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 UF LAH surveillance and infection control (video; 20min)
4 Elements of animal disease surveillance systems
   – Elements
   – Are swine farms flu factories?

• Homework: review questions
• Additional information

1 Terminology / Definitions

• Disease monitoring
• Disease surveillance
• Active vs passive surveillance
• Traditional, risk-based (targeted), syndromic surveillance
• Sentinel surveillance
• Remote sensing
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 and intervention strategies that over a prolonged period of time are 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 disease (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

Passive surveillance
• Disease reporting by producers, veterinarians, laboratories:
  – Veterinary services wait for information to come
  – “Passive” is not a good term. Who is being passive?
  – Bedrock of early detection of trans-boundary animal diseases

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

- Down the road testing
  - Old days: TB and brucellosis in cattle at farms, markets, and slaughter plants

Risk-based (targeted) surveillance

Subpopulations of animals with known risk factors are targeted for sampling and testing: HPAI in poultry

Risk factors
- Proximity to wetlands (2-5 miles)
- Proximity to rehab aquatic birds
- Proximity to markets, shows
  …where density of backyard poultry is high

Temporal factors and sampling intensity
- South-Central USA (winter)
- Date(s) of big shows
- High risk periods (ie, winter); sampling every 21 days
Syndromic surveillance

- Subpopulations of animals showing selected syndrome are targeted for sampling and testing
  - HIGH MORTALITY + LOW EGG PRODUCTION: HPAI, NC disease in poultry
  - VESICULAR DISEASES: FMD, VSV, BT in cattle
  - RESPIRATORY DISEASE: influenza in birds, pigs, dogs, people
  - DIARRHEA COLIC: salmonellosis in horses
  - NEUROLOGIC SIGNS: BSE in cows + rabies in horses + EHV-1 in horses
  - ABORTION: brucellosis, leptospirosis, BVD, IBR, Campylobacter in cows

Source: Swiss Federal Veterinary Office
Sentinel surveillance is used

- To monitor or identify outbreaks and epidemics caused by infectious agent
- To investigate changes in the prevalence or incidence of endemic diseases or infectious agents
- To evaluate the effectiveness of newly instituted disease control programs
- 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.

Remote sensing has been used

- To identify ecological conditions associated with Rift Valley Fever outbreaks in the Horn of Africa
  - National Oceanographic and Atmospheric Administration (NOAA) data from a series of polar orbiting satellites
  
  - 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
### 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 with sheep | 3.0 | 1.3, 6.7
Animals at home | 3.5 | 1.3, 9.1

Emerging Infectious Diseases: February 2002

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**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 with sheep | 3.0 | 1.3, 6.7
Animals at home | 3.5 | 1.3, 9.1

Emerging Infectious Diseases: February 2002
### Saudi Imports

2005

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<td>1 223 421</td>
<td>2 300 000</td>
<td>11 600</td>
<td>4 555 700</td>
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### Hajj

...the oldest and largest international gathering of people in the world

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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
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
3 UF LAH surveillance activities (video)

4 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
  - Case definition
  - 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

Influenza pH1N1: Mexico
1 April – 24 September 2009

29 April WHO phase 5
11 June WHO phase 6
21 June Enhanced mitigation +++ in Yucatan

Confirmed cases
Mexico: 29,417
Yucatan: 2,991

24 April Schools closed Mexico City
2 May School & NEA suspended nationwide
11 May Schools re-open
16 April Obama in Mexico City
17 April EPI Alert
Breaking News


Mortality from severe pneumonia according to age
2006-2008 vs March-April 2009


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<th>Seasons 2006-2008 Mortality %</th>
<th>24 March – 29 April 2009 Mortality %</th>
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</table>
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

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

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<td><strong>Enhanced surveillance:</strong> how?</td>
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<tr>
<td>Vaccination</td>
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<td>Animal movement control</td>
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</table>
...94% of swine with positive (PCR) swine specimens had few or no clinical symptoms.

