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Monitoring endemic diseases in pig herds

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Outline presentation

- Introduction
- Respiratory disease
- Enteric diseases
- Other diseases
- Discussion and conclusions

Animal health

- **Different from realizing genetic potential of animals**
- **We do not measure health, but:**
  - (absence of) disease
  - level of management and biosecurity
- **Different levels: animal, group, herd, region, country, …**
- **Distinction: « infection » ↔ « disease »**

Why so many infectious diseases? → numerous transmission routes!!

- **<u>Direct pig contact</u>, incl. sow-piglet**
- **<u>Indirect</u>: personnel and visitors, contaminated objects, rodents, insects, feral pigs, ..**
- **Other: feed, water, via needles, etc.**
- **Semen (AI)**
- **Airborne!**

Transmission routes infectious diseases

Pig-to-pig transmission

- **Most important for most diseases**
- **Within and between herds**
- **Subclinical infections, carrier animals, long viremia**

N : number of pigs → risk increase on transmission of pathogens = $N^2 - N$

15 pigs →210; 50 pigs →2450

Transmission routes infectious diseases

Pig-to-pig transmission

- **from sow to piglet ("vertical transmission")**
- **"Early" vs. "late" colonizing pathogens**

Transmission routes infectious diseases

- Contaminated people:

  Examples: CSF, FMD, *E. coli*, TGE, PRRSV
  Mainly by persons having direct contact with pigs

- Rodents:

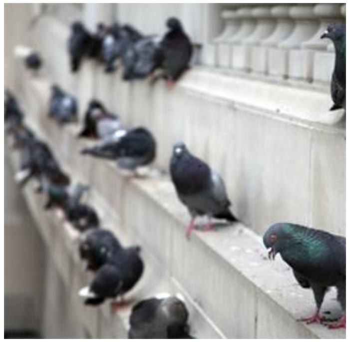
  Examples: swine dysentery, leptospirosis, *Salmonella*

Transmission pig diseases by insects

Examples
African swine fever, Classical swine fever, *Mycoplasma suis*, PRRSV, Aujeszky's disease virus, *Salmonella*, *Streptococcus suis*, Swine pox, Vesicular stomatitis

- Biological or mechanical vectors
- Musca domestica → 1.5 km
- Mostly based on experimenal data

Transmission pig diseases



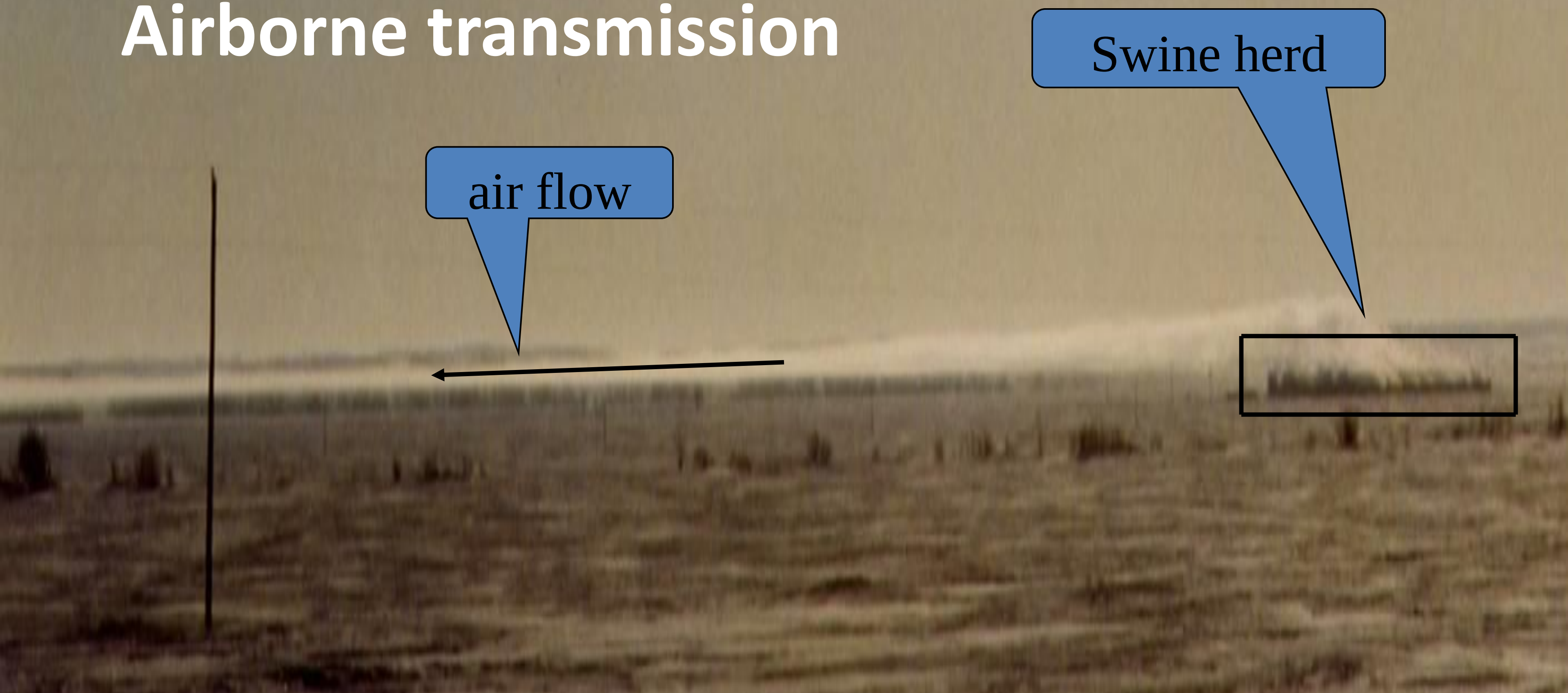
- Birds
- Iatrogenic transmission → injections
- Vehicles → CSF, PRRSV
- Feed, water
- Other: *e.g.* feral pigs

