DTU Library

A simple decision tool to help optimize the control strategy 2 weeks into a Danish FMD epidemic

Willeberg, Preben

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

A simple decision tool to help optimize the control strategy 2 weeks into a Danish FMD epidemic

Preben Willeberg

DVM, PhD, Dr.med.vet., Dr.med.vet.h.c.

Senior Veterinary Global Health Specialist

Center for Animal Disease Modelling and Surveillance

School of Veterinary Medicine

University of California, Davis

UC DAVIS VETERINARY MEDICINE

National Veterinary Institute DTU
Adjunct Professor

UNIVERSITY OF COPENHAGEN
Adjunct Professor
Faculty of Life Sciences

“Blind belief in authority is the greatest enemy of truth”

Albert Einstein

Few of us have any practical experience with FMD control

Transparency and documentation to substantiate implementation of FMD control measures are prerequisites in achieving political and public acceptance

Modelling may provide part of the answer to those needs

Aspects of emergency vaccination against foot-and-mouth disease

P. Barnett[a,*], A.J.M. Garland[b], R.P. Kitching[c], C.G. Schermbrucker[d]

Comparative Immunology, Microbiology & Infectious Diseases 25 (2002) 345–364

- **The choice of whether or not to apply emergency vaccination is probably the most difficult decision facing the authorities when disease breaks out in an erstwhile FMD free country.**

- **Effective computational models should be actively financed for a range of outbreak scenarios to assist objective decision-making and minimise bureaucratic delays in vaccine application.**

- **Contingency planning should include provision for emergency vaccination and must address the complex decisions of not only when, where, and how to apply vaccine but also its economic consequences.**

- **Computer modelling may be a useful aid to cost benefit and decision support systems in this context. Planning must be detailed and regularly reviewed.**

- **Although the option of emergency vaccination is included in the EU contingency plans, the qualifying conditions for vaccination have not been finally determined.**

Council Directive 2003/85/EC

Article 50

Decision on introducing emergency vaccination

1. It may be decided to introduce emergency vaccination where at least one of the following conditions applies:

(a) outbreaks of foot-and-mouth disease have been confirmed and threaten to become widespread in the Member State where such outbreaks have been confirmed;

(b) other Member States are at risk due to the geographical situation of or the prevailing meteorological conditions in relation to reported outbreaks of foot-and-mouth disease in a Member State;

(c) other Member States are at risk due to epidemiologically relevant contacts between holdings on their territories and holdings keeping animals of susceptible species in a Member State where there are outbreaks of foot-and-mouth disease;

(d) Member States are at risk due to the geographical situation or the prevailing meteorological conditions in a neighbouring third country where there are outbreaks of foot-and-mouth disease.

2. When deciding on the introduction of emergency vaccination, consideration shall be given to the measures provided for in Article 15 and to the criteria listed in Annex X.

ANNEX X

CRITERIA FOR THE DECISION TO APPLY PROTECTIVE VACCINATION AND GUIDELINES FOR THE EMERGENCY VACCINATION PROGRAMMES

1. Criteria for the decision to apply protective vaccination (*)

Criteria	Decision	
	For vaccination	Against vaccination
Population density of susceptible animals	High	Low
Predominant species clinically affected	pigs	ruminants
Movement of potentially infected animals or products out of the protection zone	Evidence	No evidence
Predicted airborne spread of virus from infected holdings	High	Low or absent
Suitable vaccine	Available	Not available
Origin of outbreaks (traceability)	Unknown	Known
Incidence slope of outbreaks	Rising rapidly	Shallow or slow rise
Distribution of outbreaks	Widespread	Restricted
Public reaction to total stamping out policy	Strong	Weak
Acceptance of regionalisation after vaccination	Yes	No

Original publication:

Predictions for the timing and use of culling or vaccination during a foot-and-mouth disease epidemic

A.M. Hutber [a,*], R.P. Kitching [b], E. Pilipcinec [c]

Research in Veterinary Science 81 (2006) 31–36

ABSTRACT:

First-fortnight incidence (FFI) is a modelling parameter that can be used to predict both the prevalence and duration of a foot-and-mouth disease (FMD) epidemic at regional and national levels. With an indication of how long an epidemic might last by the end of week two, it becomes possible to estimate whether vaccination would be economically viable from the start of an epidemic,

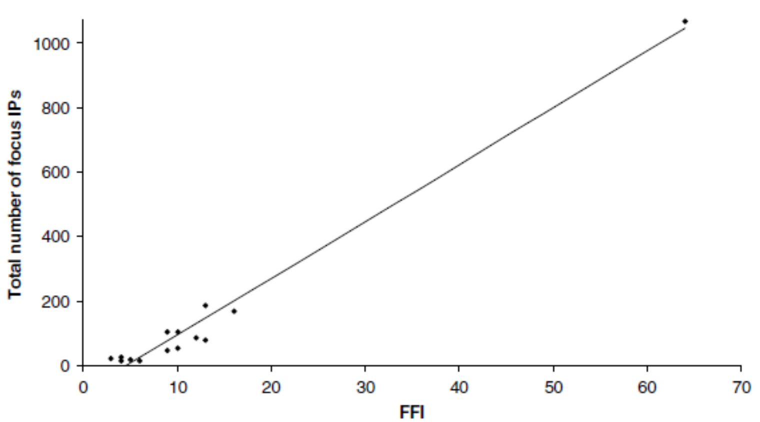
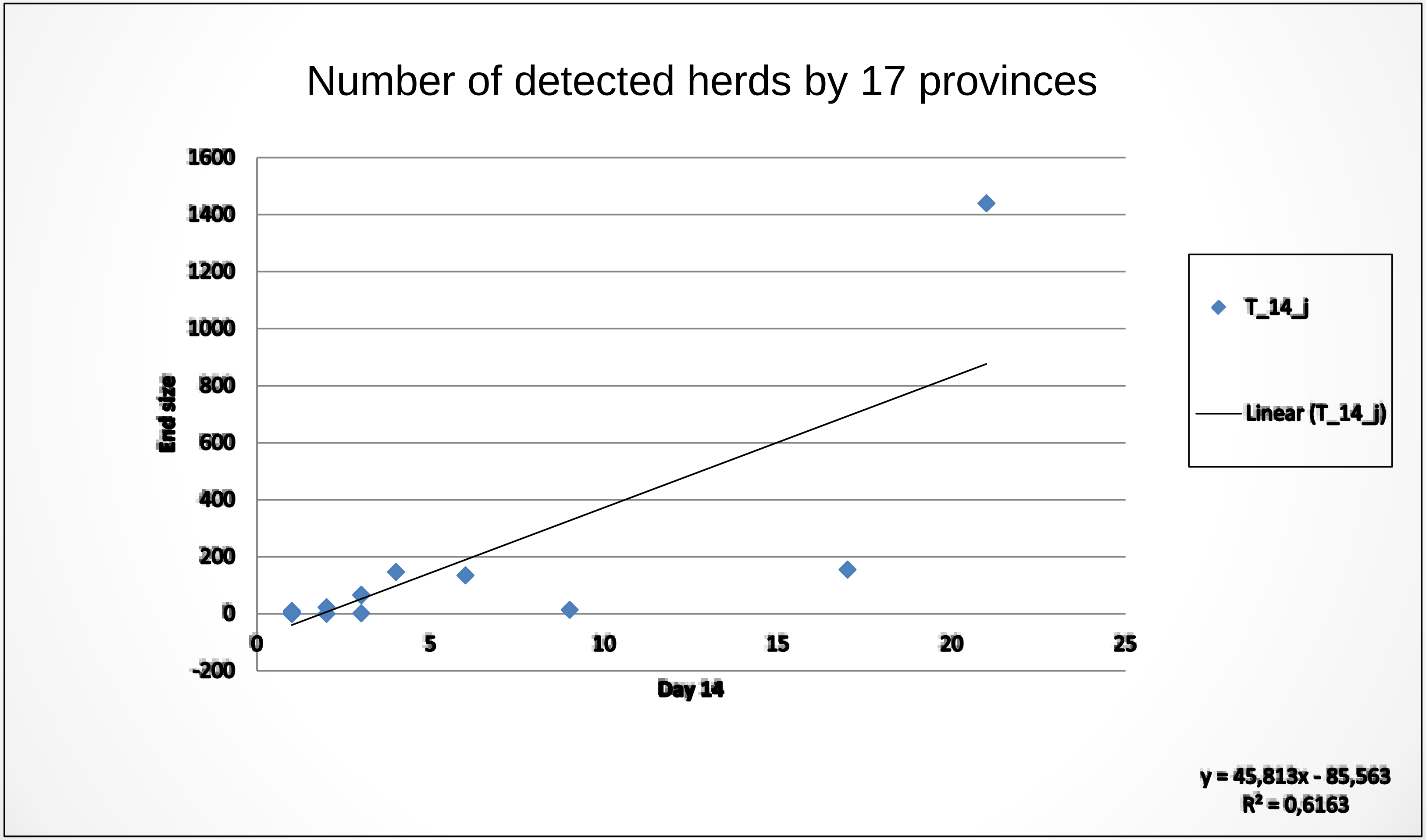