...Swine influenza virus surveillance in 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...
...94% of swine with positive (PCR) swine specimens had few or no clinical symptoms

Yes, but there are sampling issues that need clarification:

* 2 pigs (1%) with ILI were tested (6/29 and 7/4)
* 180 pigs (99%) with ILI were not tested (6/19 to 7/4), why?
* Most importantly, why were the first 10 pigs with ILI on 6/19 not tested for pH1N1?

Virus excretion in pigs after experimental infection with pH1N1 influenza virus

Journal of General Virology 2009;90:2119-2123

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Virus shedding and **clinical signs of respiratory disease** in pigs after experimental infection with pH1N1 influenza virus

Journal of General Virology 2009;90:2119-2123

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Morbidity: 30% 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
Types 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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</table>
Systems costs BSE Switzerland

| Source: Swiss Federal Veterinary Office |

Clinical cases

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<tr>
<th>E Union</th>
<th>Detect</th>
<th>Switzerland</th>
<th>Detect</th>
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<tbody>
<tr>
<td>No. tests</td>
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<tr>
<td>2 578</td>
<td>306</td>
<td>€ 589</td>
<td>54</td>
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Emergency slaughter

<table>
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<th>Rate positives</th>
<th>No. positives</th>
<th>Rate positives</th>
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<td>264 312</td>
<td>358</td>
<td>738</td>
<td>8 830</td>
<td>2 943</td>
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Slaughter at the farm

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<th>Rate positives</th>
<th>No. positives</th>
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<td>425</td>
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<td>10 794</td>
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Volunteer testing

<table>
<thead>
<tr>
<th>No. tests</th>
<th>No. positives</th>
<th>Rate positives</th>
<th>No. positives</th>
<th>Rate positives</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 716 481</td>
<td>265</td>
<td>€ 2.3 m</td>
<td>159 777</td>
<td>€ 2.7 m</td>
</tr>
</tbody>
</table>

System costs BSE, cost per sample: € 70 (year 2003)
Evaluation of 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**

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

Terminology / Definitions
- Disease monitoring
- Disease surveillance
- Active vs passive surveillance
- Traditional, risk-based (targeted), syndromic surveillance
- Sentinel surveillance
- Remote sensing
Homework  Review question 1

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

A) Active surveillance
B) Passive surveillance

Homework  Review question 2

• 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
Homework  Review question 3

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

Homework  Review question 4

• 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
**Homework** Review question 5

- 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

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**Homework** Review question 6

- 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
**Homework** Review question 7

- 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

**Homework** Review question 8

- Compared to serological testing, estimate the Se, Sp, NPV, and PPV of the human influenza-like illness case definition

<table>
<thead>
<tr>
<th></th>
<th>Serology pos</th>
<th>Serology neg</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILI pos</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>ILI neg</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

Swine outbreak of pandemic influenza A virus on a Canadian Research Farm supports human-to-swine transmission. Clinical Infectious Disease;2011:52:10-18
Homework Review question 9

- Serology results show that the human influenza-like illness case definition used in this study produced

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<td>10</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

A) A low number of false positives
B) A high number of false positives

Homework Review question 10

- Serology results show that the human influenza-like illness case definition used in this study produced

<table>
<thead>
<tr>
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<tbody>
<tr>
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<td>10</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

A) A low number of false negatives
B) A high number of false negatives
Additional information

Swine population in the region

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
</tr>
</thead>
<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>
</tr>
<tr>
<td>Honduras</td>
<td>389,170</td>
</tr>
<tr>
<td>El Salvador</td>
<td>395,000</td>
</tr>
<tr>
<td>Guatemala</td>
<td>587,861</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>671,905</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>800,000</td>
</tr>
<tr>
<td>Cuba</td>
<td>2,653,410</td>
</tr>
<tr>
<td>Mexico</td>
<td>15,206,310</td>
</tr>
</tbody>
</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 farm 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 100%</th>
<th>30%</th>
<th>20%</th>
<th>10%</th>
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<tbody>
<tr>
<td>1,000</td>
<td>1</td>
<td>9</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>90</td>
<td>1</td>
<td>9</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>80</td>
<td>1</td>
<td>9</td>
<td>13</td>
<td>24</td>
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<tr>
<td>70</td>
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<td>23</td>
</tr>
<tr>
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