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Standardizing
output-based surveillance
to control non-regulated
diseases of cattle in the EU

1st Training school

BASIC CONCEPTS IN EPIDEMIOLOGY AND SURVEILLANCE

CONTENT

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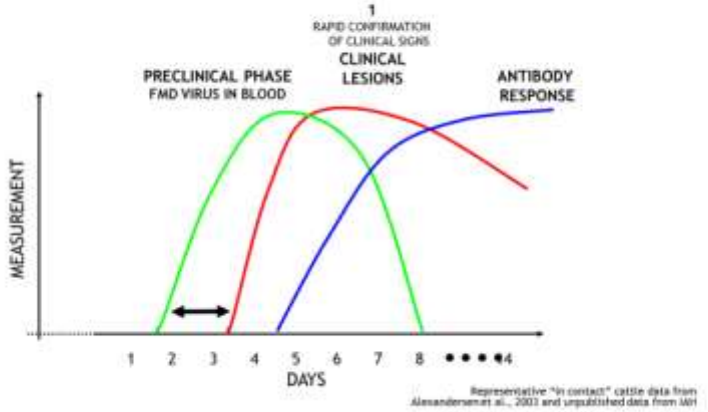
Basic Concepts in Epidemiology and Surveillance

DISEASE MEASURES

Jörn Gethmann, Carola Sauter-Louis

What happens after an infection?



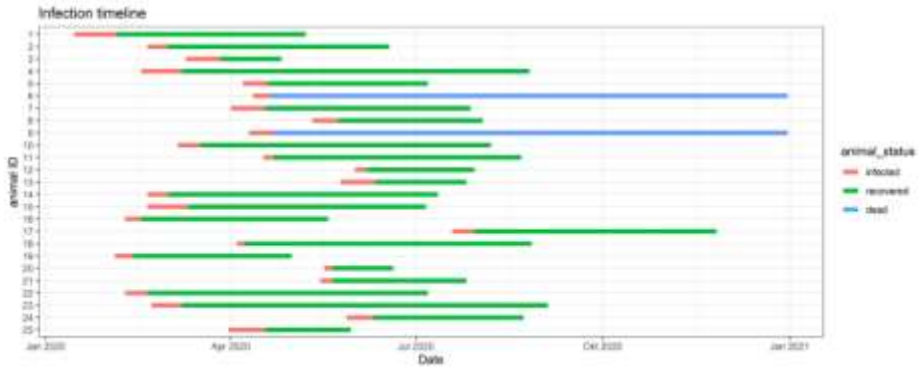
Representative "in contact" cattle data from Alexandersen et al., 2003 and unpublished data from IAH

Source: EUFMD

What happens after an infection?

What happens after an infection?

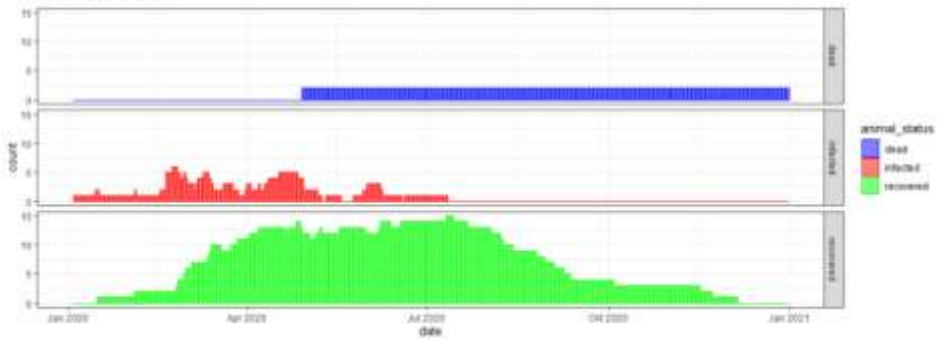
- Virtual farm with 25 animals.
- All animals are at the farm the whole year



What happens after an infection?

- Virtual farm with 25 animals, all animals are at the farm the whole year

Epidemic curve



Case definition

- What is a case?
  - Clinical signs
  - Laboratory diagnostics (PCR, antibody test)
  - Contact to other infected animals?

Your turn (think two minutes about the following questions)

- When do you count a case?
- Discuss the pros and cons?

Go to www.menti.com and use the code 59 45 17 9

Case definition

- As it might be difficult to decide, whether an animal/person is counted as diseased or not, there often is a case definition, e.g.

Article 9
Case definitions
1. The competent authority shall classify an animal or a group of animals as a suspected case of a listed disease or of an emerging disease when:
   a) clinical, post-mortem or laboratory examinations conclude that ***clinical sign(s)***, post-mortem lesion(s) or histological findings are indicative of that disease;
   b) result(s) from ***a diagnostic method*** are indicating the likely presence of the disease in a sample from an animal or from a group of animals; or
   c) an ***epidemiological link*** with a confirmed case has been established.

Morbidity

$$morbidity = \frac{number\ of\ \textbf{diseased}\ individuals\ in\ a\ defined\ period}{population\ at\ risk}$$

- Proportion of animals diseased (in a defined period) divided by the population (at risk)
- What are „diseased" animals?
  - Infected
  - Clinically ill
  - Positive tested

Mortality

$$mortality = \frac{number\ of\ \textbf{dead}\ individuals\ in\ a\ defined\ period}{population\ at\ risk}$$

- Proportion of animals died (in a defined period) divided by the population (at risk)

Case fatality

$$case\ fatality = \frac{number\ of\ \textbf{dead}\ individuals\ in\ a\ defined\ period}{number\ of\ \textbf{diseased}\ individuals\ in\ a\ defined\ period}$$

- number of animals died (in a defined period) divided by the number of animals diseased (in a defined period)

Incidence

- Incidence relates to the number of new events
- It can be expressed at
  - Incidence count
  - Incidence times
  - incidence risk (R), or cumulative incidence
  - incidence rate (I), or incidence density

Source: Ian Dohoo, Methods in epidemiologic Research, 2012

Incidence risk (R) or cumulative incidence

$$R = \frac{number\ of\ newly\ affected\ individuals\ in\ a\ defined\ period}{population\ at\ risk}$$

- Incidence risk
  - Incidence risk measures the number of new cases over a period of time in the population (at risk)
- Cohort study, monitoring
  - Animals that are diseased at the begin of the study need to be excluded
- Caution: Often wrongly called as „incidence-'rate'"

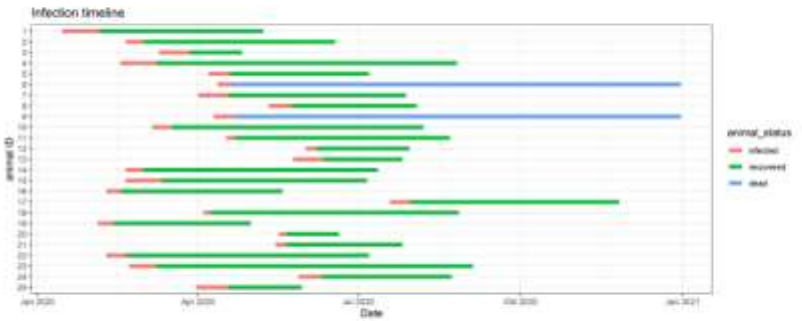
Incidence risk (R) or cumulative incidence

$$R = \frac{number\ of\ newly\ affected\ individuals\ in\ a\ defined\ period}{population\ at\ risk}$$

- What is the „population at risk"?
  - Mastitis

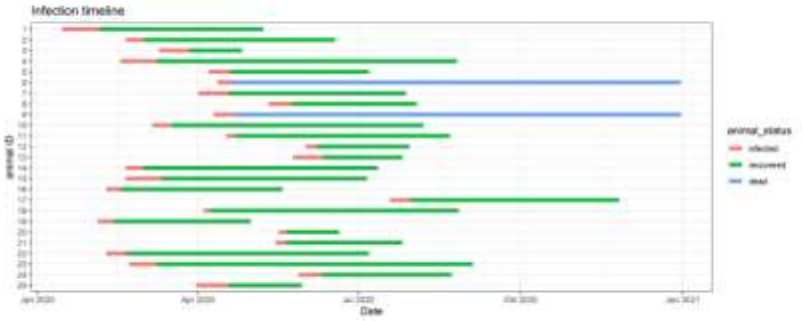
Go to www.menti.com and use the code 21 34 25 5

Incidence



- What is the cumulative incidence between 1st January and 31st March?
- When only 10% of the infected animals show clinical signs: How many new cases would have been detected?

Incidence



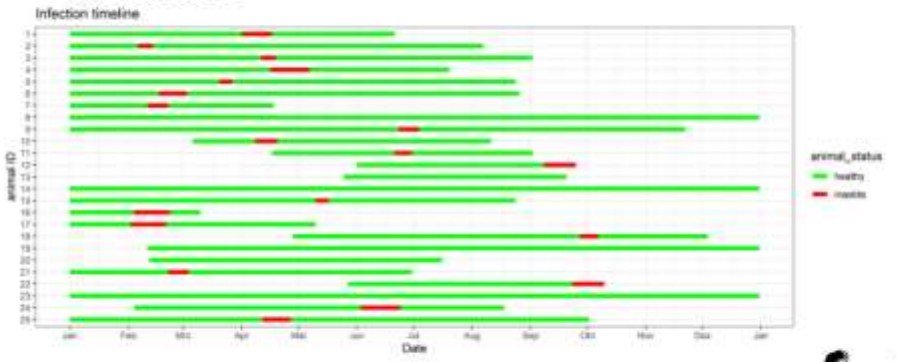
- What is the incidence between 1st January and 31st March? 12
- When only 10% of the infected animals show clinical signs: How many new cases would have been detected? 1

Incidence rate (I) or incidence density

$$I = \frac{number\ of\ newly\ affected\ individuals\ in\ a\ defined\ period}{number\ of\ person-time\ units\ at\ risk\ during\ the\ time\ period}$$

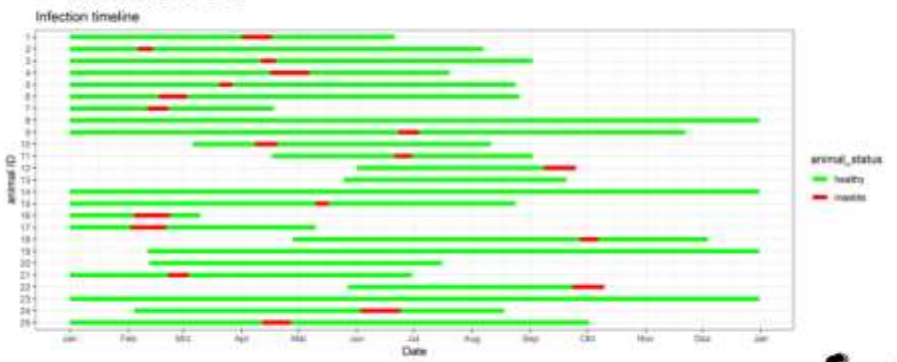
- Incidence rate
  - Incidence rate measures the number of new cases over a period of time
- Cohort study, monitoring

Incidence



- What is the population at risk?
- What is the incidence rate (time unit month) and incidence risk in the farm in the whole year?

Incidence



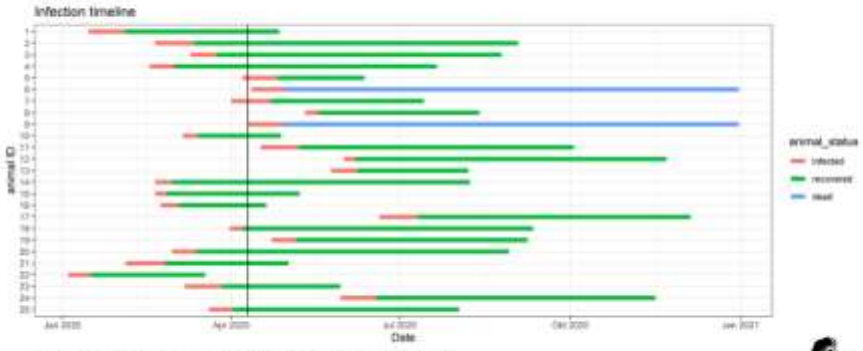
- What is the population at risk? All 25 animals
- What is the incidence rate (time unit days) and incidence risk in the farm in the whole year? 19/5209 days= 0.36% or ~19/173 months = 11 %

Prevalence

$$P = \frac{number\ of\ cases}{population\ at\ risk}$$

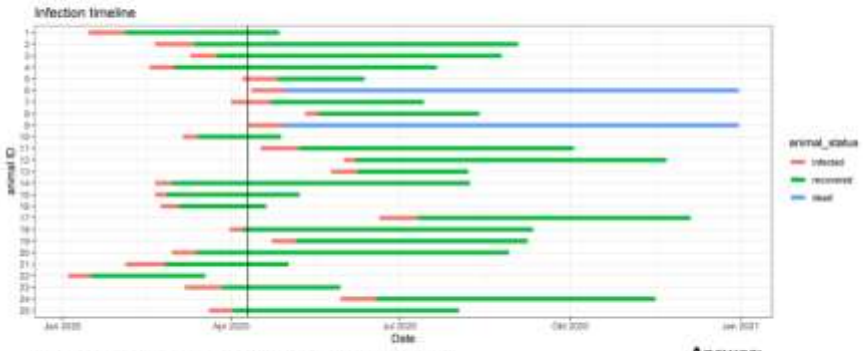
- Prevalence:
  - Proportion of a population found to have a condition.
  - Number of individuals with the disease at a certain point of time among those, which can get the disease.
- Cross-sectional study

Prevalence



- What is the prevalence at 10th April? (see line)
- What is the difference in prevalence using a antigen/antibody test?

Prevalence



- What is the prevalence at 10th April? (see line)
- What is the difference in prevalence using a antigen/antibody test?

