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**Surveillance,
Epidemiology,
and Tracing**
Epidemiology Part 1:
Principles of Epidemiology
Adapted from the FAD PReP/NAHEMS Guidelines:
Surveillance, Epidemiology, and Tracing (2014).

An animal health emergency could have a detrimental effect on the nation's agriculture, food supply, and economy. Veterinary responders, animal health technicians, and other trained personnel may assist with surveillance, epidemiology, and tracing activities. In order to perform these job duties, a broad understanding of surveillance and epidemiological concepts is required. This presentation reviews the principles of epidemiology. [This information was derived from the *Foreign Animal Disease Preparedness and Response (FAD PReP)/National Animal Health Emergency Management System (NAHEMS) Guidelines: Surveillance, Epidemiology, and Tracing (2014)*.]

S | **This Presentation**
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- Introduction to epidemiology
- Overview of disease characteristics
- Disease occurrence
- Understanding data and measures of disease

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This presentation provides an introduction to epidemiology activities during a foreign animal disease (FAD) outbreak. It defines disease characteristics and occurrence as it applies to epidemiology. An overview of measuring disease in a population based on understanding collected data is discussed.

S | **What is Epidemiology?**
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- Study of disease in populations and factors that determine the occurrence of disease

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Epidemiology is the study of disease in populations and the factors that determine the occurrence of disease. This presentation focuses on animal health emergencies, such as foreign animal disease (FAD) outbreaks.

S | **Functions of Epidemiology**
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Epidemiology has four core functions: surveillance, field investigation, analytic studies, and evaluation.

S i d e 5	Core Functions
	<ul style="list-style-type: none">• Surveillance<ul style="list-style-type: none">– Ongoing data collection, analysis, interpretation, and dissemination– Used to determine specific actions for FAD mitigation• Field investigation<ul style="list-style-type: none">– Used to collect additional information about cases identified via surveillance<ul style="list-style-type: none">• Disease source, history of disease, etc.

Surveillance involves ongoing collection, analysis, interpretation, and dissemination of data related to disease. This data is used to determine specific actions for FAD mitigation (e.g., quarantine, vaccination, depopulation, etc.). Surveillance is conducted to monitor a population for the presence, or absence, of disease. Surveillance provides information for action. In an FAD outbreak, surveillance will be used to detect cases or clusters of disease cases in the field. Epidemiologists will then collect additional information regarding the disease outbreak. This may include identifying the disease source, determining if other animals have been exposed, and learning more about the history of disease.

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S i d e 6	Core Functions (cont'd)
	<ul style="list-style-type: none">• Analytic studies<ul style="list-style-type: none">– Utilizes information gleaned from surveillance activities and field investigations– Disease rates and risk factors• Evaluation<ul style="list-style-type: none">– Effectiveness– Efficacy– Impact of activities

In an FAD response, information gleaned from surveillance activities and field investigations will be used in analytic studies. Disease rates will be calculated, and parts of the animal population that may be at higher risk than others will be described. This information will aid in identification of risk factors for disease, and determination of the source of disease. Many epidemiologic studies will require advanced analytic techniques. In an FAD response, strategies to contain, control, and/or eradicate a contagious FAD must be constantly evaluated to ensure that appropriate actions are undertaken. Evaluation is the process of determining the effectiveness, efficiency, and impact of activities with respect to established goals.

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S i d e 7	Disease Characteristics

In an FAD outbreak, information collected via surveillance will be utilized by epidemiologists in a number of ways. One of the first tasks of epidemiologists is to describe the characteristics of disease. In some instances, such as a novel FAD outbreak, limited information may be available. Characteristics of disease include the history/spectrum of disease and disease transmission mode(s).

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S i d e 8	Natural History of Disease
	<ul style="list-style-type: none">• Course of disease progression<ul style="list-style-type: none">– Pathogen exposure– Subclinical illness– Onset of clinical signs– Recovery, disability, or death

For most infectious diseases, the course of disease progression is predictable (when treatment does not occur). However, for emerging diseases, such information may not be known. Described as the natural history of disease, the process begins with exposure to a pathogen. The onset of clinical signs marks the transition from subclinical to clinical disease. Most diagnoses are made during the stage of clinical disease. In some animals, disease does not progress to clinically apparent illness (known as subclinical disease); animals may be infectious nonetheless. These animals are known as carriers. Ultimately, the disease process ends either in recovery, disability, or death.

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Transmission Modes

- Many ways to transmit disease
 - Direct transmission
 - Indirect transmission
- Zoonotic diseases
 - Diseases transmissible between animals and humans
 - May be transmitted directly or indirectly

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Every pathogen lives, grows, and multiplies in a particular environment known as the reservoir. Humans, animals, and the physical environment can all be reservoirs. The reservoir is often, but not always, the source of infection. Diseases can be transmitted many different ways. Modes of pathogen transmission must be understood when conducting an epidemiological investigation. Generally, transmission may be classified as direct or indirect. Zoonoses or zoonotic diseases are diseases transmissible between animals and humans and may be transmitted directly or indirectly. *[Illustrations of examples of the direct and indirect modes of disease transmission. Illustration by: Andrew Kingsbury, Iowa State University]*

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Disease Occurrence

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Another important task of epidemiologists is to describe disease occurrence. This includes the level (or amount) of disease occurring in an area and the factors that work together to cause disease.

