Objective

- To know different types and applications of surveillance systems used for early detection and management of diseases in animal populations
Talking points

1 Terminology / Definitions

2 International, national, state, and local institutions involved in disease surveillance

3 Elements of animal disease surveillance systems
   – Are swine farms flu factories?

4 UF LAH surveillance and infection control (video; 20min)

1. Terminology / Definitions

• Disease monitoring
• Disease surveillance
• Active vs passive surveillance
• Traditional, Risk-based (targeted), syndromic surveillance
• Sentinel surveillance
• Remote sensing and public health
Disease monitoring
• Is a systematic process that requires the collection and analysis of health-related data for early detection of priority diseases in a population.

Disease surveillance
• Is a systematic process that requires the collection and analysis of health-related data for early detection of priority diseases in a population.

• Health policy is implemented when the prevalence or incidence of disease is above a certain threshold; the objective is to control and prevent disease transmission and its consequences in a population.
Influenza surveillance in the US

• National responses to emerging pandemic strains are triggered by surveillance data
  – 122 cities
  – 144 labs
  – 3000 outpatient health providers.

Disease control program (DCP)

• Is the combined system of monitoring and surveillance, disease control strategies, and intervention strategies that over a prolonged period of time is employed to reduce the frequency of a specific disease

Disease eradication program

• Is a special case of a DCP in which the objective is to eliminate the specific (the pathogen causing the disease)

Active surveillance
• Resources are allocated for sampling, early detection and risk management of priority diseases:
  – Veterinary services go out and look for information
  – Limitations with early detection of acute diseases with short IPs and duration of clinical signs

Passive surveillance
• Disease reporting by producers, veterinarians, labs (eg, trans-boundary animal diseases, reportable diseases):
  – Veterinary services wait for information to come
  – “Passive” is not a good term. Who is being passive?
  – Bedrock of early detection of TADs
  – Social capital (trust)

Traditional surveillance
• Down the road testing
  – Old days: TB and brucellosis in cattle at markets and slaughter plants

Risk-based (targeted) surveillance
• Subpopulations of animals with known risk factors are targeted for sampling and testing
  – Age (> 2 year-old): BSE in cows
  – GeoLocation & Wildbirds: HPAI in commercial or backyard poultry

Syndromic surveillance
• Subpopulations of animals showing selected syndrome are targeted for sampling and testing
  – Respiratory disease: influenza in birds, pigs, dogs, people
  – Diarrhea or colic: salmonellosis in horses
  – Neurologic signs: BSE in cows + Rabies in horses + EHV-1 in horses
  – Abortion: brucellosis, leptospirosis, BVD, IBR, Campylobacter in cows
  – High mortality: HPAI, Newcastle disease in poultry
**Sentinel surveillance**

- Is used to monitor or identify outbreaks and epidemics caused by infectious agents, to investigate changes in the prevalence or incidence of endemic diseases or infectious agents, to evaluate the effectiveness of newly instituted disease control programs, and to confirm a hypothesis about the ecology or epidemiology of an infectious agent.

- The concept is one in which the health status of populations is periodically assessed.

- Promotes targeting of herds or areas with higher probabilities of disease.
Considerations in establishing sentinel herd surveillance

Establishing priorities and goals
- Trans-boundary animal diseases

Herd selection criteria
- Where
  - Cooperative owners

Animal selection criteria
- How many animals
  - Sampling (what animals)

Sampling frequency
- Disease occurrence
  - Vector-borne

Testing
- Clinical cases
  - Serology


Suggested frequency of sampling for sentinel herd surveillance applications

<table>
<thead>
<tr>
<th>Disease occurrence</th>
<th>Disease effect</th>
<th>Example</th>
<th>Sampling frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very rare</td>
<td>Severe</td>
<td>FMD in a nearby country</td>
<td>Weekly</td>
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<tr>
<td>Rare</td>
<td>Severe</td>
<td>Bovine BR in free countries</td>
<td>Annually</td>
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<tr>
<td>Sporadic</td>
<td>Severe</td>
<td>N caninum (outbreaks)</td>
<td>Quarterly</td>
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<tr>
<td>Sporadic</td>
<td>Moderate</td>
<td>VSV in SW USA</td>
<td>Semiannually</td>
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<td>Endemic</td>
<td>Severe</td>
<td>BT endemic countries</td>
<td>Semiannually</td>
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<tr>
<td>Endemic</td>
<td>Moderate</td>
<td>VSV Central America</td>
<td>Annually</td>
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</table>