Answer:
Antigen: 2/25= 8 %
Antibody: 13/25 = 52%

Exercise 1

- "Exercise Incidence1.xlsx"
- Calculate the prevalence in December and March
- Calculate the cumulative incidence and incidence density for the year

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Basic Concepts in Epidemiology and Surveillance

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RISK ANALYSIS

Tanja Knific, Inge Santman-Berends

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Learning objectives

- Understand terms: hazard, risk, ...
- Know the components of risk analysis
- Understand risk analysis reports and studies

Risk analysis

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Defintion of Risk

= *a situation involving exposure to danger/hazard*

The possibility that something unpleasant or unwelcome will happen

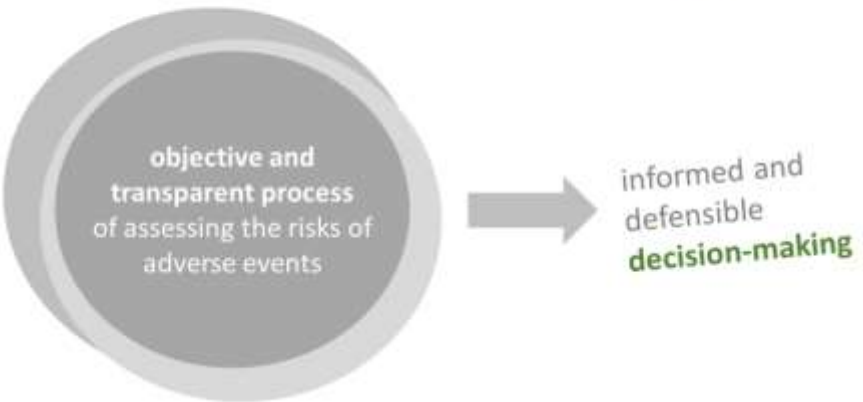
= probability of occurrence × likely magnitude of consequences (biological and economic)

Risk is never 0

Acceptable levels of risk depend on:

- country
- susceptable species (zoonoses)
- morbidity, mortality
- economic consequences
- ...

Risk analysis - WHAT



Risk analysis

Disclaimer

There is no one right way to do a risk analysis.

Risk analysis
WHY: The beginings

Babylon (3200 BCE) – risky venture, arranged marriage, building site -> advice by priest-like consultant

Formal risk analysis (1960s and 1970s)

- nuclear and chemical industries

Microbial risk assessment (early 1990s)

- water quality management
- space exploration

EFSA - 2002

Risk analysis
WHY: The trade awakens

1. Prevention of international disputes
   (e.g. EU ban on US beef import)

WTO: **Sanitary & PhytoSanitary (SPS) agreement**
National health and safety regulations for protection of:

- human health – food safety
- animal health
- plant Health

➢ should not be used as an excuse for protection of domestic industries

2. Prevention of public scare
   (e.g. BSE, AI, corona beer ;)

Risk analysis
WHY: The rise of applicability

- rational and objective review of what is known at a particular point in time
- consensus between different stakeholders
- identification of knowledge/data gaps

It never includes all the possible information

- time constraints
- data availability

Risk analysis - WHO

- Food Safety
  - WHO, FAO, Codex Alimentarius
  - EC, EFSA
- Animal Health
  - OIE, Terrestrial Animal Health Code
- Plant Health
  - FAO, Int. plant protection convention

Risk analysis - WHO

Multidisciplinary team:
- experts on risk-analysis
- scientists – on the topic
- + many other fields
- policy/decision makers
- stakeholders

Requirements:
- broad approach to the problem
- participation of all stakeholders
- extensive data collection

Risk analysis - components

General framework

Hazard identification

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Hazard = biological, chemical or physical agent in an animal or animal product with the potential to cause an adverse health effect

Precise question/objective of the analysis
- identify hazard – pathogenic agent
- risk – disease introduction, epidemic, exposure via food
- level – country/region/herd
- time frame

What are possible consequences?

Risk assessment

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A scientifically based process, evaluation of
- likelihood and
- biological and economic consequences

Steps - depending on the question
1. Entry assessment
2. Exposure assessment
3. Consequence assessment

Type – depending on the goal, available data
- qualitative
- quantitative

Risk assessment

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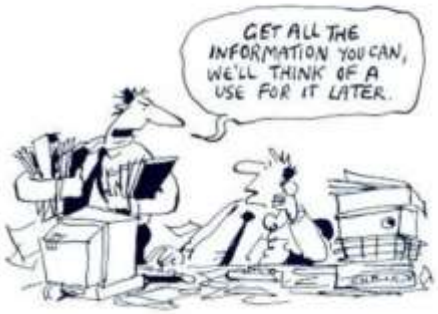
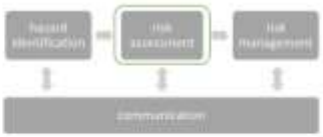
Collection of information

Define the information needs

Sources
- empirical data - preferred
- literature
- expert opinion



Quantitative vs qualitative



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Qualitative

- not in exact probabilities; e.g. low or high risk
- not so detailed
- faster
- applicable in many situations
- subjective perception of meaning of the results

-> inconsistent decisions, ineffective risk management

- useful as a comparative first step

Quantitative

- exact results: probability (distribution)
- in depth analysis
- time consuming
- requires reliable data
- statistical, mathematical models
- better information for decision making
- less ambiguous
- perceived too certain

Qualitative

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Qualitative measures of likelihood.

Level	Descriptor	Example description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur or should occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

FAO/WHO. 2009. Risk characterization of microbiological hazards in food: guidelines. Microbiological Risk Assessment Series 17. Rome. 116 pp.

Table 3.4b Qualitative measures of consequence or impact.

Level	Descriptor	Example description
1	Insignificant	Insignificant impact; little disruption to normal operation; low increase in normal operation costs
2	Minor	Minor impact for small population; some manageable operation disruption; some increase in operating costs
3	Moderate	Minor impact for large population; significant modification to normal operation but manageable; operation costs increased; increased monitoring
4	Major	Major impact for small population; systems significantly compromised and abnormal operation, if at all; high level of monitoring required
5	Catastrophic	Major impact for large population; complete failure of systems

Qualitative

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Risk matrix

FAO/WHO. 2009. Risk characterization of microbiological hazards in food: guidelines. Microbiological Risk Assessment Series 17. Rome. 116 pp.

Table 3.4c Qualitative risk analysis matrix: level of risk.

Likelihood	Consequences				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A (almost certain)	Moderate	High	Very high	Very high	Very high
B (likely)	Moderate	High	High	Very high	Very high
C (possible)	Low	Moderate	High	Very high	Very high
D (unlikely)	Low	Low	Moderate	High	Very high
E (rare)	Low	Low	Moderate	High	High

Quantitative

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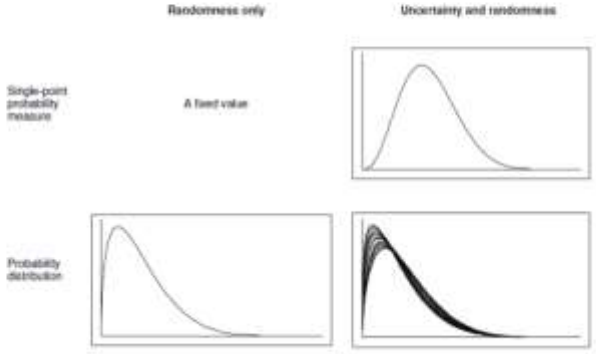
Types of models
- deterministic
- stochastic



FAO/WHO. 2009. Risk characterization of microbiological hazards in food: guidelines. Microbiological Risk Assessment Series 17. Rome. 116 pp.

Risk management

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Decision between alternative risk reduction options
- risk assessment = scientific information
- stakeholders' opinions/values
- other factors: economic, social, cultural, ethical, trends

Risk managers/decision makers
- need to understand used methods and results

Risk management

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Implementation of regulatory measures

Monitoring of the effectiveness of measures by
government, private sector and other stakeholders

Inclusion of new findings -> changes in measures

Risk communication

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All involved
- risk assessors
- risk managers/policy makers
- consumers + interested parties

Distrust between public and institutions

Public percepion of risk
- yes/no
- personal beliefs
- emotional reactions

Risk analysis – END(LESS)

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Many feedback loops and steps

The individual steps are repeated:
- as many times as required
- when better information is available

Repetition of interactions between risk managers, risk assessors and other stakeholders!

The big picture

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- You are advocate for science
  - what you do and how you do it matter
  - be mindful of your communication with everyone
- Set priorities - this is the only way to know where you are going
- Avoid unnecessary risk - check your relationship with risks in your life
- You are not alone
  - no matter of the problem you have, there are people who had and have the same problem - find data, books, mentors
  - know that hardly anything is only about you – so listen to other people
- *Expectation management* - failure is part of learning


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Basic Concepts in Epidemiology and Surveillance

Diagnostic Tests

Maria Guelbenzu, Carola Sauter-Louis, Jörn Gethmann

Contents

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What is a diagnostic test?

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- Clinical examination
- Temperature measurement
- PCR analysis of the blood → virological test
- Ab ELISA → test for antibodies

Any device or process design to detect, or quantify, a sign, substance tissue change or body response in an animal. Test can also be applied at herd level or other level of aggregation.

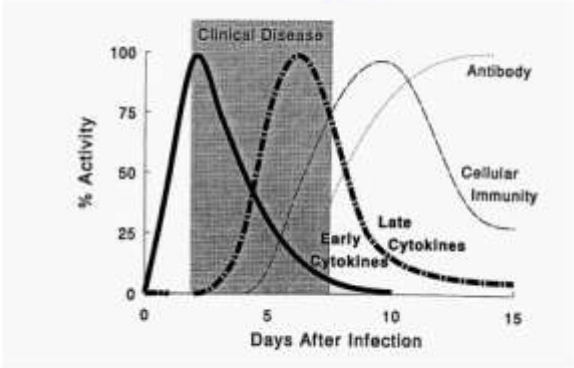
Diagnostic tests

Direct methods

- Culture: slow, low sensitivity
- PCR: high sensitivity and specificity
- Virus isolation

Indirect methods

- Antibody testing
- ELISA
- CFT
- SNT



Campos et al. 1994

Diagnostic tests

- Screening versus diagnostic
- Analytical sensitivity: lowest concentration of a chemical /organism/substance that the test can detect.
- Analytical specificity: capacity of a test to react to only one chemical compound.
- Accuracy: ability to give a true measure
- Precision: how consistent results are

Sensitivity and Specificity

- *Sensitivity* is the proportion of true positives that are correctly identified by the test
- *Specificity* is the proportion of true negatives that are correctly identified by the test

Sensitivity and Specificity

		Condition (as determined by "Gold standard")	
		Positive	Negative
Test outcome	Positive	a	b
	Negative	c	d

Sensitivity and Specificity

		Condition (as determined by "Gold standard")		
		Positive	Negative	
Test outcome	Positive	True Positive a	False Positive (Type I error) b	a+b
	Negative	False Negative (Type II error) c	True Negative d	c+d
		a+c	b+d	

Sensitivity

- *Sensitivity* is the proportion of true positives (individuals with the disease) that are correctly identified by the test
- The likelihood of an individual having the disease delivers a positive test result.

Sensitivity and Specificity

		Condition (as determined by "Gold standard")		
		Positive	Negative	
Test outcome	Positive	True Positive a	False Positive b	a + b
	Negative	False Negative c	True Negative d	c + d
		Sensitivity	Specificity	

$$Se = \frac{a}{a+c} = \frac{TP}{TP+FN}$$

Number of sick animals with a positive test result/ Number of all sick

Sensitivity and Specificity

- *Specificity* is the proportion of true negatives (individuals without the disease) that are correctly identified by the test (who give a negative result on the test)
- The likelihood that an individual will give a negative test result without the disease.

Sensitivity and Specificity

		Condition (as determined by "Gold standard")		
		Positive	Negative	
Test outcome	Positive	True Positive a	False Positive b	a + b
	Negative	False Negative c	True Negative d	c + d
		Sensitivity	Specificity	

$$Sp = \frac{d}{b+d} = \frac{TN}{FP+TN}$$

Number of healthy animals with a negative test result/ Number of all healthy

Sensitivity and Specificity

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	True Positive	True Negative
Test Positive	True Positive a	False Positive b
Test Negative	False Negative c	True Negative d
	Sensitivity	Specificity

$$Se = \frac{a}{a+c} = \frac{TP}{TP+FN}$$

$$FN = 1 - Se$$

$$Sp = \frac{d}{b+d} = \frac{TN}{FP+TN}$$

$$FP = 1 - Sp$$

Sensitivity and Specificity

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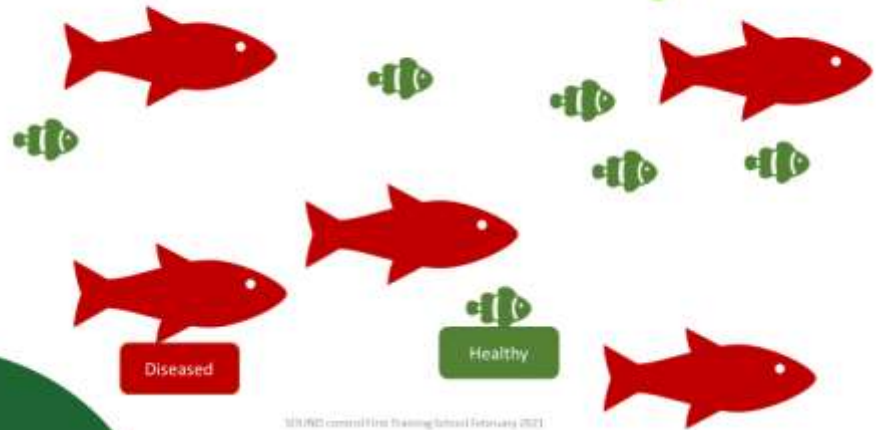