Important viruses in pig semen

(Maes et al., Theriogenology, 2008)

Organism	Timing of detection (test used)
Classical swine fever virus	7-63 DPI (RT-PCR); 11-53 DPI (virus isolation)
FMD virus	Up to 9 days post exposure (virus isolation)
Japanese encephalitis virus	35 DPI
Porcine circovirus	Intermittently between 5-47 days DPI (nPCR)
Porcine enterovirus	45 DPI (virus isolation)
Porcine parvovirus	Detected (virus isolation)
PRRS virus	Up to 92 DPI (nested RT-PCR) Up to 43 DPI (swine bioassay)
Pseudorabies virus	10 DPI (virus isolation)
Rubula virus	2 to 49 DPI (virus isolation)
Swine vesicular disease virus	Up to 4 DPI (virus isolation)

Airborne transmission



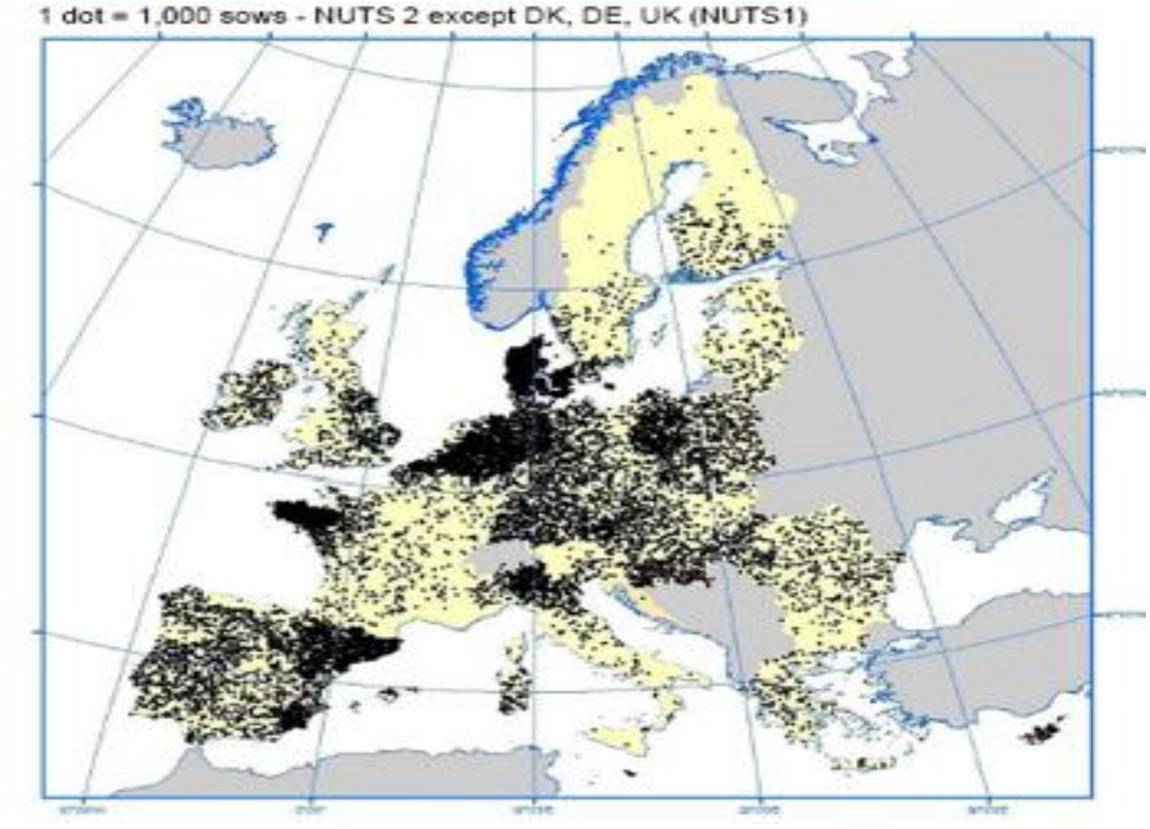
PRRS virus and Mycoplasma: > 9 km (Otake et al., 2010)