Fig. 1. The association between FFI and the prevalence of IPs within regional foci.

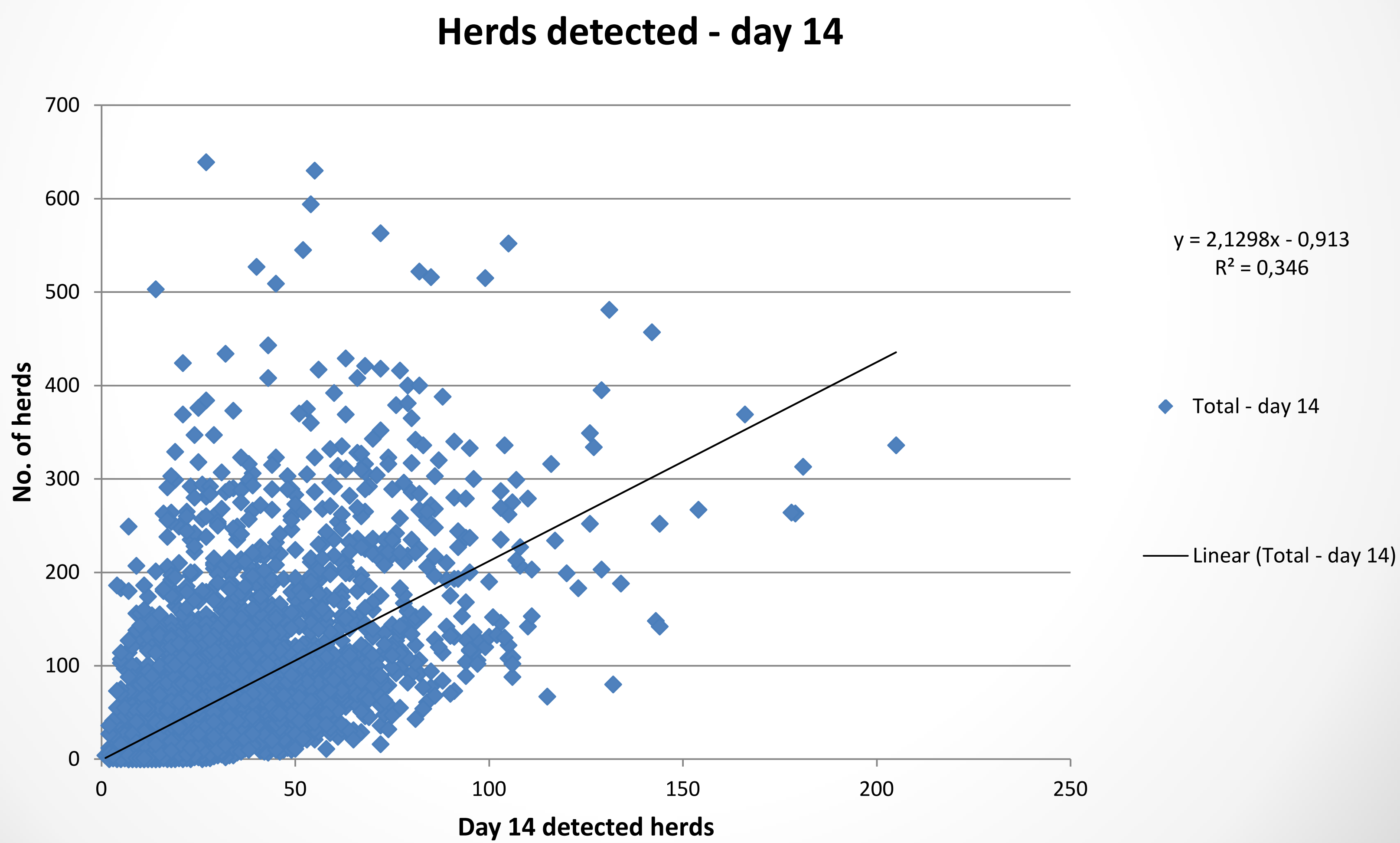
There was a highly significant association ($F_{1,13} = 649.08$, $r = 0.99$, $P < 0.0001$) between focus FFI and focus prevalence, where the relationship explained 98% ($r^2 = 0.98$) of the observed variance (Fig. 1). Hence focus FFI can be used to estimate the prevalence for future epidemic foci (and using the equation $y = mx + c$ from Fig. 1, prevalence = 17.62 FFI − 83).