Sensitivity and Specificity

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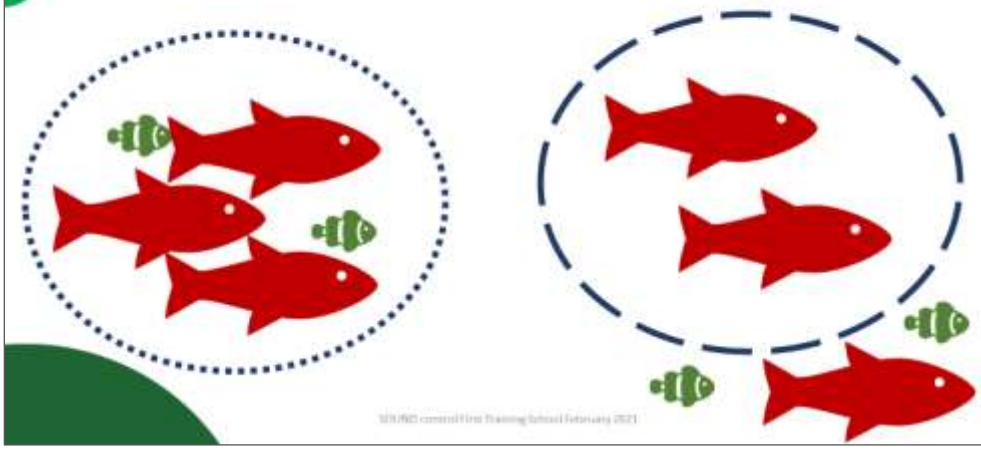
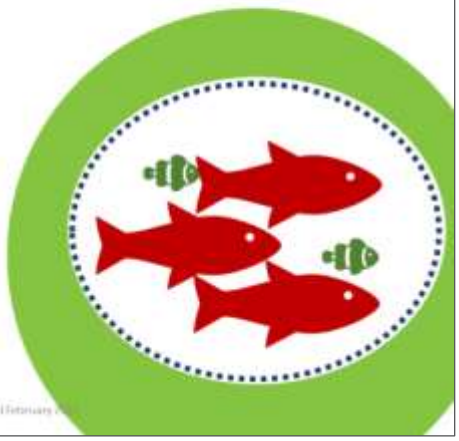


Sensitivity and Specificity

Sensitivity:

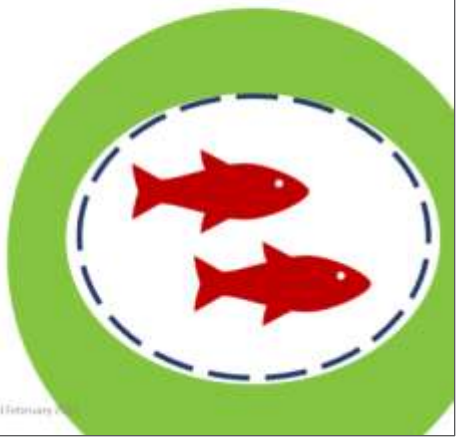
- Tight mesh = high sensitivity
- Fish out many, if possible all, with infection
- Increased false positives
- If ELISA: 99.5% sensitivity
- 995 out of 1000 animals are really positive
- 5 out of 1000 are false negatives



Sensitivity and Specificity

Specificity:

- Wide mesh = high specificity
- Those who are fished out should really have the disease
- Increased false negatives
- ELISA: 99.5% specificity
- 995 out of 1000 animals are really negative
- 5 out of 1000 are false positives



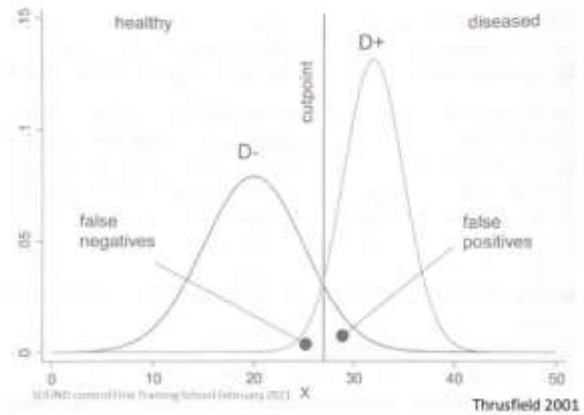
Sensitivity and Specificity

Test with: Sensitivity 98%; Specificity 95%; Prevalence 10%

- 50 out of 500 infected
- 49 out of 50 infected detected
- Of 50 infected, 1 false negative
- Of 450 non-infected animals, 22 test positive (false positive)

Cut off value

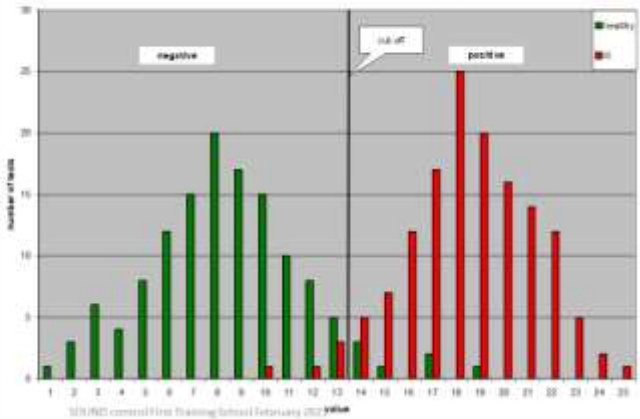
Interpreting test results that are measured on a continuous scale



Thrusfield 2001

Cut-off value

value	healthy	ill	
1	1		
2	3		
3	6		
4	4		
5	8		
6	12		negative
7	15		
8	20		
9	17		
10	15	1	
11	10		
12	8	1	
13	6	3	cut off
14	3	5	
15	1	7	
16		12	
17	2	17	
18		25	
19	1	20	positive
20		18	
21		14	
22		12	
23		5	
24		2	
25		1	



Cut off value

- Depending on purpose: i.e. initial screening – increased Se

Calculation:

- 2 or 3 standard deviations greater than the mean of the test values of the unaffected individuals.
- Values that minimise cost or misdiagnosis
- Calculation of **likelihood ratios**, and construction of **ROC curves**
- **Likelihood ratio:** provides a suitable summary measure of a test's performance, when the test is applied in a population, which is independent of prevalence.

Cut off value

- **Likelihood ratio of a positive test result (LR+)** is the ratio of the proportion of affected individuals that test positive, and the proportion of healthy individuals that test positive.

$$LR+ = \frac{Sensitivity}{(1 - Specificity)}$$

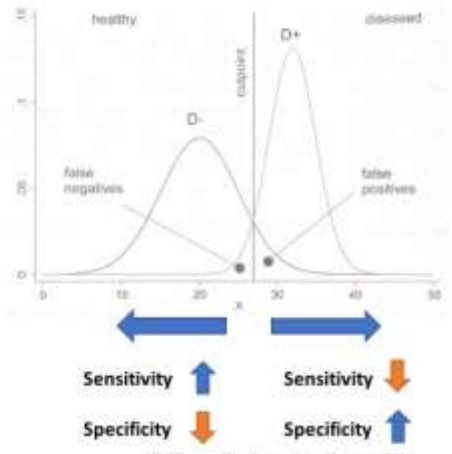
If LR+ = 110, a positive result is 110 times as likely to come from an animal with disease, as from an animal without the disease.

- The **likelihood ratio of a negative test result (LR−)** is the ratio of the proportion of affected individuals that test negative, and healthy individuals that test negative.

$$LR- = \frac{(1 - Sensitivity)}{Specificity}$$

The LR+ for various cut-off values for continuous or ordinal test variables can be presented graphically by drawing a ROC curve

Cut off



Positive Predictive Value (PPV)

Predictive value of the positive result of a certain test with regard to a certain disease:

- The percentage of individuals who test positive who also have the disease.
- The likelihood that an individual who tests positive will have the disease.
- The likelihood that a positive test result is really positive.

Positive Predictive Value (PPV)

SOUND control

		Condition (as determined by "Gold standard")		
		Positive	**Negative**	
Test outcome	**Positive**	True Positive a	False Positive b	PPV
	Negative	False Negative c	True Negative d	NPV
		Sensitivity	Specificity	

Sensitivity: a / (a + c) = TP/ (TP + FN)

Specificity: d / (b + d) = TN / (FP+TN)

$$PPV = \frac{a}{a+b} = \frac{TP}{TP+FP}$$

Negative Predictive Value (NPV)

SOUND control

Predictive value of the negative result of a specific test for a specific disease:

- The proportion of individuals who test negative who do not have the disease.
- The likelihood that an individual who tests negative will not have the disease.
- The probability that a negative test result is really negative.

Negative Predictive Value (NPV)

SOUND control

		Condition (as determined by "Gold standard")		
		Positive	**Negative**	
Test outcome	**Positive**	True Positive a	False Positive b	PPV
	Negative	False Negative c	True Negative d	**NPV**
		Sensitivity	Specificity	

Sensitivity: a / (a + c) = TP/ (TP + FN)

Specificity: d / (b + d) = TN / (FP+TN)

$$NPV = \frac{d}{c+d} = \frac{TN}{FN+TN}$$

Sensitivity, Specificity, PPV and NPV

SOUND control

		Condition				
		Positive	*Negative*	total		
Test outcome	*Positive*	136	7	143	0,951	PPV
	Negative	5	124	129	0,961	NPV
	total	141	131	272		
		0,965	0,947			
		Se	Sp			

Influence of prevalence on PPV

SOUND control

Pop.: 10000;
Prev: 20%;
Se: 0,98; Sp: 0,99

		Condition			
		Positive	*Negative*	total	
Test outcome	*Positive*	1960	80	2040	→ PPV: 0,960
	Negative	40	7920	7960	
	total	2000	8000	10000	

Pop.: 10000;
Prev: 1%;
Se: 0,98; Sp: 0,99

		Condition			
		Positive	*Negative*	total	
Test outcome	*Positive*	98	99	197	→ PPV:0,497
	Negative	2	9801	9803	
	total	100	9900	10000	

Prevalence:
Proportion of individuals in a population who have the disease at a given point in time.
Probability that an individual, chosen at random from the population, has the disease.

Influence of prevalence on PPV

SOUND control

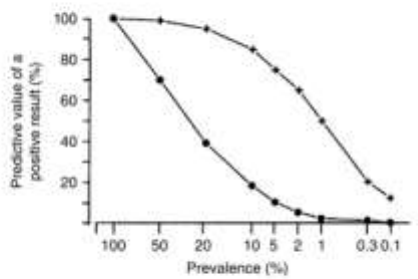


Fig. 20.3 The relationship between prevalence and predictive value of a positive test result. +: Sensitivity = 99%, specificity = 99%; •: sensitivity = 70%, specificity = 70%.

Thrusfield 2001

Influence of prevalence on PPV

http://www.winepi.net/uk/index.htm
Diagnostic
Estimation of predictive values

10% Prevalence
Se 99% Sp 99%
Population 10M
Calculate PPV, TP and FP

- PPV 91.7%
- 990,000 true positives
- 90,000 false positives

0.01% Prevalence
Se 99% Sp 99%
Population 10M
Calculate PPV, TP and FP

- PPV 1%
- 990 true positives
- 99,990 false positives

Influence of prevalence on PPV

How to increase the PPV?

- Use it in a population with higher prevalence
- Use a more Specific test with same or higher Sensitivity- As Sp increases, so does PPV as the number of false positives approaches cero
- Use more than one test

Limits of diagnostic tests

- The quality of a diagnostic test determines if I can use it for a special purpose. E.g. a test with a Sp 92% can not be used to detect a threshold prevalence of 1 %
- Se and Sp can be varied by changing the cut off value
- The diagnostic test has to be chosen by looking at Se, Sp and prevalence

Influence of imperfect tests on sample size

SOUND control

- Sample size increases
- A population can be free even if you have positive test results

Example:

Detection of disease 5% threshold prevalence, 95% confidence, population size 10,000

- 59 samples required with Se 100%, Sp 100%
- 376 samples required, cutpoint no of reactors: 27 with Se 96,5%, Sp 94,7%

Comparison of two testing systems

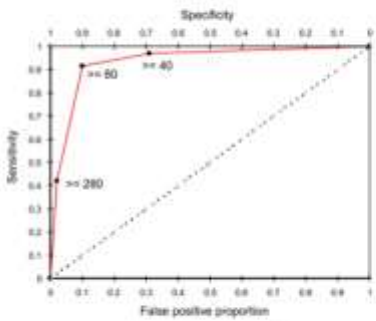
SOUND control

- 'Gold standard'.... Not always perfect!
- Lower Se in Gold Standard will cause decrease in Sp of the test evaluated
- Lower Sp in Gold Standard will cause decrease in Se of the test evaluated
- Gold standard should be applied to animals (healthy and diseased) that are representative of the population

Comparison of two testing systems

SOUND control

Receiver-operating characteristic (ROC) curve



1-Spec.	Sens.	Cutoff
0	0	
0.02	0.42	>=280
0.10	0.92	>= 80
0.31	0.97	>= 40
1	1	

Pfeiffer 2002

Parallel/sequential testing

Parallel testing

- Conducting two or more tests at the same time
- Animals are considered to be affected if they are positive to any of the tests.
- Increases Se and NPV
- Reduces Sp and PPV
- Disease is less likely to be missed – but false positives more likely

Parallel/sequential testing

Sequential testing

- Conducting two or more tests in sequence (i.e. consecutively)
- Typically, animals are considered to be affected if they are positive to ALL tests.
- Increases Sp and PPV
- Reduces Se and NPV
- Increases the risk that disease will be missed
- Test with highest Specificity should be used first

Parallel/sequential testing

Parallel	Sequential
Tests performed at the same time. Results are combined.	Second test only performed if the first is positive.
Positive = Any positive result	Positive = All positive results
Higher Sensitivity & NPV Lower Specificity	Higher Specificity & PPV Lower Sensitivity
Rule out a disease	Rule in a disease
Rapid assessment.	Test & removal.