Other pathogens *e.g.* swine flu → neighborhood infections (Madec et al. 1982)

:

Brad CHAPEL

Pig production in the EU



High density populated areas (e.g. >3000 pigs / km2)

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Respiratory pathogens in pigs

	PRIMARY	SECONDARY
Viruses	**Influenzavirus (H1N1, H3N2, H1N2)** **PRRSV, PRCV, PCV2, …**	
Bacteria	***M. hyopneumoniae*** ***A. pleuropneumoniae*** ***H. parasuis*** ***B. bronchiseptica***	***A. pleuropneumoniae*** ***H. parasuis*** ***P. multocida*** ***B. bronchiseptica*** ***M. hyorhinis, S. suis*** ***T. pyogenes, …***
Parasites	***A. suum***	

Can damage lung tissue by themselves

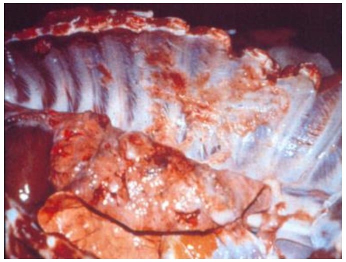
Previous damage of lung tissue needed

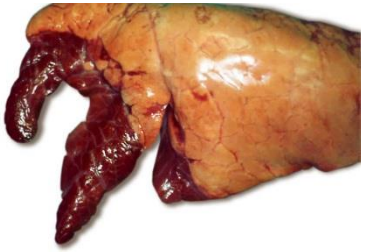
- Importance of each pathogen very variable ~ continent, country, herd, time within herd, health status (conventional vs. high health)

% of slaughter pigs with lung lesions

(Meyns et al 2011; Fraile et al 2010; Merialdi et al. 2012)

Parameter	Belgium	Spain	Italy	Major pathogens
% pleuritis	**21**	**14**	**26**	***A. pleuropneumoniae, H. parasuis, P. multocida, M. hyorhinis, S. suis, ..***
% pneumonia	**25**	**56**	**46**	***M. hyopneumoniae*, viral pathogens,..**





→ **similar prevalences as 20-30 years ago !**

- 1978: Backström and Bremer 27%
- 1990: Christensen and Culinane 45%
- 1991: Charrier 30%
- 1993: Paisley et al 63%

% of herds with seropositive slaughter pigs

(European study, 2008; Meyns et al., Vet J 2011)

Parameter	Belgium (50 herds)	Spain (107 herds)	Italy (46 herds)
A. pleuropneumoniae	96	89	100
M. hyopneumoniae	98	82	91*
PRRSV	94	89	100*
Influenza (H1N1)	100	90	78
Influenza (H3N2)	98	100	63
Influenza (H1N2)	98	97	14

* Blood sampling at 80 kg

Monitoring respiratory pathogens

- **Historic information**
- **Clinical symptoms, ev. coughing index (Nathues et al. 2012)**
- **Routine necropsies affected pigs → further diagnostic work-up**
- **Slaughter checks:**