Argentina 2001 FMD epidemic

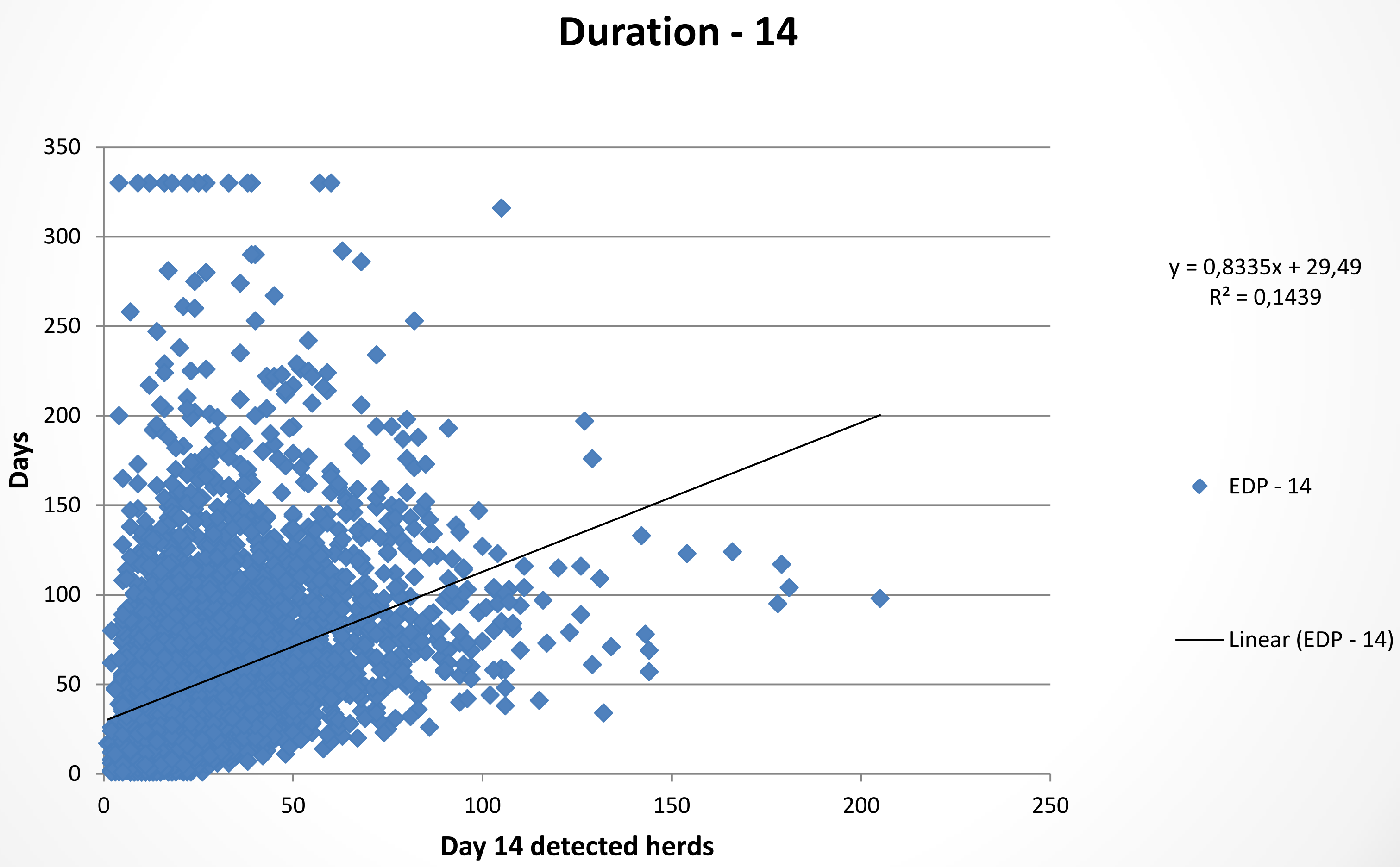
Vaccination strategies varied throughout the epidemic