Parallel/sequential testing

SOUND control

Test :	Test A	Test B
Sensitivity :	80%	90%
Specificity :	90%	99%
Prevalence %:	20	
Population Size :	200000	

	Serial	Parallel
Sensitivity :	**72.0%**	**98.0%**
Specificity :	**99.9%**	**89.1%**
Positive Pred. Value :	99.4%	69.2%
Negative Pred. Value :	93.5%	99.4%
Apparent Prev. :	14.5%	28.3%
Youden's J :	71.9%	87.1%
Fiability :	94.3%	90.9%

		Dis.	Heal.
Diag.	+	28800	160
	-	11200	159840

		Dis.	Heal.
Diag.	+	39200	17440
	-	800	142560

Winepi.net

Parallel/sequential testing

SOUND control

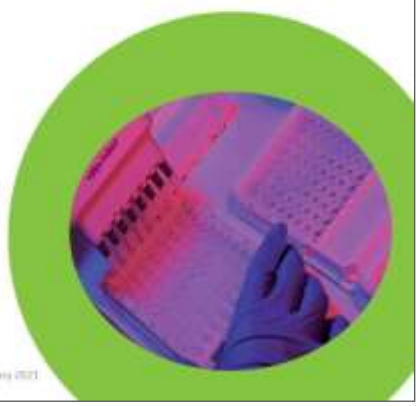
Considerations

- Test independence: PCR/antibody testing
- Test/disease characteristics:
- Johne's testing in animals < 2 years old
- BSE testing < 12 months-old

Summary

SOUND control

- Diagnostic tests characteristics will influence the quality of data obtained
- Se and Sp can be varied by changing the cut off value
- The diagnostic test must be chosen by looking at Se, Sp and prevalence
- Need to know the disease and test characteristics
- Multiple tests may be used



Resources

SOUND control

http://www.winepi.net/uk/index.htm

https://epitools.fp7-risksur.eu/tools/index?toolId=44

https://epitools.ausvet.com.au/roccurves

SOUND control
COST Action CA17110

Training school

Basic Concepts in Epidemiology and Surveillance

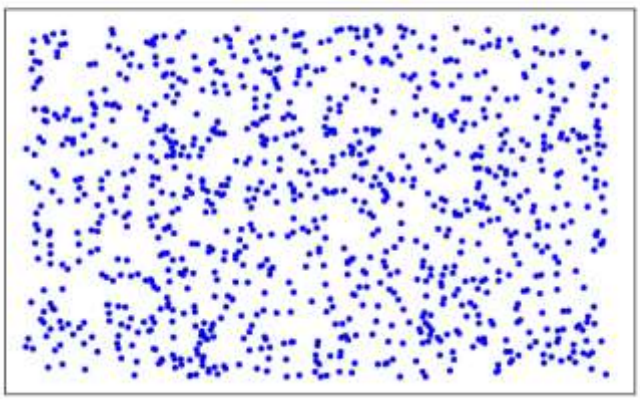
Sample size

Jörn Gethmann, Carola Sauter-Louis

Agenda

- Why sampling?
- Sampling methods
- Mathematical background
- Sample size calculation
  - Detection of disease
  - Prevalence estimation
- Influence of Se/Sp on sample size

Population



N=1000

Status	n
diseased	??
healthy	??

Disease status

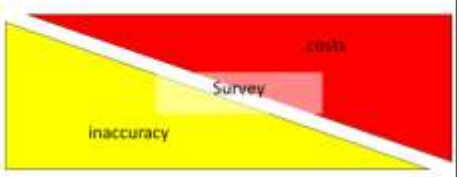
How to find out, if and how many animals are diseased?

Write your suggestions in the chat

Sampling

- Census
  - **All** individuals of a population are investigated.
  - Only means of measuring the distribution of a variable in population **exactly.**
    - Expensive, difficult
- Sample survey
  - **Some** individuals of a population are investigated.
  - The distribution of variables is estimated
    - Assumption: population consists of representative subunits, characteristics of the aggregate can be estimated form the subunits
    - Less expensive, easier

Thrusfield, 1995



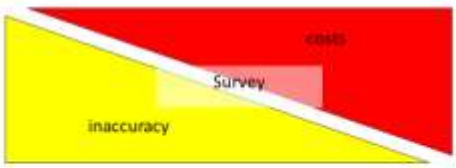
Sampling

What is a sample?

- Only a small proportion (sample) of the population

Why to use a sample?

- Inexpensive and fast
- Monitoring and Surveillance



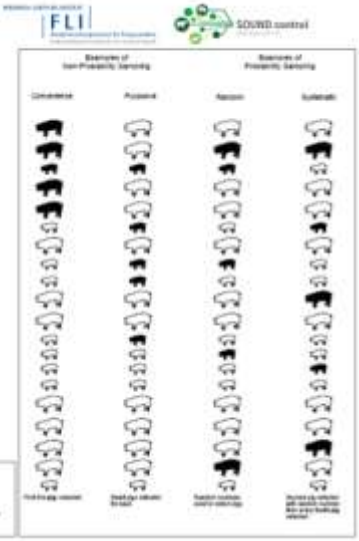
Sampling

You decided to run a sample survey to find out
1) if the disease is present
2) How many animals are diseased

Discuss briefly, what you need to know
- To determine how many animals need to be tested
- To decide, which animals have to be tested
- How to perform the sampling

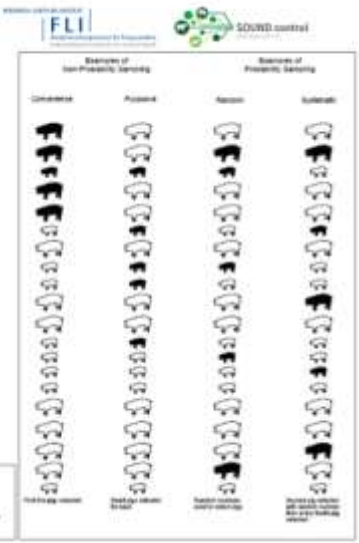
Sampling methods

- Non-probability s. m.
  - Convenience
  - Purposive
- Probability s. m.
  - Simple random
  - Systematic
  - Stratified
  - Cluster
  - Multistage



Sampling methods

- Non-probability s. m.
  - Convenience
  - Purposive
- Probability s. m.
  - Simple random
  - Systematic
  - Stratified
  - Cluster
  - Multistage



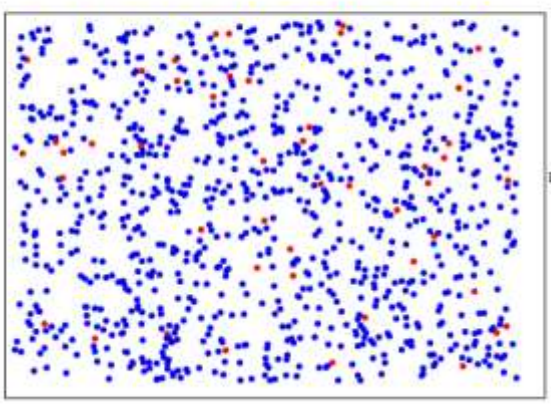
Non-probability sampling

- Convenience sampling
  - Simple
  - Not representative
  - Biased
- Purposive sampling
  - Selection from population
  - No information for the whole population

Probability sampling

- Simple random sampling
  - In the field not "simple"
  - Representative
- Systematic sampling
  - Easier be done than Simple random sampling
  - Bias might be higher

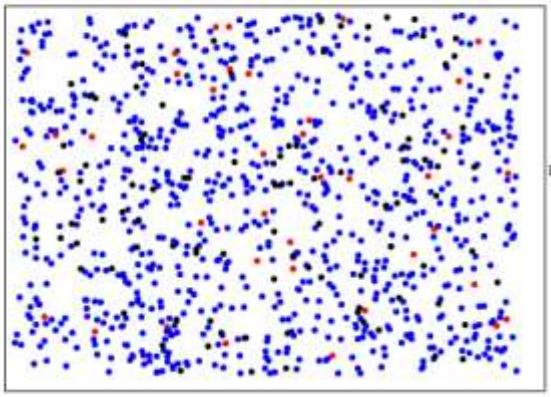
Population



BVD

Status	n
diseased	49
healthy	951

Sampling - random

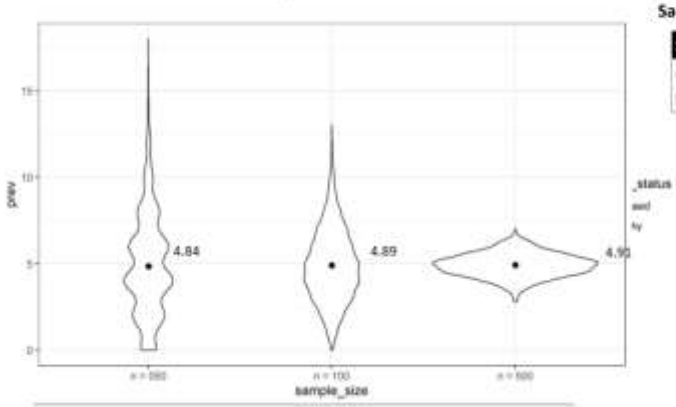


BVD

Status	n
diseased	49
healthy	951

Sampling

1000 repetitions

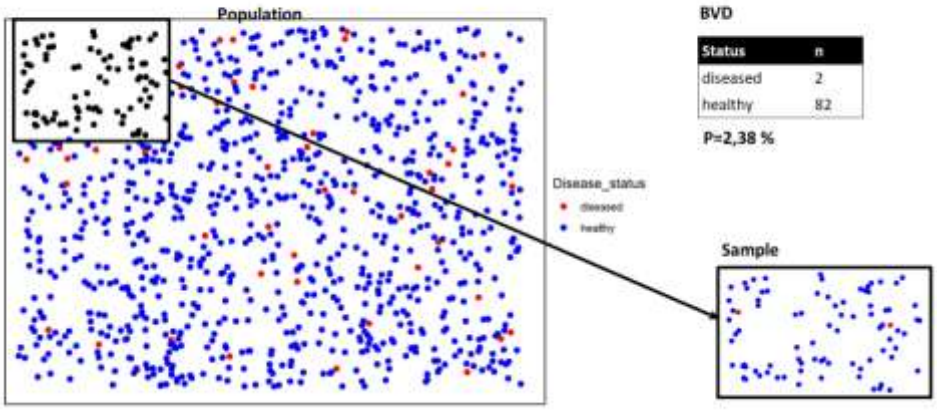


Sample of 100 animals

Status	n
diseased	8
healthy	92

P=8 %

Sampling - convenience

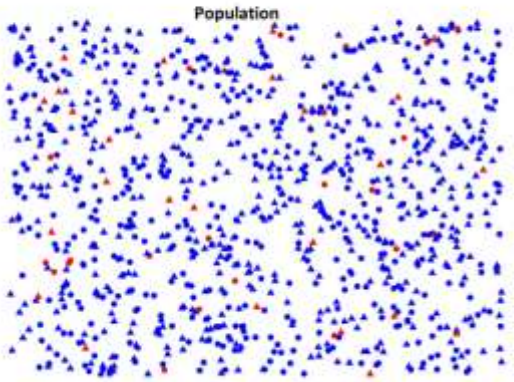


BVD

Status	n
diseased	2
healthy	82

P=2,38 %

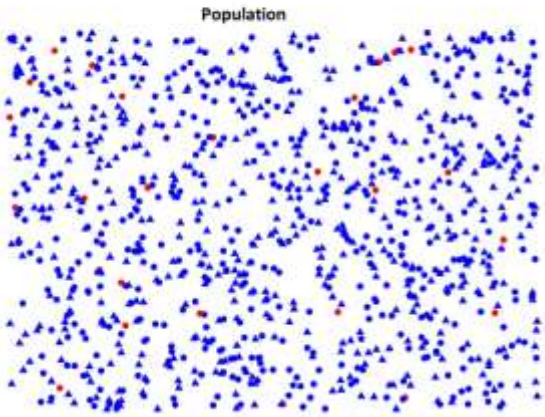
Sampling



BVD

Sex	Status	n
female	diseased	26
female	healthy	429
male	diseased	23
male	healthy	522

Sampling



Metritis

Sex	Status	n
female	diseased	26
female	healthy	473
male	healthy	501

Sampling -*Representativeness*

Census	Prevalence in population	=	Prevalence in population
Representative sample	Prevalence in population	≈	Prevalence in sample
Risk based sample	Prevalence in population	<	Prevalence in sample
Biased sample	Prevalence in population	≠	Prevalence in sample

Mathematical background
Sampling and probabilities

Two options

- Sampling without replacement
  - E.g.: lotto, poker, survey

- Sampling with replacement
  - E.g.: to dice

What's the difference?

The population size in sampling with replacement is constant

Sampling and probabilities

1) **Sampling without replacement**
   - Probabilities are changing
   - **Not** independent from previous result

     selecting a certain number with the first ball: $\frac{1}{49}$,

     Selecting a certain number with second ball $\frac{1}{48}$ or $\frac{0}{48}$

2) **Sampling with replacement**
   - E.g.: roll dices
   - Probabilities always the same
   - Independent from previous roll
   - Probability, to roll a 6 is always $\frac{1}{6}$

Sampling and probabilities

1) **Sampling without replacement (in general, a survey for animals)**
   - Calculation more difficult, for large populations not possible (needs factorials, limit in Excel and r 170…)
   - With some specific methods large numbers possible

2) **Sampling with replacement**
   - Calculation easy
   - No difference in sample size between SwoR and SwR for large numbers
   - Can be carried out in all standard apps

Detection of disease

- Sample size estimation (Cannon & Roe (1982)):

$$n = \left(1 - (1 - CL)^{\frac{1}{d}}\right) \times \left(N - \frac{(d-1)}{2}\right)$$

n = sample size

N = Population size

d = estimated cases in population (design prevalence)

CL = Confidence level (e.g. 95 % = 0,95)

More details at

Survey Toolbox for Livestock Diseases

A Practical Manual and Software Package for Active Surveillance in Developing Countries

Detection of disease

- Sample size estimation (Cannon & Roe (1982)):

$$n = \left(1 - (1 - 0.95)^{\frac{1}{(1000 \times 0.05)}}\right) \times \left(1000 - \frac{((1000 \times 0.05) - 1)}{2}\right)$$

$$n = 0.0581 \times \left(1000 - \frac{((1000 \times 0.05) - 1)}{2}\right) = 57$$

n = sample size

N = Population size

d = estimated cases in population (design prevalence)

CL = Confidence level (e.g. 95 % = 0,95)

Prevalence estimation

- Sample size estimation

$$n = \left(\frac{t \cdot \sqrt{p \cdot (1-p)}}{d}\right)^2 = \frac{t^2 \cdot p \cdot (1-p)}{d^2}$$

- correction, when n/N<5%:

$$n(c) = \frac{n}{1 + \left(\frac{n}{N}\right)}$$

n	sample size
t	Student's t-value
d	accepted absolute error or precision (e.g. 5%)
p	prevalence
n(c)	corrected sample size
N	population size

Confidence interval	Student's t-value
90	1,6448
95	1,96
97,5	2,2414
99	2,5758
99,5	2,807

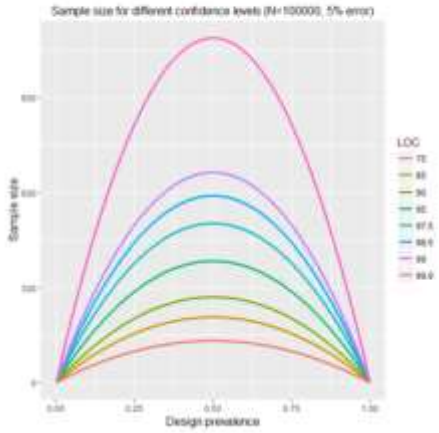
Prevalence estimation

- Highest sample size, when design prevalence is 50%
- Smaller absolute error lead to bigger sample size

More details at

Survey Toolbox for Livestock Diseases

A Practical Manual and Software Package for Active Surveillance in Developing Countries



Effect of imperfect tests on sample size

- Previously, we assumed that we have perfect tests
- Please discuss the influence of imperfect tests on
  - Sample size
  - The interpretation of the outcome of the survey
- Does Se or Sp have a higher impact on the sample size?