Remote sensing

- It has been used to identify ecological conditions associated with Rift Valley Fever outbreaks in East Africa
  - National Oceanographic and Atmospheric Administration (NOAA) series of polar orbiting satellites data
  - Normalized Difference Vegetation Index (NDVI) data (absence, presence and abundance of vegetation in a wide range of environmental conditions)
  - Sea Surface Temperature (SST) in region 3.4 equatorian eastern Pacific and WIO
Rift Valley Fever, the virus

Family: Bunyaviridae
Genus: Phlebovirus
IP 2-3 days
Viremia: 5-7 days

Rift Valley Fever, a disease of animals

Cattle
Goats
Camels
Sheep
Abortion
CFR lambs: 90%
CFR adults: 10%
Rift Valley Fever, a disease of humans

- Fever (92%)
- Nausea (59%)
- Vomiting (52%)
- Abdominal pain (38%)
- Diarrhea (22%)
- Jaundice (18%)
- Neurologic signs (17%)
- Bleeding (7%)
- Vision loss (1%)

More than 400 cases
More 120 deaths

Dx
ELISA Ag
ELISA IgM
RT-PCR

FIGURE 1. Number of suspected severe cases of Rift Valley fever (RVF),* by outcome and week of disease onset—Saudi Arabia, August 26–November 1, 2000

- Dead
- Alive
### Rift Valley Fever Risk Factors

**Exposure | OR | 95% CI**
---|---|---
Age < 15 years | 0.3 | 0.06, 1.0
Male | 1.6 | 1.0, 2.8
Drink raw sheep milk | 1.6 | 0.9, 2.9
Contact w sheep | 3.0 | 1.3, 6.7
Animals at home | 3.5 | 1.3, 9.1

Emerging Infectious Diseases: February 2002

---

**Exposure | OR | 95% CI**
---|---|---
Age > 15 years | 3.3 | 1.0, 16.6
Male | 1.6 | 1.0, 2.8
Drink raw sheep milk | 1.6 | 0.9, 2.9
Contact w sheep | 3.0 | 1.3, 6.7
Animals at home | 3.5 | 1.3, 9.1

Emerging Infectious Diseases: February 2002
### Saudi Imports 2005

<table>
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<tr>
<th></th>
<th>Sudan</th>
<th>Australia</th>
<th>Uruguay</th>
<th>Rumania</th>
<th>Total</th>
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<td>1,003,421</td>
<td>2,300,000</td>
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<td>Goats</td>
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<td>Camels</td>
<td>12,785</td>
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<td>Cattle</td>
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<td>Total</td>
<td>1,223,089</td>
<td>1,223,421</td>
<td>2,300,000</td>
<td>11,600</td>
<td>4,555,700</td>
</tr>
</tbody>
</table>

**Hajj**

...the oldest and largest international gathering of people in the world
10 vessels are here and 20 more are coming today. What do we do?
Remote Sensing
DOD Global Emerging Infections System

Western Indian Ocean SST

EPO Niño 3.4 SST

NDVI in Horn of Africa: 2006
The Savanna Mask

Savanna mask / RVF risk maps
Rift Valley Fever: 2006-2007

Somalia
- 114 cases, 51 deaths: 45%

Kenya
- 30 Nov – 12 Mar 2007
- 684 cases, 155 deaths: 23%

Tanzania
- 13 Jan – 3 May 2007
- 264 cases, 109 deaths: 41%

UN, CDC, US Air Force Risk management

- Refugees from Dadaab Camp should remain in the Nairobi Transit Center for 10 d before departure to the United States
- During these 10 d, refugees should have temperatures checked twice a day
- Persons who have RVF like-illness should be tested
2. International, national, state, and local institutions involved in disease surveillance

- WHO, OIE, FAO
- CDC, USDA
- FDA, FDoH
- UF LAH
OIE
World Organization for Animal Health [http://www.oie.int/]

UN FAO  Emergency Prevention System for transboundary animal and plant pests and diseases

- Influenza
- African swine fever
- Foot-and-mouth disease
- Rift Valley Fever
- Rinderpest

[www.fao.org]
CDC Surveillance, epidemiology & laboratory services

- Anthrax
- Arboviral diseases
- Brucellosis
- Influenza
- Rabies
- Salmonellosis
- Tuberculosis

www.cdc.gov
USDA Animal Health Monitoring & Surveillance

- Aquaculture viral haemorrhagic septicemia
- Cattle tuberculosis, brucellosis, BSE
- Captive deer & elk chronic wasting disease
- Equine WNV EEE WEE EHV EIA...
- Poultry influenza
- Sheep and goats scrapie
- Swine pseudorabies

www.aphis.usda.gov/vs/nahss

Florida Department of Agriculture
Division of Animal Industry

Florida Department of Health

Zoonotic diseases

• Mosquito borne diseases
• Rabies
• Tick-borne diseases
• Brucella

LAH Surveillance & Infection Control Program

Salmonellosis
Equine herpes virus
Rabies
Strangles
3. Elements of disease surveillance systems

- Elements
- Are swine farms flu factories?