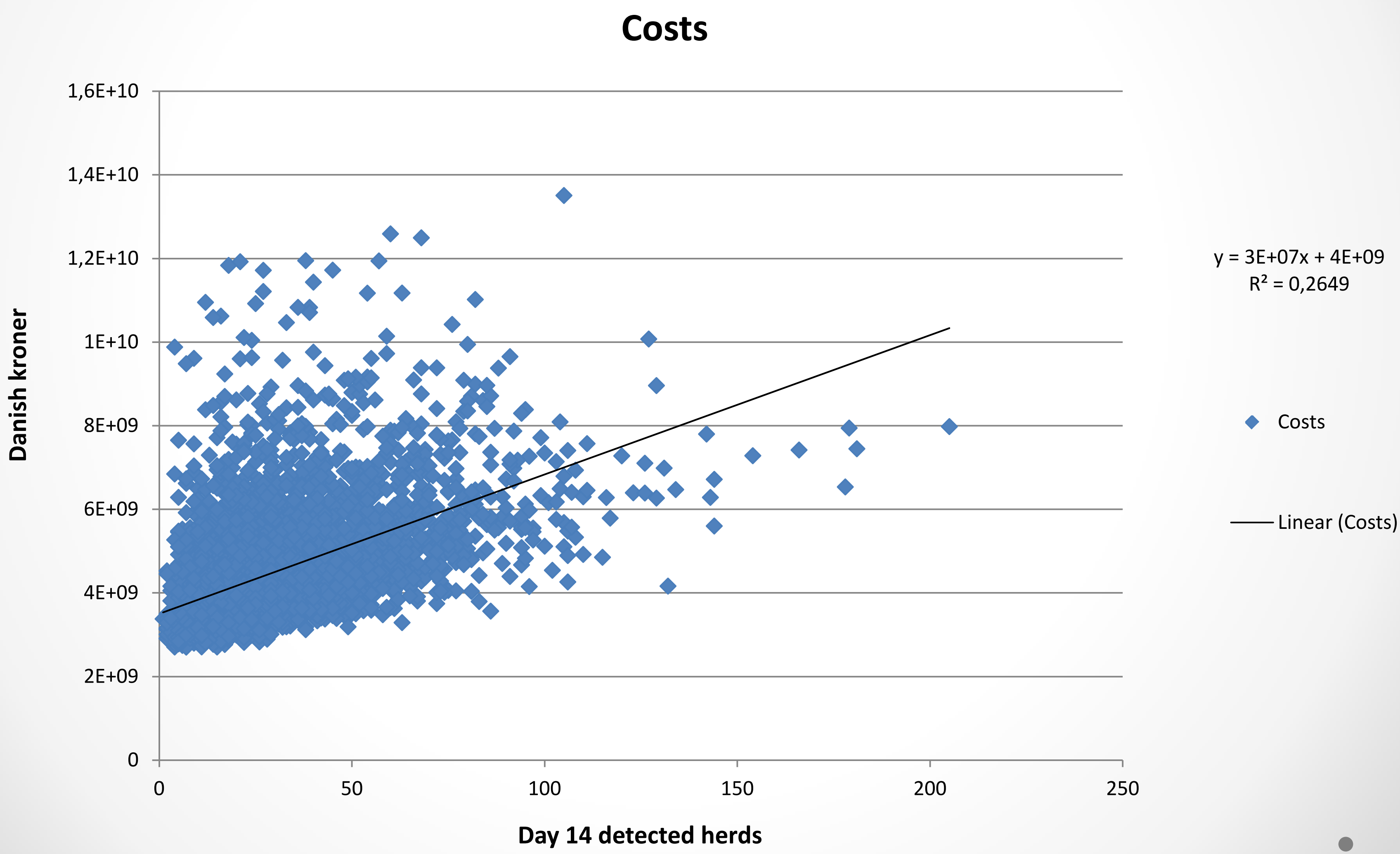
Use of FFI with DTU-DADS model simulations of FMD in Denmark



