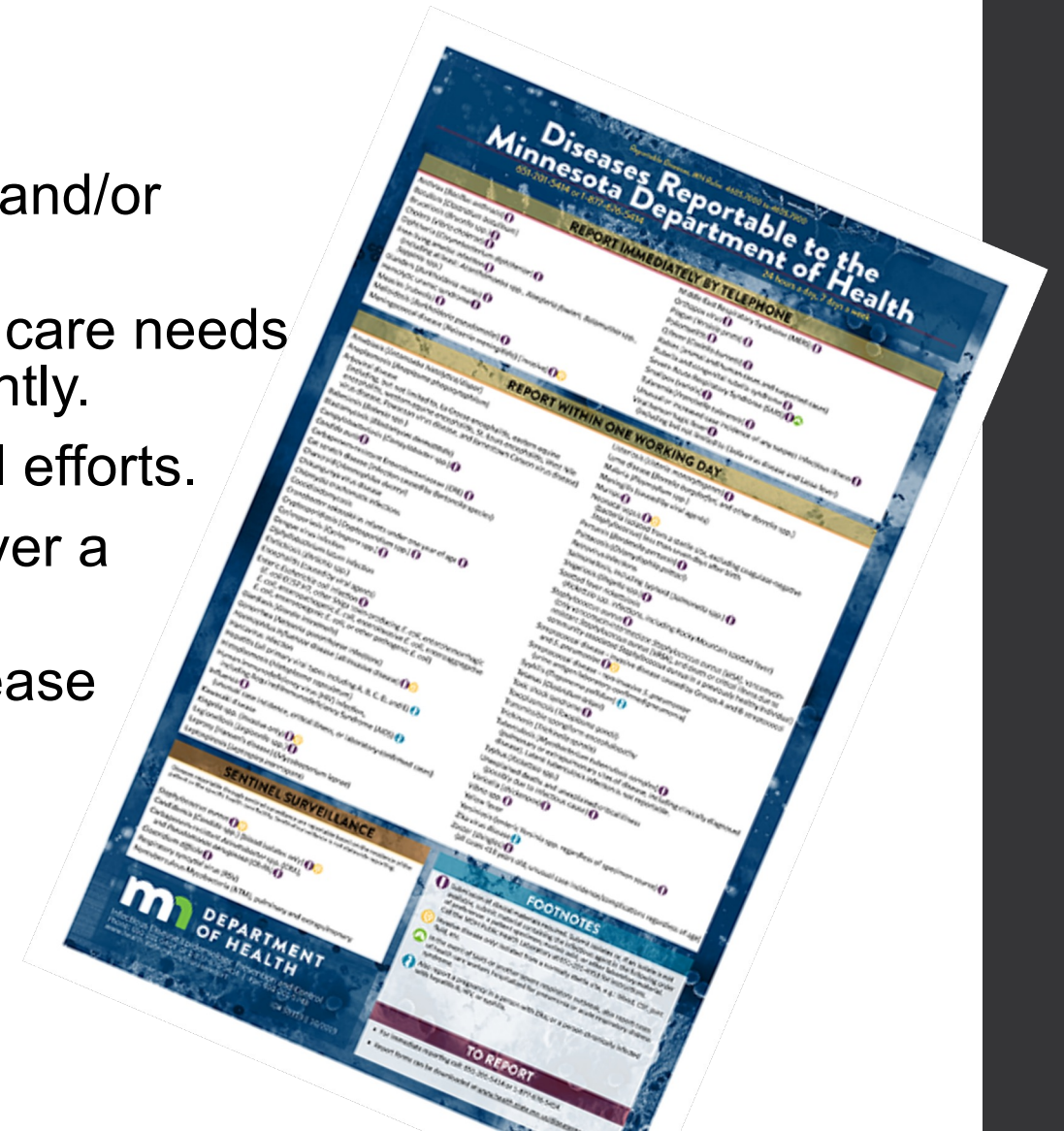
What Diseases to include in your Human Health Surveillance Systems?