Key elements of a surveillance system

- **Risk identification**
  - ID priority pathogens
  - Define objective(s)

- **Risk assessment**
  - Population(s) of interest
  - Sample size
  - Type of samples
  - Diagnostic test(s)
  - Data analysis

- **Risk management**
  - Enhanced surveillance and biosecurity

- **Risk communication**

- **Evaluation**

~ 16 million deaths

~ 50 million deaths worldwide
Breaking News


Director of the National Museum of Anthropology took President Obama on a tour of the museum, shook Obama’s hand, and died the following week from symptoms similar to those of swine flu…
### Mortality from severe pneumonia according to age

2006-2008 vs March-April 2009


<table>
<thead>
<tr>
<th>Age group</th>
<th>Seasons 2006-2008 Mortality %</th>
<th>24 March – 29 April 2009 Mortality %</th>
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<tr>
<td>0 – 4</td>
<td>11</td>
<td>5</td>
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<tr>
<td>5 – 9</td>
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<td>25 – 29</td>
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<td>30 – 34</td>
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<td>35 – 39</td>
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<td>45 – 49</td>
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<td>70 – 74</td>
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<td>75 – 79</td>
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<td>≥ 80</td>
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Why is the pig important?
Trying to see past the front gate
*Belize, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama*

**FAO Influenza Project.** Panama City, Panama. September 11, 2009

What influenza viruses are circulating in swine populations in the region? Are pigs the source of influenza infections in humans?

Risk management *without scientific information*
Risk management

What options do we have? ...which are justified and acceptable?

- Quarantine
- Enhanced biosecurity
- Enhanced surveillance: how?
- Vaccination
- Animal movement control

...94% of swine with positive (PCR) swine specimens had few or no clinical symptoms
...94% of swine with positive (PCR) swine specimens had no clinical symptoms.

...Swine influenza virus surveillance is commercial SPU is passive and requires unusual illness in pigs. This is adequate for swine production purposes but tremendously deficient from a public health perspective...
Virus excretion in pigs after experimental infection with pH1N1 influenza virus

Journal of General Virology 2009;90:2119-2123

<table>
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<tr>
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Virus excretion and **clinical signs of respiratory disease** in pigs after experimental infection with pH1N1 influenza virus

Journal of General Virology 2009;90:2119-2123

<table>
<thead>
<tr>
<th>Pig</th>
<th>Group</th>
<th>0</th>
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</table>
Pandemic (H1N1) 2009 Outbreak on Pig Farm, Argentina

Morbidity: 30% in nursery pigs

Pandemic (H1N1) 2009 Virus on Commercial Swine Farm, Thailand

Morbidity: 50%
Mortality: 10% in nursery pigs
**FAO Project**

**Case definition** that triggers a field investigation

When a Swine Production Unit is affected with a cluster of clinical cases showing ILI symptoms and affecting ≥ 10% of the animals in that Unit

---

**Swine population in the region**

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
</tr>
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<tbody>
<tr>
<td>Belize</td>
<td>13,146</td>
</tr>
<tr>
<td>Panama</td>
<td>327,253</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>336,328</td>
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<tr>
<td>Honduras</td>
<td>389,170</td>
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<td>El Salvador</td>
<td>395,000</td>
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<td>Guatemala</td>
<td>587,861</td>
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<tr>
<td>Nicaragua</td>
<td>671,905</td>
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<tr>
<td>Dominican Republic</td>
<td>800,000</td>
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<tr>
<td>Cuba</td>
<td>2,653,410</td>
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<tr>
<td>Mexico</td>
<td>15,206,310</td>
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</table>
Swine population in Nicaragua and CR

<table>
<thead>
<tr>
<th></th>
<th>Nicaragua</th>
<th>Costa Rica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of pigs</td>
<td>671,905 (100)</td>
<td>336,328 (100)</td>
</tr>
<tr>
<td>Backyard</td>
<td>638,403 (95)</td>
<td>42,501 (16)</td>
</tr>
<tr>
<td>Commercial</td>
<td>33,502 (5)</td>
<td>290,827 (86)</td>
</tr>
<tr>
<td>Total number of farms</td>
<td>258,525 (100)</td>
<td>12,721 (100)</td>
</tr>
<tr>
<td>Backyard</td>
<td>258,490 (99.9)</td>
<td>11,259 (89)</td>
</tr>
<tr>
<td>Commercial</td>
<td>35 (0.1)</td>
<td>1,462 (11)</td>
</tr>
</tbody>
</table>