Use of FFI with DTU-DADS model simulations of FMD in Denmark



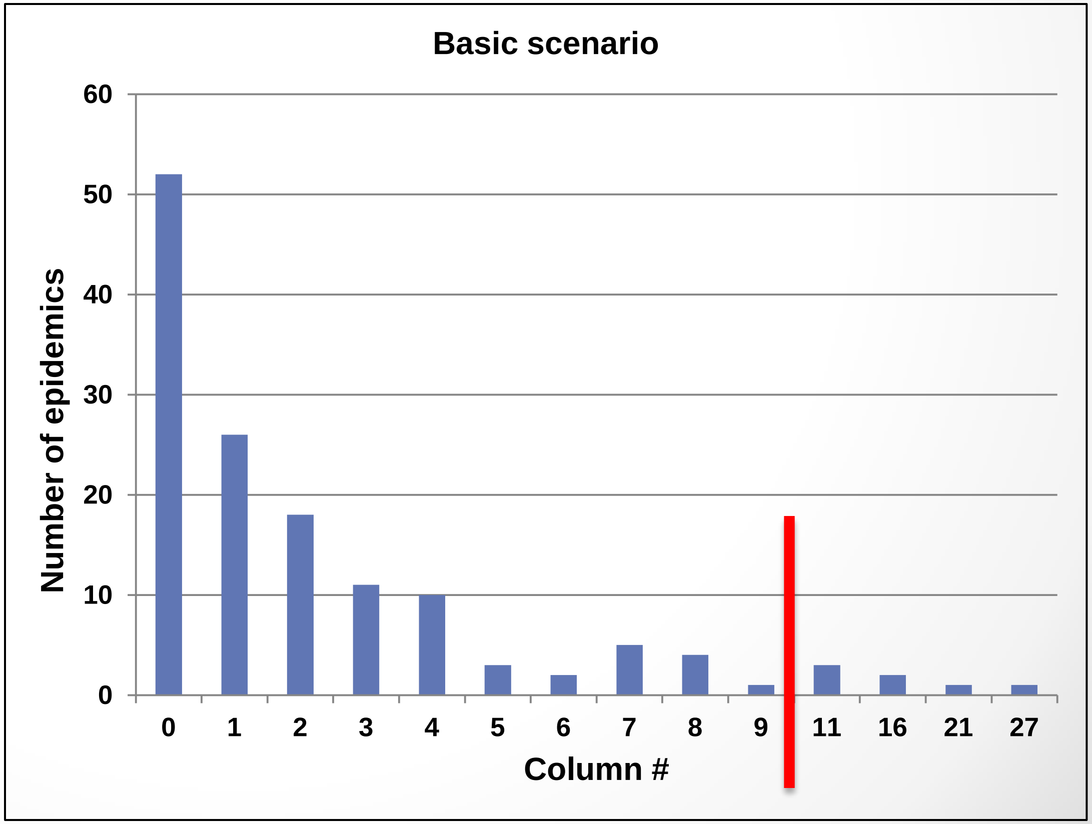
Use of FFI with DTU-DADS model simulations of FMD in Denmark