Go to www.menti.com and use the code 74 76 03 2

Effect of imperfect tests on sample size

- Assume we have a test for our disease with a sensitivity (Se) of 90% and a specificity (Sp) of 99%
- Remember, we have a population with 1000 animals and a prevalence of 5 %
- With CI = 95%, Se=1 and Sp=1 ➔
- Sample size = 57

		True value				
		pos	neg	total		
Test	pos	45	9.5	**54**	**ppV**	82,57
	neg	5	940.5	**946**	**npV**	99,47
	total	**50**	**950**	**1'000**		
		Se	**Sp**			
		90	99		P =	5,00

Effect of imperfect tests on sample size

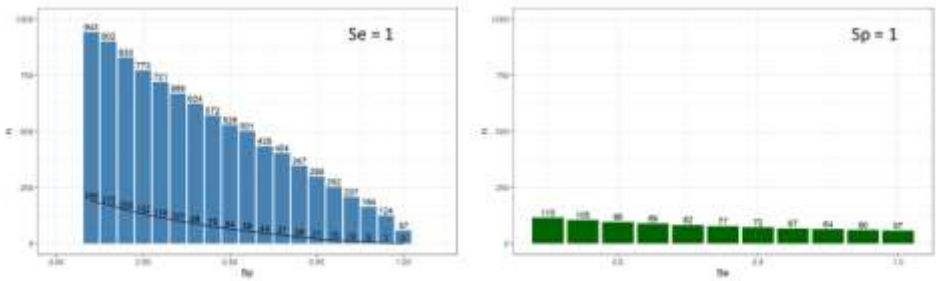
https://epitools.fp7-risksur.eu/tools/index?toolId=46

Population size	1000	1000	1000	1000
Test sensitivity	**1**	**0.9**	**0.9**	**1**
Test specificity	**1**	**0.99**	**1**	**0.99**
Design prevalence	0.05	0.05	0.05	0.05
Required sample size:	57	136	64	124
Cut-point number of positives:	0	3	0	3
Interpretation:	If a random sample of **57** units is taken from a population of **1000** and **0** or fewer reactors are found, the probability that the population is diseased at a prevalence of **0.05** is **0.0492**.	If a random sample of **136** units is taken from a population of **1000** and **3** or fewer reactors are found, the probability that the population is diseased at a prevalence of **0.05** is **0.0491**.	If a random sample of **64** units is taken from a population of **1000** and **0** or fewer reactors are found, the probability that the population is diseased at a prevalence of **0.05** is **0.0481**.	If a random sample of **124** units is taken from a population of **1000** and **0** or fewer reactors are found, the probability that the population is diseased at a prevalence of **0.05** is **0.0495**.

Effect of imperfect tests on sample size

https://epitools.fp7-risksur.eu/tools/index?toolId=46

N	prev	CI
1000	0.05	0.95



Complex sampling design

- Stratified sampling
  - Useful, if the prevalence between strata shows large differences (e.g. number of positives by age)
  - Information for each stratum needed
  - Random sample in each stratum
  - Summarize results and estimation of overall sample size
- Cluster sampling and multistage cluster sampling
  - Simple: several clusters (e.g. regional clusters) will be selected and all animals in one cluster will be tested
  - Complex: sample size for clusters and animals will be calculated separately
- Error on each level
  - Bonferroni correction necessary
- Examples at
  - https://epitools.fp7-risksur.eu/tools/index?toolId=41
  - https://epitools.ausvet.com.au/twostageprevalencetwo


SOUND control
COST Action CA17110
Training school
Basic Concepts in
Epidemiology and Surveillance
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Training school

Basic Concepts in Epidemiology and Surveillance

MONITORING AND SURVEILLANCE

John Berezowski, Jörn Gethmann

What you will learn in this part of the course

SOUND control

- Purpose and outputs of surveillance
- Relationship between surveillance and disease control
- Activities involved in surveillance
- Different types of surveillance, where they are used; their advantages and limitations
- Important concepts to consider when designing a surveillance system

http://www.fp7-risksur.eu/project

SOUND control

RISKSUR

Project | Partners | Progress | News & Events | Links | Terminology

Challenges | Objectives & Impact | Project Architecture | Facts & Figures

Objectives & Impact

The overall aim of RISKSUR is to develop and validate conceptual and decision support frameworks and associated tools for designing efficient risk-based animal health surveillance systems. RISKSUR will develop tools and frameworks targeted at the following surveillance objectives associated with livestock diseases:

- Detection of incursion of exotic, new (emerging) and re-emerging diseases
- Declaration of freedom from specified diseases and infections
- Monitoring of endemic diseases (case detection, disease frequency estimation)

Outline

1. Introduction
2. Purpose of surveillance
3. Surveillance activities
4. Types of surveillance
5. Surveillance design considerations

1. Introduction

- History
- Who Does Surveillance
- Surveillance Stakeholders
- Surveillance and VPH
- Surveillance Definition
- Monitoring Definition

Outline

1. Introduction
2. Purpose of surveillance
3. Surveillance activities
4. Types of surveillance
5. Surveillance design

History of Animal Health Surveillance

- Origins in the reporting of animal plagues of 18th century
- 1924 the OIE was established
- 20th century disease erradication programs
- BSE
- 1995 WTO, SPS, OIE
- Sept 11, 2001
- 2002 EU came into force

All Countries do Some Animal Health Surveillance

Every country should be able to:

- Describe the diseases that are present (endemic) and their importance
- Prove freedom from important diseases
- Detect - in a timely fashion:
  - New disease introductions
  - Change in important endemic diseases
  - Exotic (transboundary) disease introductions

Required for: international dz reporting and trade
managing disease in national populations

AH Surveillance Stakeholders

Many:

- Farmers, the public, consumers
- Livestock traders, all farm support industries
- Veterinarians, veterinary associations, researchers
- Government organizations (local, state, national)
- NGOs, producer groups, industry associations
- International Organizations: OIE, FAO, WHO, EU

Who conducts AH surveillance?

- Governments agencies/organizations
- Academic researchers
- Veterinary practices
- Veterinary associations
- Producers
- Producer/industry associations

Most AHS is conducted by Veterinary Services working as part of state or national governments

Surveillance in VPH

- Conducted by Veterinary Service Organizations
  - Partnerships with NGOs are common
- For public good
- Under various legislative authorities/regulations
  - International
  - National
  - State/province/canton
- Resources are always limited
  - Expenditures must be justified
  - Efficiency is essential

Definition of the Word Surveillance

Miriam Webster

- "close watch kept over someone or something (as by a detective)"

Origin:

- French, from *surveiller* to watch over,
- from *sur-* + *veiller* to watch,
- from Old French *veillier,*
- from Latin *vigilare,* from *vigil* watchful
- First Known Use: 1802

AH Surveillance Supports Action

RISKSUR Definition:

- The systematic, continuous or repeated, measurement, collection, collation, analysis, interpretation and timely dissemination of animal health and welfare related data from defined populations.

- These data are then used to describe health hazard occurrence and to contribute to the planning, implementation, and evaluation of risk mitigation actions

AH Surveillance Supports Action

SOUND control

Data collection And Observation → Information Production → Decision, Action, Disease Control, Policy development

→ Confirmed Case of FMD on farm X in county Y → Farm quarantined Outbreak investigation Farms identified in trace back-forward quarantined

AH Monitoring Does Not Support Action

SOUND control

RISKSUR Definition:

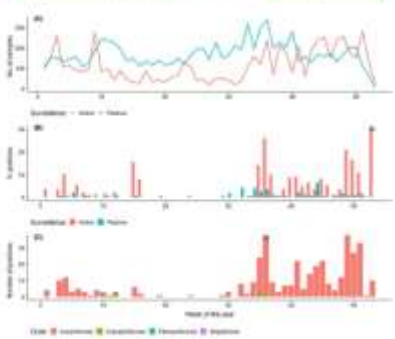
- The systematic, continuous or repeated, measurement, collection, collation, analysis and interpretation of animal health and welfare related data in defined populations

- When these activities are not associated with a pre-defined risk mitigation plan/response
- **HOWEVER:** extreme changes are likely to lead to action.

AH Monitoring Does Not Support Action

SOUND control

Data collection And Observation → Information Production



Annual Report on surveillance for avian low path influenza in poultry and wild birds in Member States of the European Union in 2018

- Low Path AI
- Birds are sampled
- Data collected, stored and monitored over time
- No mitigation action

EFSA Journal, Volume 17, Issue 12, First published: 19 December 2019, DOI: (10.2903/j.efsa.2019.5946)

2.Purpose of Surveillance

SOUND control

- Theory of surveillance
- Policy purpose and surveillance purpose
- Surveillance and disease control
- Surveillance purposes
  - Early detection
  - Freedom from disease
  - Measuring disease
  - Case finding

Outline

1. Introduction
2. Purpose of surveillance
3. Surveillance activities
4. Types of surveillance
5. Surveillance design

The Big Picture

SOUND control

Surveillance reduces the burden of disease (hazard):

- Pubic health (zoonoses, food safety)
- Animal health, productivity and welfare
- International trade

What is needed to initiate surveillance?

SOUND control

Data collection And Observation → Information Production → Decision, Action, Disease Control, Policy development

1. **Dissatisfaction**
   - Occurs when the current state is unsatisfactory compared to a desired state
2. **Need:**
   - For information:the source of dissatisfaction
3. **Motivation**
   - Eliminate the dissatisfaction and meet the information need

*El Allaki F 2012 A population Health Surveillance Theory

Policy purpose defines the surveillance purpose

Policy purpose:

- How the information produced by surveillance will be used to make decisions relating to animal health, animal welfare, public health, food safety and trade.

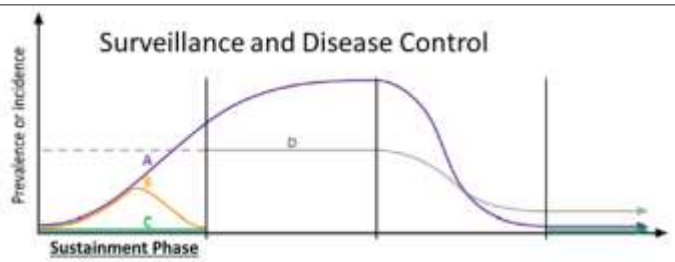
Surveillance purpose:

- The type of information produced by surveillance

Surveillance AND Disease Control

Intimately linked

Surveillance and Disease Control



The disease may be:

A. Increasing

B. Short outbreaks that are successfully managed can occur

C. Absent

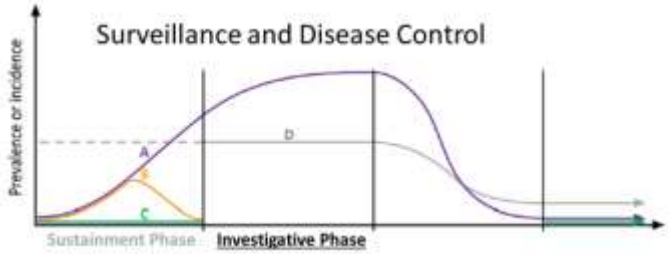
D. Or there may be uncertainty about the disease. Dashed line

Surveillance information:

- Early detection: emerging or exotic dz incursions: C
- Prevalence/Incidence estimation: A, B, D
- Proving disease freedom: C

Häsler et al. BMC Health Services Research 2011, 11:225

Surveillance and Disease Control

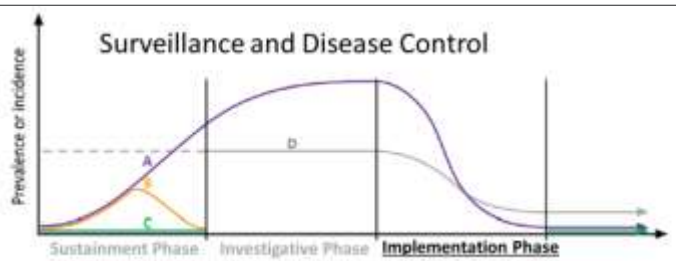


The disease:
- Has a significant burden
- A decision must be made whether to intervene or not
- What sort of intervention would be needed ?