· Disease of International concern (International Health Regulations, WHO)

· Diseases of National, Regional, Local Public Health concern
  · Nationally notifiable disease list (minimum)
  · Each state has its own list of reportable diseases (includes nationally notifiable diseases plus whatever that state wishes to add)

· Who has Disease X?
  · Person, place and time (descriptive epidemiology)
  · How are they getting it? (transmission pathways)
  · What is the source?
  · What is the trend (incidence/prevalence going up or down over time)?

  How can we intervene (interrupt transmission)?
      · Food or product recall
      · Vaccination campaign
      · Health education
      · Etc.

What Diseases to include in your Animal Health Surveillance Systems?

- Disease of International concern (Codex Alimentarius, WOAH)

- Diseases of National, Regional, Local Animal Health concern
  - Nationally notifiable disease list (minimum)
  - More limited diagnostic capability, fewer animal health laboratories
  - More limited funding in general

- Different objectives, both <u>Health AND Economic</u> issues
  - Productivity - diseases of producer or industry concern
  - Animal movement restrictions – Departments/Ministry if Agriculture or Livestock, trading partners
  - Product movement restrictions – Codex Alimentarius

About Animals....

Objectives of Animal Health Surveillance

To answer questions about presence of disease

- Do we have X disease?
- In what species do we have X disease?
- Where do we have X disease?
- How much disease X do we have? (prevalence)
- Economic impact (producer or national level)

To prove freedom from certain diseases

- Different methods and techniques used
- More difficult
- Required for export to disease-free trading partners

Animal Health Surveillance in the US

- A comprehensive, coordinated, integrated surveillance system is the foundation for animal health, public health, food safety, and environmental health.

- Animal health surveillance is designed to detect threats to animal health in a timely manner. The U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Veterinary Services (VS) works with a vast network of partners to carry out surveillance activities in the United States.

- Together, these partners work to <u>protect animal health, national economic viability, and the food supply.</u>

- In addition, these surveillance programs and efforts assure international trading partners of the health of the Nation's herd and safety of our livestock and livestock products. Our national surveillance system also provides the tools necessary to detect chemical or environmental agents that could affect animal health.

- https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/monitoring-and-surveillance/sa_nahss/animal-health-monitoring-and-surveillance

USDA Species Specific Programs (not all are zoonotic)

https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/monitoring-and-surveillance/SA_NAHSS

Animal Surveillance Resources

- National Animal Health Surveillance System

- National Animal Health Monitoring System
  - The National Animal Health Monitoring System (NAHMS) Unit conducts national studies on the health and health management of United States domestic livestock, equine, aquaculture and poultry populations.

- National Animal Health Laboratory Network
  - The National Animal Health Laboratory Network (NAHLN) is a network of animal disease diagnostic laboratories that provides ongoing disease surveillance, responds quickly to disease events, communicates diagnostic outcomes to decision makers, and has the capability and capacity to meet diagnostic needs during animal disease outbreaks.

- WOAH – International Standard Setting Activities
  - Successful movement and trade of U.S. animals and animal products within the global marketplace requires participation in the activities of the World Organisation for Animal Health (WOAH – founded as OIE).

https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/monitoring-and-surveillance/nahms
https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/monitoring-and-surveillance/SA_NAHSS
https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/lab-info-services/nahln/nahln
https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/export/international-standard-setting-activities-oie/regionalization/woah

State Level Reporting

- List will vary by state (https://www.bah.state.mn.us/reportable-diseases/)

- May be organized by condition or by species

- No local level organization equivalent to a local health department

One Health When is Surveillance Information Sharing Critical?

Always Zoonotic Disease!

Specifically

- Foodborne Illness/Outbreaks of animal origin
  - Salmonella
  - E. coli
  - Campylobacter

- Common exposure for both humans and animals?
  - Aflatoxin
  - Water source
  - Common ingredient in human and animal food?

- Multiple contributors to the problem
  - Antimicrobial resistance

- Can animals be sentinels for human illness?
  - Avian Influenza
  - Coronaviruses

Tripartite and UNEP support OHHLEP's definition of "One Health"
Joint Tripartite (FAO, OIE, WHO) and UNEP Statement
1 December 2021 Joint News Release

The Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE), the United Nations Environment Programme (UNEP) and the World Health Organization (WHO) welcome the newly formed operational definition of One Health from their advisory panel, the One Health High Level Expert Panel (OHHLEP), whose members represent a broad range of disciplines in science and policy-related sectors relevant to One Health from around the world.