Decision tool step 1

- At day 14 during an outbreak the actual number of detected herds is known, e.g. 15 herds
- Among the simulated epidemics under the basic control scenario we select the ones with 15 detected herds at day 14, i.e. 139 epidemics out of 4,458 simulations
- The distribution of the number of detected herds at the end minus the number at day 14:

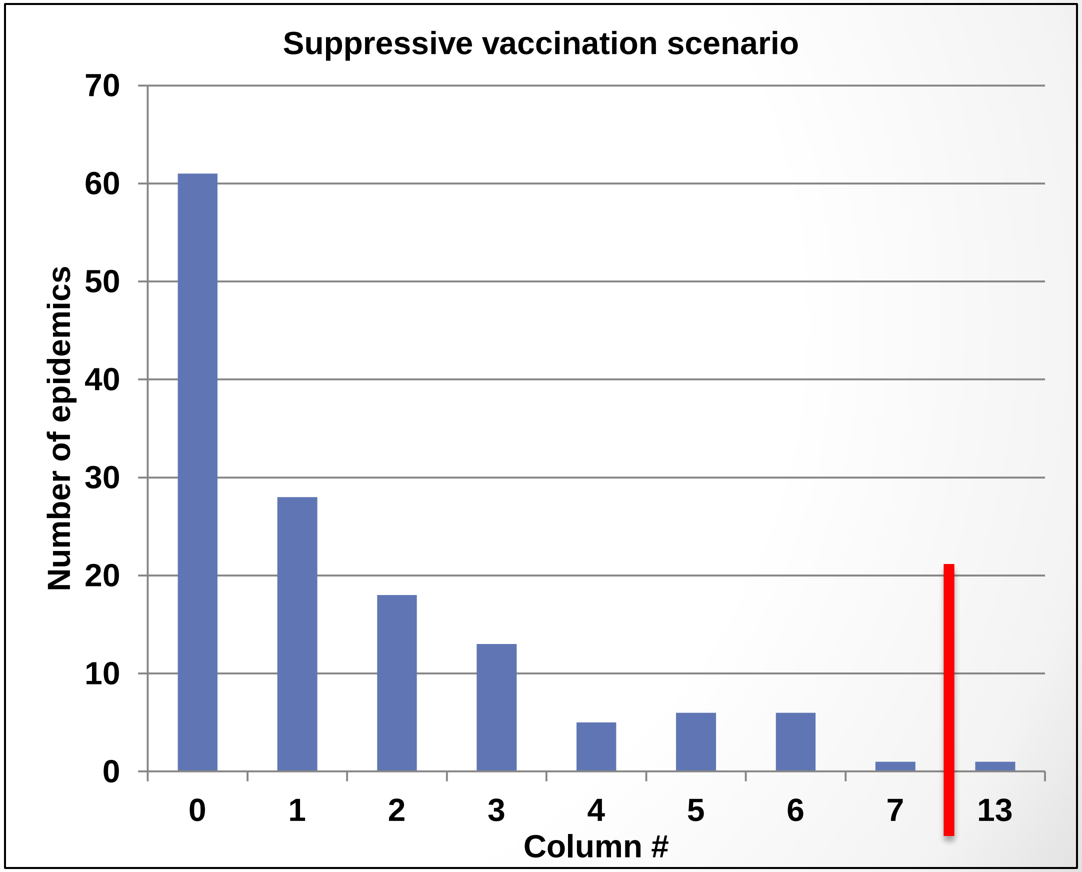
Basic scenario		
Histogram column #	Detected herds	Number of epidemics
0	< 10	52
1	10 - 19	26
2	20 - 29	18
3	30 - 39	11
4	40 - 49	10
5	50 - 59	3
6	60 - 69	2
7	70 - 79	5
8	80 - 89	4
9	90 - 99	1
11	110 - 119	3
16	160 - 169	2
21	210 - 219	1
27	270 - 279	1
Grand total		139