  Advantages: cheap, easy, lesions are economically important

  Limitations: no etiologic diagnosis (!), regression of lesions, subjective, min. 30 animals, different scoring methods, severe pleurisy may mask other lesions, fast speed of slaughter line, …

Monitoring respiratory pathogens

- **Serial or cross-sectional sampling at herd**
  Samples:
  - **blood, oral fluids, … → <u>antibodies</u>**
  - **blood, oral fluids, BAL fluid, tracheal, tonsil / nasal swabs, ... → <u>pathogen</u> or parts of pathogen**
- **Blood sampling at slaughter**

- <u>Herd veterinarian</u> should integrate information from herd, laboratory, necropsy, etc.
- <u>Challenge</u> is mostly not "is pathogen present on herd" but mostly "<u>which pathogens are important in specific age group</u>"

Paired or serial sampling

= same animals sampled over time

Advantage:

- **provides the most informative results**

Disadvantages:

- **requires time before results are known**
- **different herd visits necessary**
- **needs individual identification of animals**

Cross-sectional sampling

= **sampling different age groups at same day**
e.g. **nursery, growing and fattening pigs**

Advantage:

- **results quickly known (one herd visit)**
- **no individual identification of animals**

Disadvantage:

- **results more difficult to interpret**

→ Possible to combine serial and cross-sectional sampling

Serology

- **Different tests:**
  - mostly ELISA
  - other (HI-test swine flu, virus neutralization, etc.)
- **Sensitivity and specificity may vary**
- **Antibodies may develop fast or slow after infection, or may not be detectable**
- **Correlation (*e.g.* HI-antibodies swine flu) or no correlation (*e.g.* Mycoplasma) with degree of protection**

Serology

- **Interpretation difficult in:**

  - vaccinated populations

  - nursery pigs because of maternal antibodies
- **Retrospective data**
- **Interpretation at group level**

Oral fluids

- **Quick, easy, and inexpensive to collect**
- **Prospective → to forecast health and productivity**
- **Mixture of saliva and "oral mucosal transudate"**
- ***e.g.* PRRSV, PCV2, SIV and *M. hyopneumoniae***

  Antibodies against these pathogens → test validation needed
- **No individual samples → no prevalence data**

Samples of respiratory tract

- **Nose → tonsil → trachea → BAL fluid**
- **Depends on pathogen *e.g.* BAL fluid and trachea more sensitive for M. hyo; nasal swabs ok for swine influenza in acute outbreaks**
- **Upper respiratory tract (nose) easier for routine sampling**
- **Detection of bacterial pathogens ~ antimicrobial medication**

For optimal laboratory testing, veterinarians should…

- **Define goal of submission**
- **Select appropriate sample(s)**
- **Use correct method of submission**
- **Select animals with typical disease**
- **Submit adequate number of samples**
- **Include samples from control animals**
- **Consider strengths and weaknesses of lab tests**
- **Interpret in relation with farm data***

* Herd veterinarian should integrate information from herd, laboratory & necropsy

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Clostridium perfringens

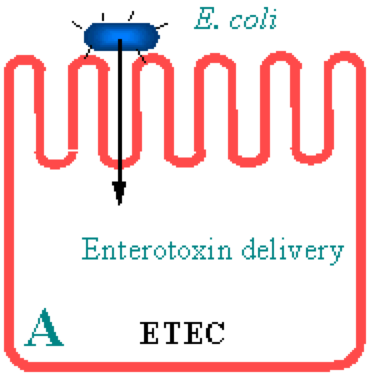
(Songer 2012)

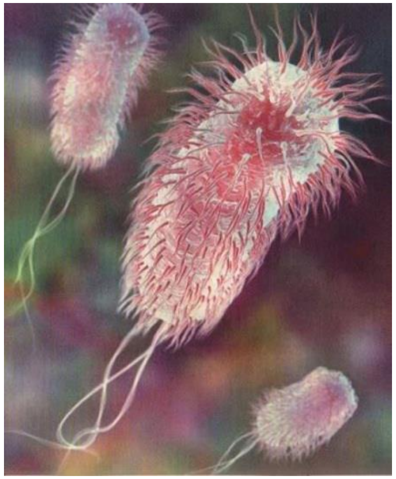
Type A	Type C
• Neonatal necrotizing enteritis, gas gangrene • Usually from 1w after birth until weaning; low mortality	• Neonatal hemorrhagic and necrotic enteritis • Mostly in 3-day-old piglets; rare >1w - directly after birth: severe bloody diarrhea + high mortality - later: lower morbidity and mortality
• α-toxin	• α- and β-toxin
• Normal inhabitant of intestinal tract → quantification (pure cultures of >10^6/g feces)	• Primary pathogen, can also colonize lesions of other diseases