The four organizations are working together to mainstream One Health so that they are better prepared to prevent, predict, detect, and respond to global health threats and promote sustainable development.

UN One Health Link

The One Health definition developed by the OHHLEP (One Health High Level Expert Panel) states:

- ***One Health*** *is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems.*

- *It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent.*

- *The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development.*

SECTORS and DISCIPLINES

ENVIRONMENT

HUMAN

ANIMAL

Communication

Collaboration

Coordination

Capacity building

ONE HEALTH

Healthy ecosystems

Healthy animals

Healthy humans

SOCIETY

Rural, urban, mobile communities

Local and national

Inclusivity, equity and access

Regional and global
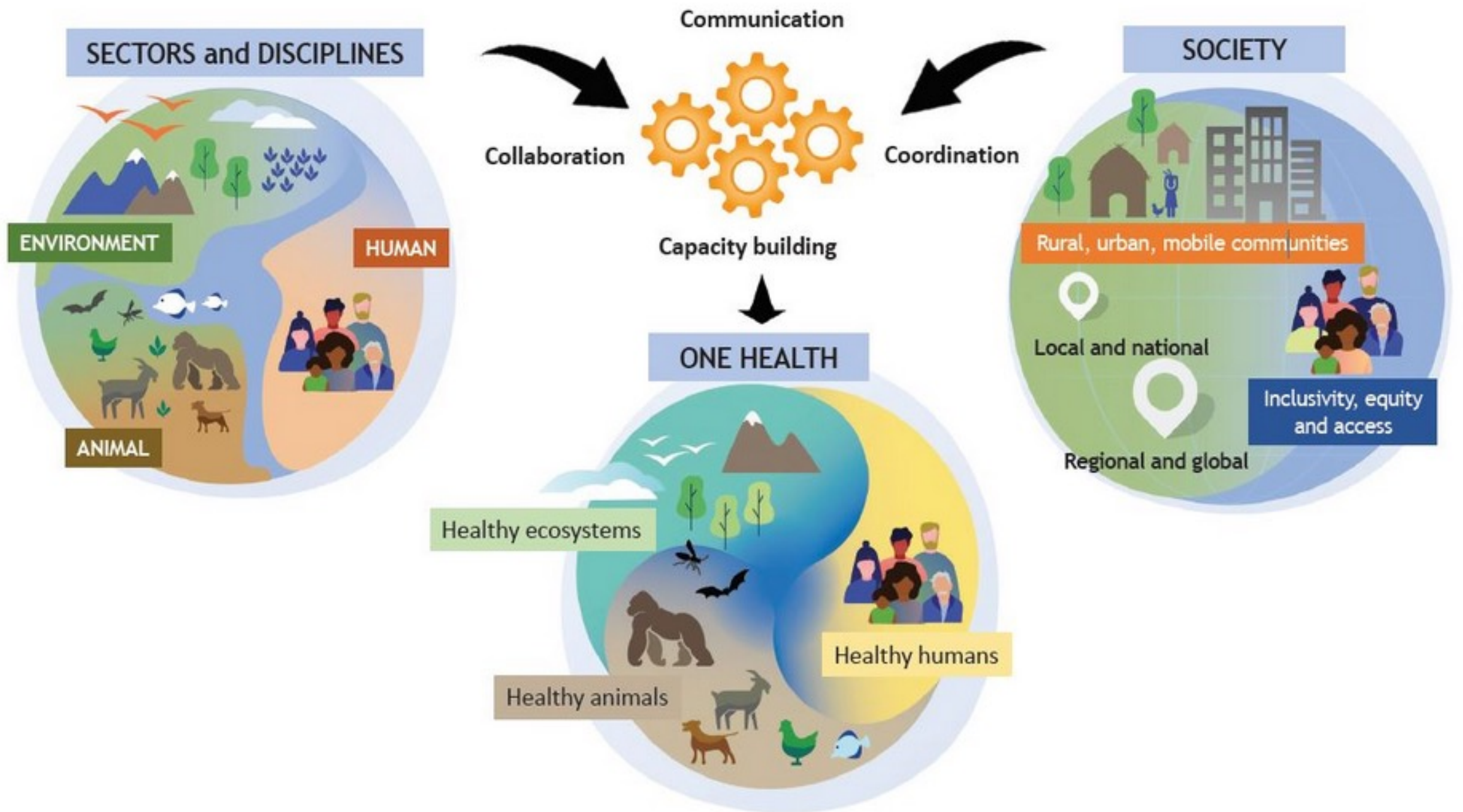
Emerging Zoonotic Disease (need for collaboration)

- Up to 75% of emerging infectious disease in humans are zoonotic, impacting the health of both humans and animals.