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Levels of Disease

- Endemic
 - Disease present in population or geographical area at all times
- Outbreak
 - Occurrence of more cases of disease than expected
 - Given area/group, specific time period
 - May be used interchangeably with the term "epidemic"

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Epidemiologists must understand the amount of disease that occurs before, and during, an FAD event. The following terms are used to describe amounts of disease in a population or area:

- Endemic: present in a population or geographical area at all times
- Outbreak: the occurrence of more cases of disease than expected in a given area, or among a specific group, over a particular time period (many epidemiologists use the terms outbreak and epidemic interchangeably)

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Levels of Disease (cont'd)

- Pandemic
 - An outbreak/epidemic that has spread over several countries

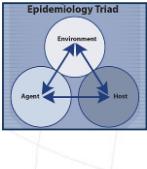
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A pandemic is an outbreak/epidemic that has spread over several countries or continents.

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Causation

- Environment
 - Husbandry, housing, climate/season, presence of vectors
- Agent
 - Host range, environmental resistance, tissue affinity, dose, mode of transmission
- Host
 - Species, breed, age, nutritional and immune status



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Agent, host, and environmental factors interrelate in a variety of complex ways to produce disease. A critical concept in epidemiology is that disease does not occur randomly in a population. The interaction of these three factors explains why some animals are more susceptible to disease than others. It is more likely to occur in some members of the population than others because of risk factors that may not be distributed randomly in the population. Risk factors may be related to the agent, host, or environment. [This illustration depicts the Epidemiology Triad and the interaction of environment, agent, and host. Illustration by: Bridget Wedemeier, Iowa State University]

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Risk Factors

- A characteristic that is associated with an increase in the occurrence of a particular disease
- May include:
 - Age
 - Species
 - Location
 - Contact

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The presence of risk factors may make disease more likely to occur in some members of a population than in others. Risk factors related to the agent, host, or environment can include age, species, geographic location, and contact with other animals or fomites. Epidemiologists study the presence and/or absence of risk factors in diseased and non-diseased animals in order to gain a better understanding of an FAD agent.

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Understanding Data and Measures of Disease

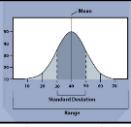
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Data are facts such as observations, clinical signs, and laboratory test results that are collected for the purpose of gaining information. Groups of data that are collected are known as data sets. Data may be qualitative or quantitative in nature. Qualitative data are non-measurable and include characteristics such as breed or sex. Quantitative data are numeric and describe amounts such as temperature or weight. There are also various measures of disease in a population which will give you a better understanding of the disease within a population. Different measures of disease in a population include; prevalence, incidence, mortality rate, and case fatality rate. Let's take a closer look at different data measurements and different measures of disease.

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Descriptive Statistics

- Measures of central tendency
 - Mean, median, and mode
- Range
 - Difference between largest and smallest value
- Standard deviation
 - Spread around mean value of data set



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Quantitative data are often summarized using descriptive statistics. **Measures of central tendency** (mean, median, and mode) are used to describe the central value of a data set. **Range** refers to the spread, or width, of a data set and describes the difference between the largest and smallest value in a data set. **Standard deviation** describes the amount of spread around the mean value in the data set. [This graph shows an example of mean, range and standard deviation. Illustration by: Katlyn Harvey, Iowa State University]

S i d e 1 7	Confidence Interval
	<ul style="list-style-type: none"> Represents range within which the true value lies Calculated based on a percentage – 95% commonly used 95% confidence interval <ul style="list-style-type: none"> True value falls within the given range 95 percent of the time

For many statistical measures, epidemiologists calculate a corresponding **confidence interval**. The confidence interval represents the range within which the true value lies. Confidence intervals are calculated based on a percentage; 95 percent is commonly used. A 95 percent confidence interval means that the true value falls within the given range 95 percent of the time.

S i d e 1 8	Measures of Disease
	<ul style="list-style-type: none"> Prevalence <ul style="list-style-type: none"> Total number of cases of a disease in a given population at a specific time Incidence <ul style="list-style-type: none"> Number of new cases of disease in a defined population over a specific time period

Epidemiologists use more complex statistics to describe disease in a population. Among these, **prevalence**, **incidence**, **mortality rate**, and **case-fatality** rate are frequently used. **Prevalence:** the total number of cases of a disease in a given population at a specific time (a “snapshot” in time). There is no distinction between old and new cases, so prevalence reflects only the presence of disease. As an example, Green Acres Dairy has 100 cows. The first disease case was reported on March 1. On March 14, 25 of the 100 cows showed signs of the FAD. The prevalence of the FAD at Green Acres Dairy on that date is 25/100 or 25 percent. **Incidence:** the number of **new cases** of disease in a defined population **over a specific time period** divided by the total number in the given population in which the cases occurred. For the week of March 7, Green Acres Dairy reported 10 new cases of the FAD. The incidence of the FAD for that period was 10/100 or 10 percent.