Other Clostridia in pigs: *C. difficile, C. novyi*

Neonatal *E. coli* enterotoxicosis

- **Enterotoxigenic *E. coli* (ETEC) important cause of diarrhea**
- **Adhesion factors (mainly F4*, F5, F6, F41)**
- **Enterotoxins (LT, Sta, Stb)**
- **Intestinal epithelium intact**





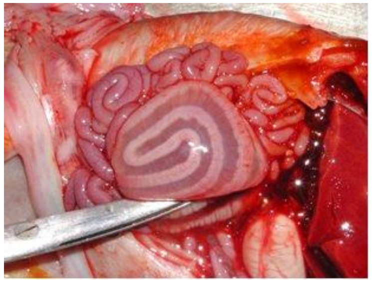
* F4+ ETEC highly prevalent in pig breeding farms – 65% of young sows seropositive (Van den Broeck et al., 1999)

Post-weaning diarrhea/edema disease

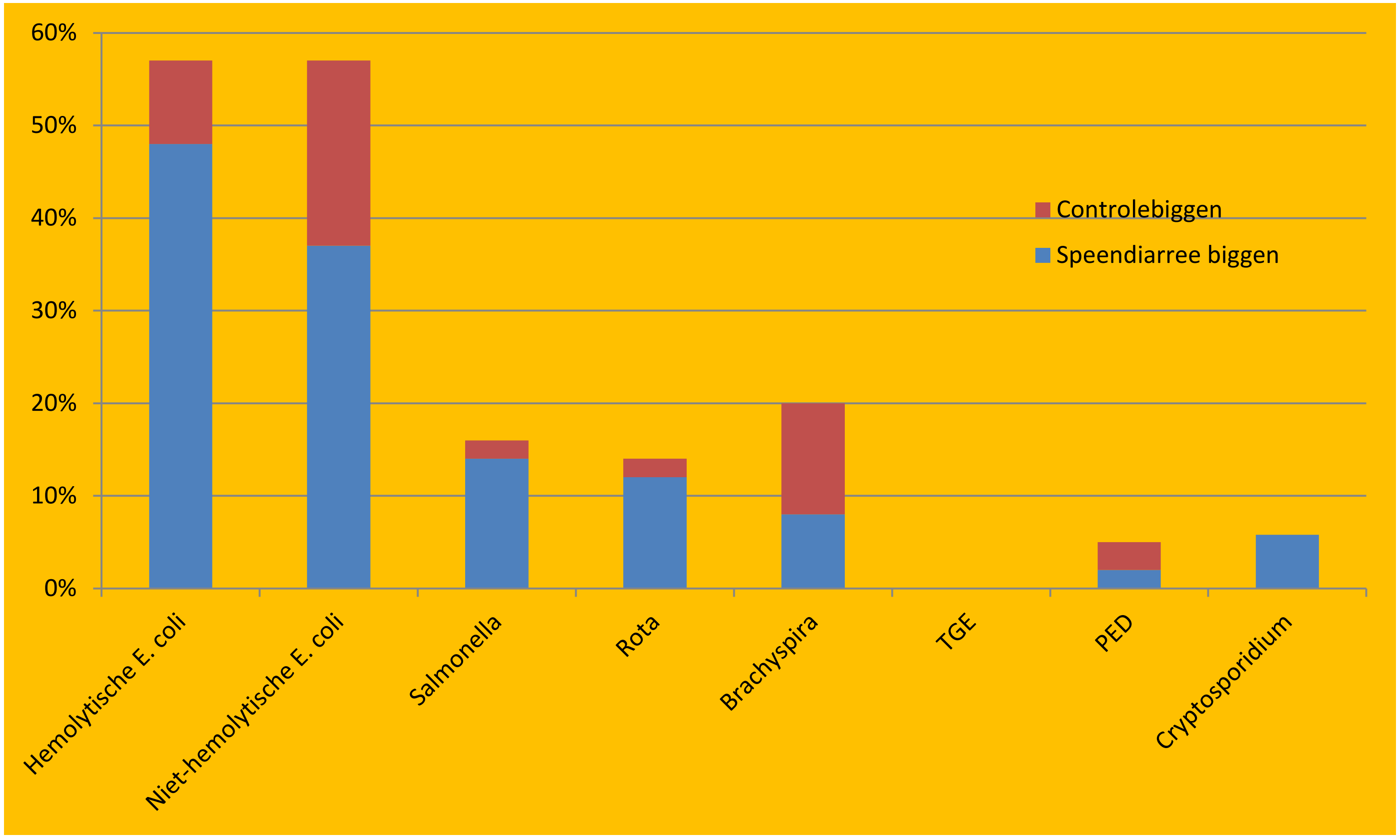
- **Both caused by *E. coli* that colonize the small intestine and produce exotoxins**
- **<u>Diarrhea</u>:** **mostly F4+ and F18+ ETEC**
  Enterotoxins