Surveillance information:
- Produce Information needed to decide whether to intervene and the nature of the intervention

Feb. 1-2, 2023 Hässler et al. BMC Health Services Research 2011, 11:225 22

Surveillance and Disease Control



The disease:
- Will be decreasing as the control program is implemented

Surveillance information:
- Case detection, infected or high risk individuals or farms
- Disease prevalence/incidence: to estimate effectiveness of the control program
- Prove freedom from disease to stop the erradication program

Feb. 1-2, 2023 Hässler et al. BMC Health Services Research 2011, 11:225 23

BVD in Switzerland

Policy purpose: eradication of BDV

Surveilance purpose: BVD prevalence and finding PI animals

- Sustainment phase: pre-2008
  - Surveillance to estimate the prevalence
- Investigative phase: 2008 census
- Implementation phase: 2008 - 2012
  - 2008: National herd tested for Aby and IHC -> 0.8% of animals and 20.0% of farms were virus positive. All PI animals removed
  - 2008 -2012: Test all newborn calves and remove PI's (decreased from 1.4% to less than 0.02%)
- Sustainment phase
  - Bulk milk sampling of dairy herds and blood testing of beef herds
  - 2015, a total of 111 farms (0.2%) newly infected through PI animals were reported

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Surveillance Purpose

The type of Infromation produced by surveillance

For infectious diseases:

If the disease is absent:

1. Early detection
2. Demonstrate dz freedom

If the disease is present

3. Describe dz (level, distribution, impact)
4. Find cases

1.Early Detection

Hazards that are:

- New (previously unknown)
- Emerging (changing in importance or region)
- Exotic (FADs, transboundary diseases)

Importance:

- Early response
- Stop pathogen spread
- Reduce the burden of the disease
- Confidence in disease freedom

1.Early Detection

Goal:

- Detect case occurrences as early as possible
- Early: depends on the rate of disease spread

Surveillance must be:

- Highly sensitive:
  - Detect cases at a low prevalence (design prevalence)
- Broad coverage:
  - Often not possible to predict where a case will appear
- Continuous
  - Often not possible to predict when a case will appear

1.Early Detection

Surveillance components (usually passive):

- Notifiable/reportable disease programs
- Laboratory testing results
- Slaughterplant surveillance for specific dzes (TB)
- Syndromic surveillance:
  - Veterinary practices
  - Slaughterplant lesions
  - Farm production data
  - Antbiotic sales
  - Laboratoy submissions

2.Demonstrating Disease Freedom

Known hazards that are:

- Exotic (transboundary dzes, FADs)
- Recently completed eradication program
- Country vs compartments

Importance:

- Trade: access to markets
- Population health protection
- Concluding eradication or control measures

2.Demonstrating Disease Freedom

Goal:

- Provide credible evidence of disease (case) absence

Surveillance:

- Must be sensitive enough to detect cases if they are present
  - Design prevalence is often higher than early detection
  - Dependant on how quick the dz spreads
- Can be intermittent and the evidence updated
  - Even though probability of case occurence is often continuous
- Valid: sampling is important

2.Demonstrating Disease Freedom

Surveillance components:

- **Active:**
  - Representative (random) population sampling
- **Passive:**
  - All passive components can be used
  - BUT: it is often difficult to estimate the population level sensitivity of passive surveillance.....important

3.Measuring the level of disease

Hazards that are:

- Endemic dseases
- Cases are present over time

Importance:

- Prioritizing hazards by their importance
- Risk analysis
- Characterizing hazard: geographical, temporal distribution, identifying changes in disease epidemiology

3.Measuring the level of disease

Goal:

- Provide an accurate estimate of the amount (prevalence or incidence) and distribution of the hazard in the population

Surveillance:

- Precise: lacking random error
  - Sample size
- Unbiased: lacking systematic error
  - Random/representative sampling
- Adhoc, periodic, doesn't need to be continuous

3.Measuring the level of disease

Surveillance components

- **Active:**
  - Representative (random) population sampling
- **Passive:**
  - Use with caution!
  - All passive samples are biased
  - Even before-after a program estimates may be biased

4.Case finding

Hazards that are:

- Recently introduced or emerged (outbreaks)
- Under control or erradication programs

Importance:

- Stop dz spread in acute outbreaks
- Mop up last cases in erradication programs

4.Case finding

Goal

- Find all cases (farms/animals that meet the case definition) in the geographic region of interest

Surveillance:

- Sensitive: detecting all cases is essential
- Broad and comprehensive coverage
  - Can be risk-based ie surveillance zones, and tracing
- Continuous

4.Case finding

SOUND control

Surveillance Components

- **Active**
  - Random/representative sampling of population
    - For slowly transmitted diseases
  - Risk-based sampling
    - Hig risk, incontact farm surveillance
- **Passive**
  - Farmer, veterinary, laboratory reporting
    - Under reporting and failure to report is a problem with stigmatized dzes
  - Slaughter plant, auction market surveys
    - Eg. finding TB and Brucellosis cases

3. Surveillance Activities

SOUND control

- Hazard selection
- Case definition
- Case finding
- Case counting
- Surveillance results
- Communication
- Response

Outline

1. Introduction
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Hazard Selection

SOUND control

- Hazards have the potential to cause adverse health effects
- Biological, chemical or physical agents
- The focus of the surveillance
- The reason for doing surveillance

RISKSUR: A biological, chemical or physical agent
in, or a condition of :
an animal or animal product
with the potential to cause an adverse health effect.

Hazard Selection

- Defined internationally
  - OIE, EU, WHO, Codex Alimentarius
- Defined by national or regional goverments
- Risk-based approaches can be used to prioritize hazards

Target Population

- The population under surveillance
  - The population about which generalizations will be made
- Further defined by:
  - Species
  - Production sector (dairy vs beef)
  - Geographic region
- Samples, data and observations are collected from the target popualation

Case and Case Definition

Animal/Farm + **Hazard** = **Case**

- **Case:** Animal (farm) that meets the case definition
- **Case Definition**: All the criteria needed to classify an animal(farm) as a case....or not
  - May change over time and through stages of the diagnostic process
  - Suspect Case -> Confirmed Case
- Establishing a well thought out case definition is a critical step in surveillance system design

Case and Case Definition

Animal/Farm + **Hazard** = Case

- Clinical signs or syndromes (including death)
- Pathology (gross/histo)
- Laboratory tests for pathogens or toxins
- Laboratory test for host response (e.g. serology)
- Risk factor(s)
- Indirect indicators (e.g. drug sales, production or performance information, abattoir submissions)

Case definition

- As it might be difficult to decide, whether an animal/person is counted as diseased or not, there often is a case definition, e.g.

Article 9
Case definitions

1. The competent authority shall classify an animal or a group of animals as a **suspected case** of a listed disease or of an emerging disease when:
   a) clinical, post-mortem or laboratory examinations conclude that ***clinical sign(s),*** post-mortem lesion(s) or histological findings are indicative of that disease;
   b) result(s) from ***a diagnostic method*** are indicating the likely presence of the disease in a sample from an animal or from a group of animals; or
   c) an ***epidemiological link*** with a confirmed case has been established.

Examples of Case Definitions

Bovine Neonatal Pancytopenia:

- a calf 28-days-old or younger,
- unexplained haemorrhages detected at necropsy,
- Trilineage hypoplasia of bone marrow confirmed by histopathology.

- Trilineage hypoplasia: concurrent depletion of erythroid and myeloid cells and megakaryocytes from bone marrow resulting in less than 25% cellularity

Examples of Case Definitions

Schmallenberg

To facilitate the identification of potential cases of Schmallenberg virus infection, the EFSA produced this checklist of clinical features for fetuses and neonates

(a)

(b)

Case Finding and Counting

SOUND control

Basic activity of surveillance

1. Find cases (animals or farms)
   - Sampling, notification etc
2. Count cases
   - Also count non-cases (denominator)

Increased number of cases : outbreak (epidemic)

Implies knowing the expected number of cases

Surveillance Results

SOUND control

Since the main activity of surveillance is counting cases..results are expressed as:

- **Incidence:** rate of occurrence of new cases
- **Prevalence:** amount (proprotion) of cases in the population

Often presented, or grouped by characteristics of the cases:

- Species, sex, age, geographic region, date (season), production type

Surveillance Communication and Response

- Communcation channels are pre-defined
  - Who will be notified and when
  - Often tightly controlled
  - Premature communication has consequences
- Responses are usually predefined
  - Range of responses
  - Investigation to confirm surveillance results
  - Immediate action: remove carcass, product recall
  - Activation of emergency response plan
  - Policy development

4. Types of Surveillance

- Active vs Passive
- Risk-based
- Sentinel
- Targeted
- Syndromic
- Participatory
- Indicator vs Event Based
- Survey

How to find cases

Outline

1. Introduction
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Active Surveillance

- Investigator actively seeks out and finds cases
- Investigator decides which animals are sampled
- Most often by sampling the target population
- Eg: A random sample of cattle in Switzerland to estimate the prevalence of BVD

RISKSUR: Investigator-initiated collection of animal health related data using a defined protocol to perform actions that are scheduled in advance. Decisions about whether information is collected, and what information should be collected from which animals is made by the investigator

Active Surveillance

Pros

- Can be representative of the population
- Valid estimates of population parameters

Cons

- Expensive, labor and resource intensive
- Not continuous, not good for early detection
- May not know the complete sampling frame

Passive Surveillance

- Investigator does not actively seek cases …..waits passively for cases
  - Cases are reported to the investigator from people outside their organization eg. reportable dz programs
- Or Investigator uses data collected for other purposes
  - Using meat inspection data for surveillance

RISKSUR: Observer-initiated provision of animal health related data (e.g. voluntary notification of suspect disease) or the use of existing data for surveillance. Decisions about whether information is provided, and what information is provided from which animals is made by the data provider.

Passive Surveillance

Pros

- Continuous: good for early detection
- Inexpensive

Cons

- Little control over who submits data/samples
- Not representative of the population
- Some animals not seen by vets, laboratories etc
- Dependant on the willingness of people to report cases:
  - Awareness campaigns vs stigmatized dzes

Enhanced Passive Surveillance

- Investigator encourages reporting of cases
  - Monetary or other rewards
  - Training, awareness campaigns
  - Indemnity programs for stamping out

RISKSUR: Observer-initiated provision of animal health related data with active investigator involvement e.g. by actively encouraging producers to report certain types of disease or by active follow up of suspect disease reports

Risk-Based Sampling/surveillance

- Use risk factors to identify subpopulations where cases are more likely to occur or be found
  - Region, season, age, production type, etc.
- Sample in high risk subpopulations
  - Trichinella: focus on farms with outdoor pig rearing

RISKSURE: Use of information about the probability of occurrence and the magnitude of the biological and/or economic consequence of health hazards to plan, design and/or interpret the results obtained from surveillance systems.

Risk-Based Sampling/surveillance

Pros

- Economical and resource efficient
- Get the information needed using less resources

Cons

- Not a random sample: issues of validity
- BE VERY CAUTIOUS: sample a subset of the population and make inferences about the whole population

Targeted surveillance

Two meanings for the term:

1. Focused on a specific hazard
   - FMD surveillance
2. Focused on a specific subpopulation
   - Targeted sampling
   - Risk based sampling/surveillance

Sentinel Surveillance

- Repeated data collection from a subset of the population
- Subset is meant to represent the population
  - Sentinel farms, vet practices, animals
  - Sentinel chickens: represent risk to population

RISKSUR: The repeated collection of information from the same selected sites or groups of animals (e.g. veterinary practices, laboratories, herds or animals) to identify changes in the health status of a specified population over time. These sentinels should act as a proxy for the larger population of interest; they may be selected on the basis of risk but can also be selected randomly or on the basis of convenience or compliance.

Indicator based surveillance

- Traditional disease surveillance
- Find and count cases
- Analyze data to determine if there **indicators** of a disease epidemic

RISKSUR: Traditional disease surveillance which relies on the collection of data about the occurrence of pre-defined diseases or conditions and which uses agreed-upon case definitions; these data are analyzed to produce indicators that point towards the existence of a threat

Event based (media-based, digital) surveillance

SOUND control

- Surveillance of events not individual cases
- Events can be outbreaks/epidemics or events that can be indicative of increased health risk
- Many data sources (WWW, nespapers, gov'ts etc)
  - Promed, healthmap, GPHIN etc
- Requires rapid assessment of the risk

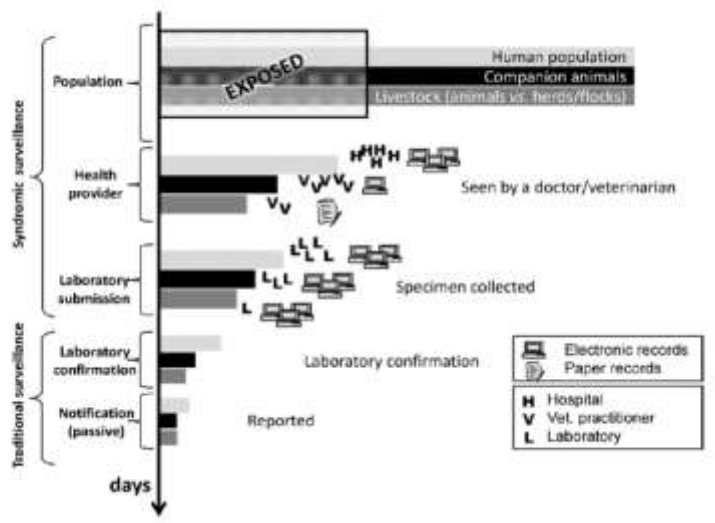
RISKSUR: Surveillance that complements indicator-based surveillance by continuously scanning the Internet and other communication media to detect information that might lead to the recognition of emerging threats

Syndromic surveillance

SOUND control

- Cases are unconfirmed surrogates for the hazard
  - Pre-diagnostic - before a diagnosis has been made
  - Number of abortions submitted to a laboratory
  - Somatic cell counts in milk
  - Adult cows with diarrhea seen by veterinarians
- May or may not focus on a particular hazard
- Increased counts indicate an increased probability that there is a change in health in the population

RISKSUR: Surveillance that uses health-related information that might precede or substitute for formal diagnosis.



Participatory Surveillance

SOUND control

- Involving stakeholders IN surveillance activities
- Planning, design, data collection, analysis and response

RISKSUR: Participatory surveillance explores traditional information networks by using participatory rural appraisal methods such as ranking, scoring and visualization techniques to conduct risk-based, hazard-specific surveillance. The approach uses semi-structured interviews with key informants. This enables communities to provide their knowledge regarding health events, risks, impacts and control opportunities by gathering qualitative health data from defined populations.