S i d e 1 9	Measures of Disease (cont'd)
	<ul style="list-style-type: none"> Mortality rate <ul style="list-style-type: none"> Number of deaths in a defined population during a specific time period Case fatality rate <ul style="list-style-type: none"> Percentage of animals diagnosed with a specific disease who die as a result of the disease within a specified period of time

Mortality rate: the number of deaths in a defined population during a specific time period. As in our example, during the week of March 7, two cows at Green Acres Dairy died. The mortality rate was 2/100 or 2 percent. **Case fatality rate:** the percentage of animals diagnosed with a specific disease that die as a result of the disease within a specified period of time. Of 35 cows infected with the FAD at Green Acres Dairy during the outbreak, 7 died. The case fatality rate is 7/35 or 20 percent.

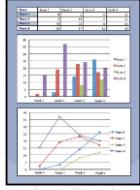
S i d e 2 0	Measures of Association
	<ul style="list-style-type: none"> Examines the differences in occurrence of disease in different segments of the population <ul style="list-style-type: none"> Factors that might influence disease occurrence Risk ratio and odds ratio

Epidemiologists measure the occurrence of disease in different segments of the population and examine the differences in relation to factors that might influence disease occurrence in order to quantify the association between exposure and disease between the different groups. Risk ratio and odds ratio are two common ways of measuring this association. Both ratios compare the likelihood of disease among one group to the likelihood of disease in another group. In an FAD outbreak, animal groups usually differ by exposure to a suspected risk factor. For example, in an African Swine Fever (ASF) outbreak, it may be useful to compare swine that ate garbage with swine that did not eat garbage.

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Displaying Data

- Tables, graphs, and charts
 - Visual means for comparing data
 - Demonstrate patterns, differences, and other relationships



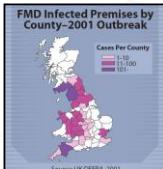
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Data are often displayed in tables, graphs, and charts. Tables present data arranged in rows and columns. They can demonstrate patterns, differences, and other relationships. Graphs display numeric data in a visual form. They can demonstrate trends, similarities, and differences in data that may not be evident from tables. Charts can exhibit various forms (e.g., bar chart, pie chart). They provide a visual means for comparing data. Maps and geographic information systems (GIS) can also provide a visual representation of data. In an FAD response, epidemiologists work with the GIS Cell to develop maps showing the geographic distribution of disease. Maps may pinpoint the location of disease cases/events. Shading or coloring may be used to show different levels of disease numbers or rates in different areas. [This graphic provides examples of data presented in different formats as a table, graph and chart. Illustration by: Katlyn Harvey: Iowa State University]

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Displaying Data (cont'd)

- Maps and GIS
 - Geographic location of disease
 - Levels and rates of disease



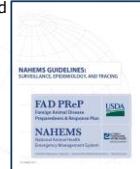
FMD Infected Premises by County - 2001 Outbreak
Cases Per County
Source: UK DEFRA, 2001.
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Maps and geographic information systems (GIS) can also provide a visual representation of data. In an FAD response, epidemiologists work with the GIS Cell to develop maps showing the geographic distribution of disease. Maps may pinpoint the location of disease cases/events. Shading or coloring may be used to show different levels of disease numbers or rates in different areas. This is an example of a map of FMD infected premises by counties during the 2001 outbreak in the United Kingdom. [This illustration is an example of data presented in map format. Content provided by: UK Department for Environment, Food and Rural Affairs. Illustration by: Bridget Wedemeier, Iowa State University]

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For More Information

- FAD PReP/NAHEMS Guidelines: Surveillance, Epidemiology, and Tracing, and SOP: Surveillance
 - <http://www.aphis.usda.gov/fadprep>
- Surveillance, Epidemiology, and Tracing web-based training module
 - <http://naherc.svs.iastate.edu/>



FAD PReP
Foreign Animal Disease Preparedness and Response Plan
NAHEMS
National Animal Health Emergency Management System
USDA APHIS and CDRS
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More details can be obtained from the sources listed on the slide, available on the USDA website (<http://www.aphis.usda.gov/fadprep>) and the NAHERC Training Site (<http://naherc.svs.iastate.edu/>).

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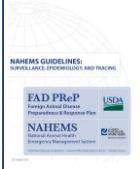
Guidelines Content

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The print version of the Guidelines document is an excellent source for more detailed information. In particular, the Guidelines document has listings of additional resources. This slide acknowledges the authors and reviewers of the Guidelines document. It can be accessed at <http://www.aphis.usda.gov/fadprep>.

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