  <u>Edema disease</u>: **mainly F18ab+ EDEC**
  Shiga-toxin

- **From 2d after weaning onwards**

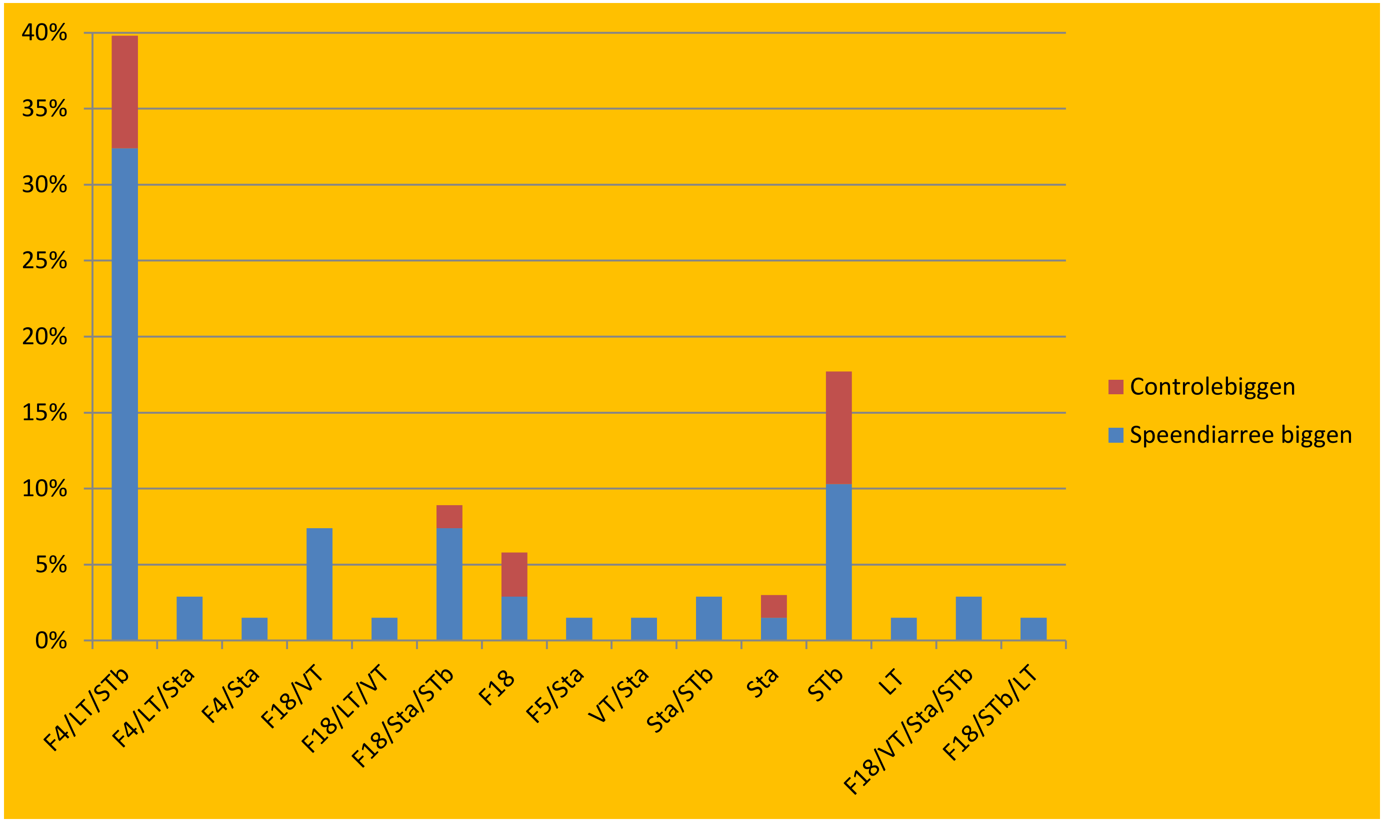


Prevalence of pathogens in recently weaned pigs (Animal Health Service, Flandres, 2012)



- 100 recently weaned pigs at necropsy during one year
- Control pigs n=25; pigs with weaning diarrhea n=75
- 57% hemolytic *E. coli*

Virotypes of *E. coli* with virulence factors in weaned pigs (Animal Health Service, Flandres, 2012)



- 114 isolated *E. coli* strains
- Approx. 60% of *E. coli* strains contained virulence factors
- Most common virotype: F4/LT/STb

Prevalence rotavirus A infections in pigs with and without diarrhea (Theuns et al. 2015)

Country	Year	Diagnostic test	Age (days)	Symptoms	n=	% RVA positive	Reference
USA, Canada, Mexico	2009-2011	RT-qPCR	1-3	D	954	30%	[62]
			4-21	D	2144	46%	
			22-55	D	2538	84%	
			>55	D	1207	61%	
Argentina	1999	PAGE + antigen EIA	<45	ND	901	3.3%	[63]
Canada	2005-2007	RT-PCR	Slaughter	ND	96	8.3%	[64]
			>24	ND	50*	16.0%	
Denmark	2006-2007	EIA	1-28	D	308	10%	[65]
Germany	nd	EM	1-21	D	102	2.0%	[66]
Italy	2004-2006	RT-PCR	28-84	D	102	71.5	[67]
Ireland	2005-2007	RT-PCR	28-63	ND	292	6.5%	[68]
Slovenia	2004-2005	RT-PCR	1-21	D	6	50%	[69]
				ND	121	11.6%	
			22-70	D	14	35.7%	
				ND	133	25.6%	
			>70	D	13	46.2%	
				ND	119	16.0%	
Japan	2000-2002	PAGE	suckling weaning	D	36 outbreaks	18 outbreaks	[70]
South Korea	2006-2007	nested RT-PCR	3-70	D	475	38.3%	[71]
Thailand	2000-2001	antigen EIA	7-49	D	175	22.3%	[72]
Vietnam	2012	RT-qPCR	all ages	D	76	19.7%	[73]