Survey

SOUND control

- A survey is not surveillance but can be part of surveillance
- A survey is a tool that is used to measure specific attributes
- Can be used for surveillance, but it can also be used for other activities such as research

- Eg. A questionnaire to survey farmers attitudes
  A sero-survey to estimate the prevalence of a disease

5. Considerations for surveillance design

SOUND control

- Resources
- Hazard characteristics
- Surveillance purpose
- Epidemiology
- Surveillance Characteristics
- Surveillance Components

Outline

1. Introduction
2. Purpose of surveillance
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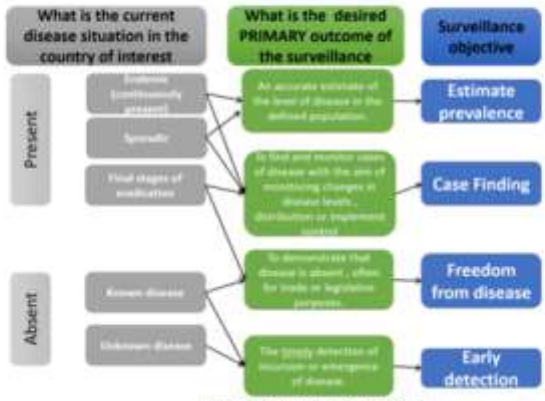
Hazard Characteristics

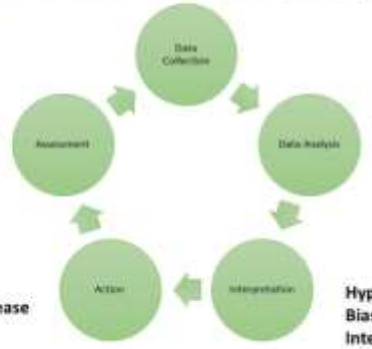
- Present vs absent
- Known or unknown
- High or low prevalence (incidence)
- Long or short incubation
- Rapid or slow transmission
- Clinically distinct or similar to other diseases

Surveillance Purpose: RISKSUR Design Tool



Surveillance is based on principles of Epidemiology

Biology and Epidemiology of Pathogens/Dzes
Surveillance/Epi Study design
Sampling: size, coverage, frequency, power
Samples: transport, testing method
Data: collection, transmisson, cleaning, storage



Principles of Evaluation
Plus everything else

Biostatistics
Test Validity
Measures of Dz
Power analysis
Time series analysis
GIS
Risk Assessment

Principles of disease control

Hypothesis testing
Bias, confounding
Interaction

Surveillance Sensitivity

Increased Sensitivity = Increased probability of finding cases

- Increase coverage, sample size, reduce the design prevalence
- Broadening the case defintion
- Risk-based surveillance
- Incentives for reporting, make reporting easy
- Consider the consequences of reporting
- Use a sensitive test
- Training, technique, quality assurance

Surveillance Specificity False Positives

Increased Sensitivity = Increased probability of finding cases + Increased False Positives

- Highly specific case definition
- Higly specific test...balance with Se
- Serial testing
- Training, technique, quality assurance
- Proper investigation of Surveillance positive is essential to identify FPs

Timeliness

- How long it takes to detect and communicate
- Important for early detection
- Make at least one component continuous
  - (or frequently repeated surveys)
- Case definition that includes early dz stage
  - Balance with FPs
- Increased sampling/observing frequency
- Rapid sample colection, transport, confirmatory testing and notification

Population Coverage

- Important for early detection and case finding
- Target additional susceptible hosts
- Ensure all segments of the population can report
- Case costs must be paid by the investigator
- Public awareness campaigns
- Incentives, endemnity
- Sampling point may affect coverage

Population Representativeness

- Surveillance accurately reflects the characteristics of the population
- Affects validity of the surveillance
- Case costs must be paid by the investigator
- Public awareness campaigns
- Increase the coverage
- Sampling point may affect coverage
- Collect descriptives to assess representativeness

Bias

- Poor case definition
  - Use a Se and Sp case defintion
- Imperfect diagnostic tests
  - Test with high Se and Sp
- Sampling errors (biased samples)
  - Consider sampling point
- Sample handling and training
  - Poor sample handling can lead to FN or FP

Bias and Precision

Ensure adequate sample size to meet needs

1. Non-Probability Sampling
   - Convenience
   - Purposive
2. Probability (Random) Sampling
   - Simple random
   - Systematic random
   - Stratified random
   - Risk-based

Resources

- Increased demands for animal health and food safety information
  - Trade, better or earlier detection because of the constant risk of dz emergence
- Reduced support for veterinary services
  - Balanced against other gov't needs in an environment of fiscal restraint
- Solutions:
  1. Prioritize hazards
  2. Risk-based surveillance
  3. Multihazard surveillance

Multi-Hazard Surveillance

Surveillance for multipe hazards

1. Parallel design
   - Surveillance designed for multiple hazards
   - Eg a survey to prove freedom from PRRS and PCV virus
2. Secondary use of samples/data
   - Surveillance designed for one hazard (mother component)
   - Data or samples are used for other purposes (child components)
   - Veterinary practice record surveillance

Surveillance System and Components

Surveillance system for a specific hazard

- Surveillance made up of components that produce data and information about one hazard
  - For example bovine TB

Surveillance component

- A single surveillance activity that produces data and information about the hazard
  - Examining adult cattle for TB like lesions at slaughter

Surveillance system for TB in US States

- Prevalence at an all time low in the US
  - Estimated at 0.0006% of population infected
  - 49 states Accredited Free (AF) Status from USDA
- But infected herds identified sporadically
  - Impacts a State's TB Status
- How is surveillance used to help AF States to maintain their status and eradicate bovine TB?

To maintain Accredited Free Status

Each State must:

1. Make bovine TB reportable by law
2. Conduct surveillance to demonstrate the prevalence of TB is less than 2% with 95% confidence in cattle and bison populations
   - TB test (caudal fold) on farm
3. Slaughter surveillance…majority of surveillance
   - In 2007: 5,892,252 cattle were slaughter tested for TB

- Have a veterinary infrastructure that can conduct a TB eradication program

Convenience sampling

SOUND control

At places where animals are collected

- Slaughter plants, markets, shared pastures

Pros:

- Easy access to large number of animals
- Reasonably good coverage of the population
- Identify possible trends in disease

Cons: biased in many ways,

- Often only health yanimals are presented
- Sick, dead animals are often not brought there
- Valid population estimates are often not possible

Farmer reporting systems

SOUND control

- Good for
  - Early detection
  - Demonstrating dz freedom
  - Identifying important dzes
  - Detecting change over time
  - Finding cases

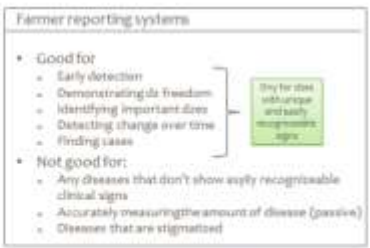
Ony for dzes with unique and easily recognizeable signs

- Not good for:
  - Any diseases that don't show easily recognizeable clinical signs
  - Accurately measuring the amount of disease (passive)
  - Diseases that are stigmatized

Veterinary Practices

SOUND control

- Similar to farmer reporting systems
- More specific case classification
- Less likely to **not** report stigmatized dzes



- Livestock value must support veterinary visits
- Dz must be serious enough to warrant a vet visit

Veterinary Diagnostic Laboratories

- Good for
  - Previously unknown or unseen diseases
  - When high specifcity is required
  - Identifying some trends
- Not good for:
  - Valid population estimates: biased sample
  - Early detection of rapidly transmitted dzes
  - Tests, level of investigation are not standardized
  - Language is not standarized

SOUND control

Thank You!

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SOUND control
COST Action CA17110

Training school

Basic Concepts in Epidemiology and Surveillance

RISK-BASED SURVEILLANCE

John Berezowski, Jörn Gethmann

RiskSur training material Katharina Stärk

SOUND control

RISKSUR

RISKSUR Training Series - Module 2

Surveillance: Risk-based surveillance

This lecture gives the concepts and methods of surveillance and is developed by the RISKSUR project with the aim of supporting animal health surveillance, and is kindly provided by:

Katharina Stärk
SAFOSO –Switserland
RVC - UK

This research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289567

What you will learn in this part of the course

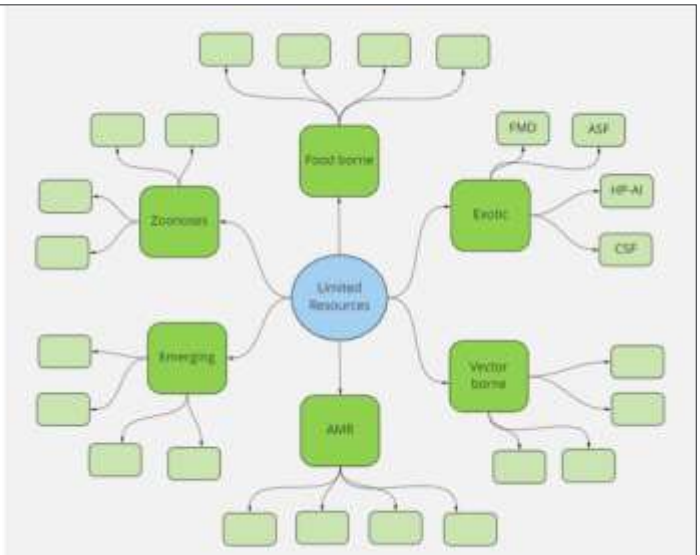
SOUND control

- Principles of risk-based surveillance
- How to apply a simple risk-based approach in the design of a surveillance program
- Similarities and differences between conventional and risk-based surveillance

The Problem

Limited resources
- Financial, people

- Many hazards



Feb. 1-2, 2021

Information:Cost Ratio

SOUND control

- Need for evidence-based decision making
- Need for documented evidence
- Need for surveillance

- Resources are always limited
- Optimize use of resources

Information / Cost

Feb. 1-2, 2021 Katharina Stärk https://www.fp7-risksur.eu/progress/training-and-webinars 5

Definition

SOUND control

Risk-based surveillance is:

*"a surveillance programme in the design of which **risk assessment methods** have been applied **together with traditional design approaches** in order to assure appropriate and cost-effective data collection"*

Stärk et al. 2006

Feb. 1-2, 2021 CDST-SOUND Surveillance Training School 6

Risk Assessment

- An element of risk analysis.
- A systematic and structured approach to collect, organize and evaluate information related to:
  1. **the likelihood of an undesired event occurring**
  2. **its biological and economical consequences.**
- **Input:** scientific publications, reports, expert opinion …
- **The outcome** may be qualitative or quantitative

Risk-based surveillance:

Uses information about:

1. the probability of hazard occurrence
2. the magnitude of the biological and/or economic consequence of health hazards

to plan, design and/or interpret the results obtained from surveillance systems.

Objectives of RBS

Identify surveillance needed to protect animal health and the health of consumers

- Set priorities
- Allocate resources effectively and efficiently

Evaluation of risk-based surveillance systems should prove that:

- Efficacy of the risk-based approach is equal or higher than that of traditional surveillance;
- **BUT:** the efficiency (cost-benefit) should be higher in risk-based systems.

Risk-Based Approaches for:

1. Prioritize hazards that have more serious consequences
   - Human health
   - Animal health

2. Prioritize sub-populations (strata) that have higher risk of being infected

Proioritizing hazard risks

- Probability of event occuring
  - Consider all information available

- Consequences of the event occuring
  - Direct losses: animals, treatment costs, production
  - Costs of disease control: stamping out, quarantine, vaccination

RBS: Design steps

Risk assessment to select hazards

Risk assessment to select strata

Risk assessment to select products/animals

Random sampling

RBS: Design steps

SOUND control

- Risk assessment to select hazards — Mandated
- Risk assessment to select strata
- Risk assessment to select products/animals
- **Random sampling**

Targeted Sampling or Surveillance

SOUND control

- A specific part of risk-based surveillance

Target a specific high risk strata

- Risk assessment to select hazards
- Risk assessment to select strata
- Risk assessment to select products/animals
- **Random sampling**

WEE Sentinel Surviellance

SOUND control

Western Equine Encephalitis

- Mosquito borne arbovirus
- Sentinel chickens
- In high risk areas
  - City parks especially with water
- Tested for WEE antibodies
- Sampling of the mosquito pop
- Sampling of the wild bird pop.

Sentinel herds/animal

Disease, condition	Country	Sentinel animal
Akabane disease	Saudi Arabia	Cattle, sheep and goat
Air pollution	Canada	Cattle
Avian influenza	France, Holland	Birds
Bluetongue	Australia	Cattle
Bovine dermatophilosis	USA	Cattle
Bovine viral diarrhoea virus	Canada	Cattle
East Coast Fever (Theileria)	Zambia	Cattle
Epizootic Hemorrhagic disease	Sudan	Cattle
Internal parasites	New Zealand	Deer
Livestock comfort	USA	Cattle
Lyme disease	USA	Dog
Rift Valley Fever	Mali, Mauritania	Sheep, goat
St. Louis encephalitis	USA	Chicken
Trypanosomiasis	Burkina Faso	Cattle
Vesicular Stomatitis	USA	Horse
West Nile	USA	Crow
Western equine encephalomyelitis	USA	Chicken
Xenotransplantation	USA	Pig

Stärk et al Proceedings of the 11th International Symposium on Veterinary Epidemiology and Economics, 2006

Risk-based surveillance:

- Uses knowledge of risk factors to improve the probability that we will find the disease or infection.
- Is more efficient at finding disease or infection than representative (random) sampling.
- **BUT:** If we do not know about the disease or any suitable risk factors, it is not possible to use risk-based surveillance.

Comparison

Steps / elements	Conventional surveillance	Risk-based surveillance
Objectives	The objectives of a surveillance programme are a key determinant of the design.	The objectives of a surveillance programme are a key determinant of the design.
Hazard selection	The hazard of interest (virus, bacteria, disease syndrome) is selected.	The hazard of interest (virus, bacteria, disease syndrome) is selected using risk assessment.
Case definition	Case definition is based on available diagnostic procedures.	Case definition is based on available diagnostic procedures.
Test procedures	Sensitivity and specificity of the diagnostic tests are major determinants of the validity of the surveillance results.	Sensitivity and specificity of the diagnostic tests are major determinants of the validity of the surveillance results.