- Over the past two decades, we have experienced devastating outbreaks caused by these diseases including West Nile virus, H1N1 influenza, and Ebola virus.

- Early detection and response to pathogens with zoonotic potential while still in animals is essential in limiting or preventing human outbreaks. (The use of animals as sentinels)

- APHIS' American Rescue Plan (ARP) Surveillance Program: Strategic Framework

Critical Gaps Identified, 2016

In 2016, the United States completed an external review of our national capacity to rapidly identify and respond to emerging zoonoses and other human health threats using a multisectoral, One Health approach.
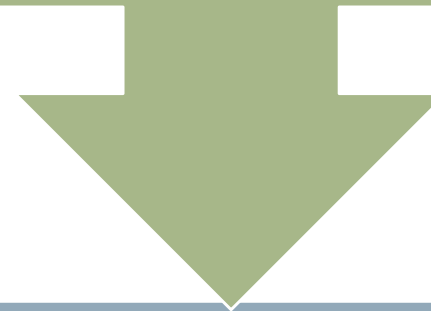
Critical gaps identified included:

Lack of surveillance tools and strategies for the rapid detection, and characterization of emerging and re-emerging pathogens at the human-animal-environment interfaces;

Inconsistent linkages between human and animal surveillance, and laboratory systems;

Challenges with data collection, exchange, analysis, and reporting.

One Health Zoonotic Disease Prioritization Workshop 2017

- The U.S. Department of Agriculture partnered with the Centers for Disease Control and Prevention (CDC) and the U.S. Department of the Interior (DOI) to organize a One Health Zoonotic Disease Prioritization Workshop to identify the zoonotic diseases of greatest national concern that should be jointly addressed.

- Notably, emerging coronaviruses, which includes SARS-CoV-2, were fifth on the list.

- Sometime during 2019, SARS-CoV-2 became the next emerging zoonotic disease that was detected only after it was well established in humans.

- Public health authorities were left with extremely limited and largely ineffective options for controlling spread and preventing the COVID-19 pandemic.

American Rescue Plan Act

Congress provided USDA $300 million through the American Rescue Plan (ARP) Act to conduct monitoring and surveillance of susceptible animals for SARS-CoV-2, addressing the long-standing need to strengthen our ability for early detection of emerging and zoonotic diseases in animals.

We developed this Strategic Framework to build One Health capacity and improve the country's ability to prevent, detect, report, and respond to SARS-CoV-2, including potential emerging variants.

PREVENT	DETECT	INVESTIGATE and CONTROL SPREAD	OUTREACH and EDUCATION
• Improve national, regional and global collaboration to build additional capacity in One Health and multidisciplinary surveillance and control measures to help the United States safeguard against the entry of diseases in the first place • Support and contribute to global surveillance and early warning systems that generate and share data and information to improve prevention, detection and control • Strengthen early warning system capacity to identify new emerging threats to prevent future pandemics • Prioritize research and capacity-building measures to address gaps in prevention • Work with One Health partners to identify risks and plan effective interventions to prevent transmission at the human-animal interface and/or impacts to the food supply	• Partner with Agricultural Research Service, Federal, academic and industry partners to identify and prioritize research needs, including improving how we find new cases and susceptible animals sooner • Work with One Health partners to strengthen surveillance tools and strategies for rapid detection and characterization of SARS-CoV-2 and emerging variants • Strengthen diagnostic laboratory capability and capacity, methods, and reporting for early detection of emerging pathogens and variants in animals • Advance data management reporting capabilities, including exchange and integration of critical information needed to protect both human and animal health	• Strengthen and standardize multisectoral and multiagency field epidemiology capacity, including investigation of new detections of SARS-CoV-2 or emerging variants to guide immediate control efforts to prevent further transmission • Engage One Health partners to use surveillance data to plan and evaluate interventions and programs to minimize the risk to human health, animal health, and the food supply • Ensure that the National Veterinary Stockpile has supplies and equipment needed to protect investigation teams from risk of zoonotic transmission and potential spillover events • Partner with CDC on One Health workforce development and training opportunities to build a skilled cadre of professionals to manage and lead activites in all focal areas	• Extensive communication and outreach to diverse and historically underserved populations, including tribal, minority and underserved farmers, ranchers, and communities to identify and address potential gaps in Strategic Framework • Strengthen coordinated messaging efforts to ensure dissemination of accurate and timely messages to the public to help prevent disease. • Expand partnerships with academia, industry and non-governmental entities to broaden reach of science-based and data-driven communication efforts