				ND	654	24.9%	

Legend: D diarrheic; ND non-diarrheic; EIA enzyme immunoassay; EM electron microscopy; PAGE polyacrylamide gel electrophoresis; * mixed samples from multiple animals

Rotavirus A infections in pigs with and without diarrhea (Theuns et al. 2015)

- **Molecular diagnostic techniques such as RT-qPCR and RT-PCR → better surveillance techniques than fast antigen detection tests and virus isolation**
- **Pigs may become successively infected with different rotavirus A types after weaning → second replication peak less pronounced → some cross-protective immunity**

Porcine epidemic diarrhea infections

- **Sporadic PEDV cases on Belgian pig farms (2015): diarrhea without mortality**
- **Strains genetically almost identical to German and US INDEL strains → milder symptoms**
- **INDEL strains:**
  genetically different from highly virulent US (spring 2013) and Asian PEDV strains, and the European PEDV strain CV777 (1970s-1990s)
- **Diagnosis: most efficiently = RTqPCR analysis of RNA extracted from diarrheic feces; Detection of virus by ELISA or EM in feces**

Swine dysentery

- **Increased prevalences in many countries**
- **Major losses to farms**
- **New Brachyspira species: *B. hampsonii, B. suanatina***
- **Treatment: expensive, few effective antimicrobials, antimicrobial resistance problem (**Herbst et al., 2014)

MIC_{50} and MIC_{90} for pleuromutilins

(Vangroenweghe et al., 2010, ESPHM)

	Tiamulin		Valnemulin	
Year	MIC_{50}	MIC_{90}	MIC_{50}	MIC_{90}
2006	0.25	2	0.03	0.50
2008	0.50	8	0.12	8
2009	>8	>8	8	>8