Comparison

Steps / elements	Conventional surveillance	Risk-based surveillance
Target population(s)		
Region, location	Usually selected at random.	Selected based on risk factor studies.
Species	Selected based on hazard biology.	Selected based hazard biology and risk factor studies.
Farms	Usually selected at random.	Selected based on risk factor studies.
Animals	Usually selected at random.	Selected based on risk factor studies.
Timing, interval	Usually selected based on the epidemiology of the agent and considering infection dynamics	Usually selected based on the epidemiology of the agent and considering infection dynamics, risk factor studies.

Strata

Factor used to define high risk strata

Spatial factors
- Climate
- Habitats
- Land use
- Population densities
- Trade
- Wildlife
- Vectors

Host factors
- Animal species
- Age of animals
- Behavior

Management factors
- Biosafety
- Husbandry
- Movement contacts
- Feeding practice
- Antimicrobial usage
- Processing practices

Historical risk
- History of cases
- History of risky practices

Risk-based sampling

Risk is the product of **likelihood** and **consequences**.

The highest risk strata maybe:
1. The strata with the highest expected prevalence
   OR
2. The strata with the highest hazard impact
   OR
3. A combination of both

Sampling -*Representativeness*

Census	Prevalence in population	=	Prevalence in population
Representative sample	Prevalence in population	≈	Prevalence in sample
Risk based sample	Prevalence in population	<	Prevalence in sample
Biased sample	Prevalence in population	≠	Prevalence in sample

Comparison

Steps / elements	Conventional surveillance	Risk-based surveillance
Statistical analysis, outcome	Standard statistical analyses	Standard statistical analyses and additional analyses for comparison to conventional surveillance
Communication of results	A series of options are available: Oral, written, web, media etc.	A series of options are available: Oral, written, web, media etc.
Consequences of positive outcome	The action steps following positive results need to be determined and organized.	The action steps following positive results need to be determined and organized.
Feedback mechanisms	Feedback to the people involved in data collection is essential for quality assurance.	Feedback to the people involved in data collection is essential for quality assurance. Inclusion in risk assessment.

Surveillance supports Risk Analysis

Surveillance

↓

Risk Assessment

↓

Risk Management

↓

Risk Communication

Risk-based surveillance cycle

Examples of RBS

- BSE
- H5N1
- Trichinella

CHAPTER 11.4.

BOVINE SPONGIFORM ENCEPHALOPATHY

Article 11.4.1.

- First important surveillance system with risk-based design
- BSE is very rare, expensive to diagnose, only in dead animals
- The incubation period is extremely long (years)
- Clinical signs may be subtle and unspecific
- Exit route is a key risk factor:
  - Emergency slaughter
  - Non-ambulatory
  - Routine slaughter
- BSE is very important for trade
- International surveillance standards apply

BSE surveillance – risk assessment

- Past history of feeding practices
- Past surveillance results
- Documentation of populations
- Efforts for clinical detection

→ Negligible BSE risk — **Surveillance B**

→ Controlled BSE risk — **Surveillance A**

→ Undetermined BSE risk — **Surveillance A**

OIE Animal Health Code, 2014[9]

Table 1. Points targets for different adult cattle population sizes in a country, zone or compartment.

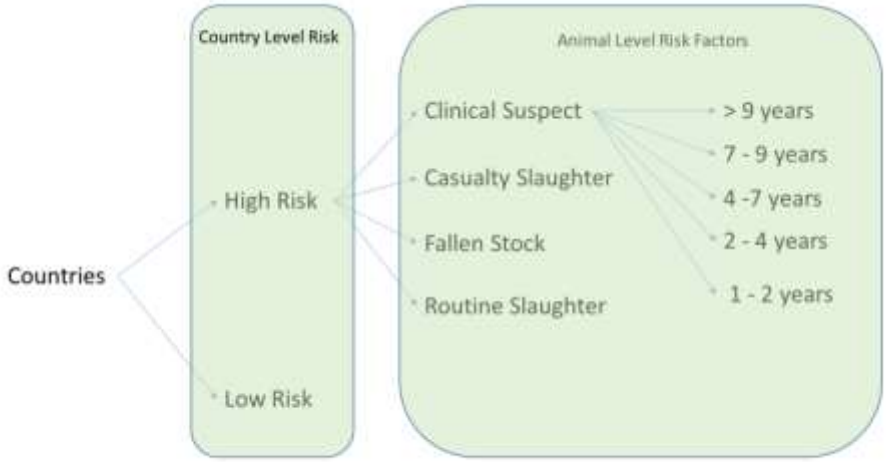
Points targets for country, zone or compartment		
Adult cattle population size (24 months and older)	Type A surveillance	Type B surveillance
>1,000,000	300,000	150,000
1,000,000	238,400	119,200
900,001-1,000,000	214,600	107,300
800,001-900,000	190,700	95,350
700,001-800,000	166,900	83,450
600,001-700,000	143,000	71,500
500,001-600,000	119,200	59,600
400,001-500,000	95,400	47,700
300,001-400,000	71,500	35,750
200,001-300,000	47,700	23,850
100,001-200,000	22,100	11,500

https://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/current/chapitre_bse.pdf

Table 2. Surveillance point values for samples collected from animals in the given subpopulation and age category.

Surveillance subpopulation			
Routine slaughter[1]	Fallen stock[2]	Casualty slaughter[3]	Clinical suspect[4]
Age ≥ 1 year and <2 years			
0.01	0.2	0.4	N/A
Age ≥ 2 years and <4 years (young adult)			
0.1	0.2	0.4	260
Age ≥ 4 years and <7 years (middle adult)			
0.2	0.9	1.6	750
Age ≥ 7 years and <9 years (older adult)			
0.1	0.4	0.7	220
Age ≥ 9 years			
0.0	0.1	0.2	45

https://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/current/chapitre_bse.pdf



Risk-based surveillance for H5N1 avian influenza virus in wild birds in Great Britain

SOUND control

L. C. Snow, S. E. Newson, A. J. Musgrove, P. A. Cranswick, H. Q. P. Crick, J. W. Wilesmith

- Infections with highly pathogenic AI viruses occur in domestic and wild birds
- Infection is rare
- Suceptibility varies greatly between bird species
- Clinical disease in domestic poultry is severe
- Mostly sub-clinical in wild birds
- Wild birds pose a significant risk to dmoestic poultry

H5N1 AI Surveillance

SOUND control

Surveillance purpose: early detection of H5N1 in poultry
Geographical surveillance units
Estimate the risk of transmission per 10 KM^2 areas

For each 10 KM^2 area:

1. Probability of AI introduction by wild birds
2. Presence of poultry
3. Combine 1 and 2 for an overall risk estimate

Probability of Introduction

- For each 10 KM^2 area:
- Estimate abundance of each species (24)

- For each species
  - Probability of being infected
  - Abundance
  - Seasonal patterns
  - Known to mix with domestic poultry
  - Social behavior (flocks vs solitary)

Poultry Risk

For each 10 KM^2 area:

- Number of poultry
  - Consequences and risk of infection
- Production type
  - Hatchery vs broiler vs layer
  - Commercial vs backyard
- Environment in which birds were kept
  - Indoors vs free range vs access to a pond
  - Distance to ponds, rivers, lakes
- Mix of quantitative an qualitative
  - Ranked risk (1-6)

Risk of Introduction

Poultry Risk

Combined Risk

Trichinella

- Can cause a life threatening disease in people
- Prevalence in pigs is very low
- Testing many pigs at slaughter → very few positive
- Not transmitted between pigs (except via cannabalism)
- Infection by ingestion of muscle with infectious larvae
  - Feeding raw waste that has infected meat
  - Eating carcasses containing infectious larvae
  - Rodents and outdoor rearing are risk factors
  - Age is a risk factor

Used risk factors to create strata: farms

Veterinary Parasitology

Ensuring a negligible risk of *Trichinella* in pig farming from a control perspective

Lis Alban*, Jesper Valentin Petersen

High–Low Risk

Veterinary Parasitology

Ensuring a negligible risk of *Trichinella* in pig farming from a control perspective

Lis Alban*, Jesper Valentin Petersen

Table 1
List of requirements that must be met by a pig farmer to obtain official EU recognition of the farm applying controlled-housing conditions – modified from Annex IV, Chapter 1 in Regulation (EU) 2015/1375 (Annex, 2015).

Issue	Specific requirement
Housing	The operator must have taken **all practical precautions** with regard to **building construction and maintenance** in order **to prevent rodents**, any other kind of mammals and large carnivorous birds **from having access to buildings where animals are kept**
Rodent control	The operator must apply a **pest-control programme, in particular for rodents**, effectively to prevent infestation of pigs. The operator must keep records of the programme to the satisfaction of the competent authority
Buying in feed	The operator must ensure that all **feed** has been obtained from a facility that produces feed in accordance with the principles described in Regulation (EC) No 183/2005 laying down requirements for feed hygiene
Storing of feed	The operator must **store feed** intended for *Trichinella* susceptible species **in closed silos or other containers that are impenetrable to rodents**. All other feed supplies must be heat-treated or produced and stored to the satisfaction of the competent authority
Disposal of dead animals	The operator must ensure that **dead animals are collected, identified and transported without undue delay**
Rubbish dump	If a **rubbish dump** is located in the neighbourhood of the holding, the operator must inform the competent authority. Subsequently, the competent authority must assess the risks involved and decide whether the holding is to be recognised as applying controlled housing conditions
Purchase of piglets	The operator must ensure that **piglets** coming onto the holding from outside and pigs purchased are born and bred under **controlled housing conditions**
Identification of pigs	The operator must ensure that **pigs are identified** so each animal can be traced back to the holding
Introduction of new animals	The operator may **introduce new animals** onto the holding only if they come from holdings also officially recognised as applying controlled housing conditions
Access to outdoor facilities	**None of the animals has access to outdoor facilities** unless the food business operator can show by a risk analysis to the satisfaction of the competent authority that the time period, facilities and circumstances of outdoor access do not pose a danger for introduction of *Trichinella* in the holding

Risk-based sampling

Veterinary Parasitology

Ensuring a negligible risk of *Trichinella* in pig farming from a control perspective

Lis Alban*, Jesper Valentin Petersen

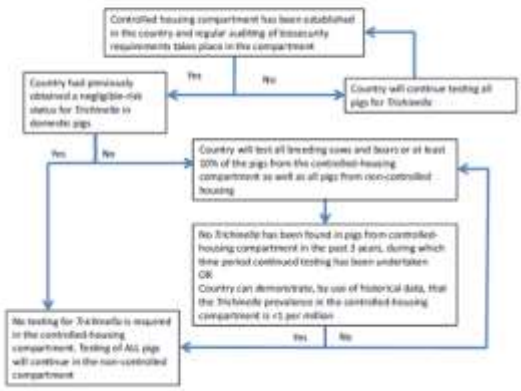


Fig. 1. Description of the new EU Regulation 2015/1375, laying down specific rules on official controls for Trichinella in meat.

- Sample 10% of pigs from low risk farms
- Sample all pigs from hi risk farms
- Sample all breeding sows and boars

Advantages - Disadvantages

SOUND control

Conventional

- + Many methods available
- + Well validated
- + Commonly accepted
- − Expensive
- − Low information content (all negative)
- − Not efficient

Risk-based

- + Higher benefit:cost ratio
- + More efficient
- + Suitable for rare events
- − Data availability
- − Analytical methods still need to be developed
- − Equivalence assessment not yet developed
- − Acceptance?

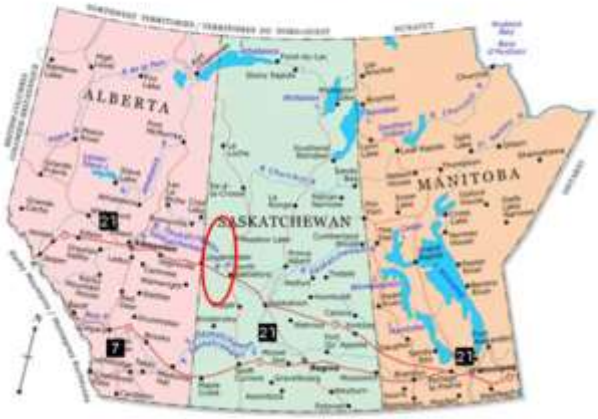
Would you accept live pigs from Italy?

SOUND control

- ASF is likely to enter from the north
  - Transmission among wild boar
  - Transmission to wild boar
- Test all hunter, road killed, and found dead wild boar above the red line AND all tested negative
- Would you accept live pig imports form Italy?

CWD Surveillance

SOUND control



Chronic Wasting Disease

In Wild Deer

In Saskatchewan

Not in Alberta

CWD Surveillance

SOUND control

Chronic Wasting Disease

In Wild Deer

In Saskatchewan

Not in Alberta

CWD Surveillance

SOUND control

Chronic Wasting Disease

In Wild Deer

In Saskatchewan

Not in Alberta

When to use Risk-Based Approaches?

SOUND control

It depend on the objectives!

Component of Risk Assessment:	Likelihood	Consequences	
		Prove Dz Freedom	Early Detection
Prioritize Hazards	Yes	Yes	Yes
Selection of Stratum	Yes	No	Yes
Selction of units within strata	No	No	No

A Random Sample

Providing freedom from disease requires evidence from all strata.

Complex Surveillance Sytems

SOUND control

- Multiple components
- Multiple active and passive components
- Traditional and risk-based
- Many data sources
- Integrated into an overall surveillance system

Brucellosis and Tuberculosis

SOUND control

Active:
- Triannual survey

Passive:
- Reportable disease
- Slaughter plant surveillance

Risk-based:
- Random sample of farms in high risk area
- Test all adults at markets around parks

SOUND control

Thank You!

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cost

SOUND control
COST Action CA17110

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Training school
BASIC CONCEPTS IN EPIDEMIOLOGY AND SURVEILLANCE

Training school organizers

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