Cross-Cutting Activities

- Research to Address Knowledge Gaps
- Leverage Technology and Information Management
- Communication
- Develop data and information sharing systems with One Health partners
- Monitoring and Evaluation

PREVENT	DETECT	INVESTIGATE and CONTROL SPREAD	OUTREACH and EDUCATION
• Improve national, regional and global collaboration to build additional capacity in One Health and multidisciplinary surveillance and control measures to help the United States safeguard against the entry of diseases in the first place • Support and contribute to global surveillance and early warning systems that generate and share data and information to improve prevention, detection and control • Strengthen early warning system capacity to identify new emerging threats to prevent future pandemics • Prioritize research and capacity-building measures to address gaps in prevention • Work with One Health partners to identify risks and plan effective interventions to prevent transmission at the human-animal interface and/or impacts to the food supply	• Partner with Agricultural Research Service, Federal, academic and industry partners to identify and prioritize research needs, including improving how we find new cases and susceptible animals sooner • Work with One Health partners to strengthen surveillance tools and strategies for rapid detection and characterization of SARS-CoV-2 and emerging variants • Strengthen diagnostic laboratory capability and capacity, methods, and reporting for early detection of emerging pathogens and variants in animals • Advance data management reporting capabilities, including exchange and integration of critical information needed to protect both human and animal health	• Strengthen and standardize multisectoral and multiagency field epidemiology capacity, including investigation of new detections of SARS-CoV-2 or emerging variants to guide immediate control efforts to prevent further transmission • Engage One Health partners to use surveillance data to plan and evaluate interventions and programs to minimize the risk to human health, animal health, and the food supply • Ensure that the National Veterinary Stockpile has supplies and equipment needed to protect investigation teams from risk of zoonotic transmission and potential spillover events • Partner with CDC on One Health workforce development and training opportunities to build a skilled cadre of professionals to manage and lead activites in all focal areas	• Extensive communication and outreach to diverse and historically underserved populations, including tribal, minority and underserved farmers, ranchers, and communities to identify and address potential gaps in Strategic Framework • Strengthen coordinated messaging efforts to ensure dissemination of accurate and timely messages to the public to help prevent disease. • Expand partnerships with academia, industry and non-governmental entities to broaden reach of science-based and data-driven communication efforts

Cross-Cutting Activities

- Research to Address Knowledge Gaps
- Leverage Technology and Information Management
- Communication
- Develop data and information sharing systems with One Health partners
- Monitoring and Evaluation

Challenge: Where can you create links between human and animal health surveillance systems?

- Data Collection
- Data Analysis
- Data Interpretation
- Data Dissemination
- Link to Action

Ability to create linkages will be context specific:

- Can laboratories share information with other labs?
- Can human health care providers share information with veterinarians?
- Can Ministry of Health and Ministry of Livestock (or Agriculture) share information?

Ability to share information will depend on your on local and national regulations.

You can become an advocate!

44

https://www.cdc.gov/training/publichealth101/surveillance.html

"The reason for collecting, analyzing, and disseminating information on a disease is to control that disease. Collection and analysis should not be allowed to consume resources if action does not follow."

—William Foege, 1976

Photo: Kay Hinton, Emory University

Foege WH, Hogan RC, Newton LH. Surveillance projects for selected diseases. Int J Epidemiol 1976;5:29–37.

Questions?

Melinda Wilkins

Email: wilki510@umn.edu

Thank You!