→ **Significant increase in MIC values!**

→ **No vaccine available against *B. hyodysenteriae***

Swine dysentery: monitoring

- **Demonstration of *B. hyodysenteriae* (and/or other types) in feces or colon:**
  - **PCR-test:** specific or more general
  - **bacteriology:** anaerobic culture – 6-9 d
    MIC testing
- **Serology → not in practice**

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Streptococcus suis

- **Early colonizer: upper respiratory tract (tonsils, nasal cavity), genital and alimentary tract**
- **Septicaemia: meningitis, arthritis, pericarditis, polyserositis, inflamm. heart valve, pneumonia (?)**
- **Zoonotic**
- **Isolation of pathogen in lesions – no serology**
- **Important for preventive use of antibiotics in piglets**

Porcine Reproductive and Respiratory Disease Syndrome (PRRS)

- **Major economic losses**
- **Many pig herds infected**
- **Large heterogeneity of strains**

Porcine Reproductive and Respiratory Disease Syndrome (PRRS)

- **Monitoring: breeding – nursery – fattening**
- **Blood samples:**

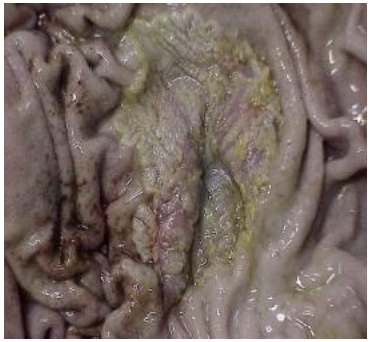
  - antibodies (IF, SN, ELISA → European vs. US strains)
  - detection of pathogen: VI, PCR
  - molecular characterisation of strains

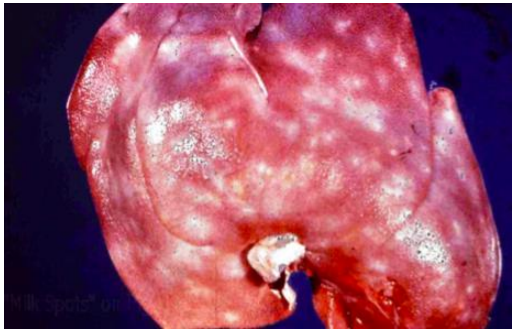
- **Oral fluids**
- **Control:**

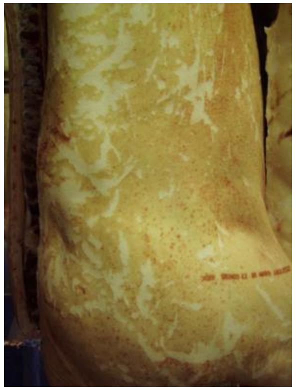
  - management and biosecurity, vaccination
  - filtration of incoming air → 80% reduction of PRRS introduction (Alonso et al., 2013)

Other diseases → slaughterhouse information

- **<u>Stomach lesions</u>:**
  - **finishing pigs: >65%**
  - **sows: 10-15%**
- **<u>*A. suum* infections</u> → liver white spots (serology)**
- **<u>Skin lesions</u> → mange**
- **<u>Urogenital</u> tract infections in culled sows**







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Primary disease prevention

- = pathogen (or virulent strains) not present
- Disease-free animals: quarantine, vaccination
- SPF or « high health » herds
- Depop-repop, partial depopulation, medication
- Balance: cost to become free vs. benefits of remaining free
- Difficult for diseases with airborne spread in pig dense areas → filtration of incoming air

Secondary disease prevention

- **Infection is present**
- **Prevention of clinical disease, maintaining optimal production targets**
- **Control programs: good balance between host and infection pressure**

Monitoring

Essential for primary and secondary prevention:

- **To confirm freedom of infection**
- **To assess infection level, affected age group, optimal age for vaccination, prevalence and severity of lesions, etc.**

Conclusions

- **Most herds infected with major pathogens, some are SPF**
- **Monitoring essential in both situations:**
  - **Health → blood, oral fluids, feces, clinical scores, slaughter data, …**
  - **Antimicrobial resistance**
  - **Performance**
  - **Feed & water intake, climatic parameters**
- **More & better diagnostics: fast testing for multiple pathogens (characterisation, virulent strains, …)**