Sample size minimum number of pigs to sample to detect influenza virus pH1N1 in one SPU affected with an outbreak of respiratory disease

\[ n = \frac{(1-(1-\alpha)^{1/D})}{(N-1/2(SeD-1))} / Se \]  

<table>
<thead>
<tr>
<th>Sick pigs</th>
<th>Prevalence</th>
<th>100%</th>
<th>30%</th>
<th>20%</th>
<th>10%</th>
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</thead>
<tbody>
<tr>
<td>1,000</td>
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<td>1</td>
<td>9</td>
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<td>10</td>
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</table>
Type of samples and diagnostic tests

Nasal swabs | oral fluids?
http://vetmed.iastate.edu/vdpam/disease-topics/oral-fluids

PCR (screening): influenza type A
PCR (confirmation) + virus isolation + sequencing

Initial surveillance efforts in the region

<table>
<thead>
<tr>
<th>Country</th>
<th>Pigs tested</th>
<th>Influenza A</th>
<th>pH1N1</th>
<th>System costs</th>
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<tr>
<td>1</td>
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</table>
### Systems costs BSE Switzerland

![Graph showing the number of diagnostic tests per year from 1990 to 2000, with the x-axis representing the year and the y-axis representing the number of tests. The graph highlights the dates when incidents occurred, marked with stars.](image)

- **Stand:** 19.07.2000
- **Total:** 460
- **Source:** Swiss Federal Veterinary Office

---

### System costs BSE, cost per sample: € 70 (year 2003)

<table>
<thead>
<tr>
<th></th>
<th><strong>E Union</strong></th>
<th><strong>Detect 1 positive</strong></th>
<th><strong>Switzerland</strong></th>
<th><strong>Detect 1 positive</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Clinical cases</strong></td>
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<td>No. positives</td>
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<td>Rate positives</td>
<td>8</td>
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<td><strong>Emergency slaughter</strong></td>
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<td></td>
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<tr>
<td>No. tests</td>
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<td></td>
<td>8 830</td>
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<td><strong>Slaughter at the farm</strong></td>
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<td><strong>Volunteer testing</strong></td>
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<td>Rate positives</td>
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<td>39 944</td>
<td>€ 2.7 m</td>
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</tbody>
</table>
Evaluation performance

• System usefulness outbreak detection and role of each element used in the system
• Flexibility system’s ability to change as needs change
• Acceptability willingness of participants & stakeholders to contribute to the data collection and analysis
• Portability how well the system can be duplicated in another setting
• Stability can be demonstrated by the duration and consistent operation of the system
• System costs

Homework Review terminology / definitions and types of surveillance that apply to specific situations

• Disease monitoring
• Disease surveillance
• Active vs passive surveillance
• Traditional, Risk-based (targeted), syndromic surveillance
• Sentinel surveillance
• Remote sensing
Review

• Testing of sentinel birds for detection of seroconversion to WNV antibodies is an example of

A) Active surveillance
B) Passive surveillance

Review

• A producer calls VS to notify an unusual sudden high mortality of birds on a commercial poultry farm. The local veterinarian believes this could be an outbreak of HPAI or Newcastle disease. This is an example of

A) Active surveillance
B) Passive surveillance
Review

• The influenza surveillance system in the US, is an example of
  A) Active surveillance
  B) Passive surveillance

Review

• A producer calls VS to notify an unusual sudden situation of low egg production on a commercial turkey farm. This is an example of
  A) Traditional surveillance
  B) Risk based surveillance
  C) Syndromic surveillance
  D) Remote sensing surveillance
Review

• FAO personnel has identified abnormal SST on the 3.4 region and WIO, as well as NDVI in the Horn of Africa, and has alerted national VS that there is a high risk of an outbreak of RVF in people and animals. This is an example of

A) Traditional surveillance
B) Risk based surveillance
C) Syndromic surveillance
D) Remote sensing surveillance

Review

• The UF LAH targets horses with colic or diarrhea upon admission for early detection of Salmonella shedding in feces. Horses with diarrhea or that test positive to Salmonella are placed in isolation. This is an example of

A) Active surveillance
B) Passive surveillance
Review

• The UF LAH targets horses with colic or diarrhea upon admission for early detection of Salmonella shedding in feces. Horses with diarrhea or that test positive to Salmonella are placed in isolation. This is an example of

A) Traditional surveillance
B) Syndromic surveillance
C) Scanning surveillance
D) Remote sensing surveillance

4. UF LAH surveillance activities (video)