Decision tool step 2

- Repeat step 1 with the vaccination scenario for the same 139 epidemics
- Compare with effect of vaccination at day 14:

Suppressive vaccination scenario		
Histogram column #	Detected herds	Number of epidemics
0	< 10	61
1	10 - 19	28
2	20 - 29	18
3	30 - 39	13
4	40 - 49	5
5	50 - 59	6
6	60 - 69	6
7	70 - 79	1
13	130 - 139	1
Grand total		139



Decision scenario A

Scenario A		Subsequent period		
		<100 herds	=>100 herds	Total
Day 14	=<20 herds	1879	110	1989
	>20 herds	1697	772	2469
	Total	3576	882	4458

Predictive values (p.v.):

Neg. p.v.: 0.94

Pos. p.v.: 0.31

Specificity: 0.53

Sensitivity: 0.88

Decision scenario D

Scenario D		Subsequent period		
		<100 herds	=>100 herds	Total
Day 14	=<50 herds	3377	526	3903
	>50 herds	199	356	555
	Total	3576	882	4458

Predictive values (p.v.):

Neg. p.v.: 0.87

Pos. p.v.: 0.64

Specificity: 0.94

Sensitivity: 0.40

DTU-DADS Model results from Denmark:

The median, 5th and 95th percentiles of epidemic outcome parameters in the three alternative control strategies for the 4,458 out of 5,000 simulated epidemics that lasted > 14 days following detection of the first infected herd.

Epidemic outcome parameters	Control scenarios		
	Basic scenario	Pre-emptive depopulation in 500 m zones	Suppressive emergency vaccination in 1,000 m zones
Cumulative number of infected herds	57 (11-273)	48 (8-174)	47 (9-182)
Epidemic duration (days)	56 (19-151)	44 (15-105)	44 (15-97)
Epidemic size (km)	386 (80-698)	363 (63-646)	363 (67-646)
Epidemic costs (× €10^6)	547 (411-947)	511 (395-770)	513 (395-751)

CONCLUSIONS (1)

- **Each country should use modelling continuously adapted to suit their national situation with regard to:**
  - **Input parameters such as:**
    - **Population sizes and densities**
    - **Location of farms**
    - **Movement patterns**
    - **Available resources**
  - **Output relevance and priorities:**
    - **Economic losses**
    - **Number of animals killed**
    - **Number of herds infected**
  - **Strategic priorities:**
    - **Importing or exporting**
    - **Duration of basic measures phase**
    - **Vaccination ”to live” or ”to kill” and/or zonal culling**

CONCLUSIONS (2)

- **Contingency planning should be adapted through application and support of continuous national modelling activities:**
    - **To cater for national and international developments**
    - **To modify input parameters as needed and update output estimates**
    - **To update and prioritize strategies using feed-back loop with model data**
    - **To ensure consistency between mandated activities and available resources**
    - **To support the exercising of decision making during outbreaks**
    - **To estimate effectiveness and efficiency of alternative preventive measures**
    - **To estimate effectiveness and efficiency of surveillance and early warning activities**

CONCLUSIONS (3)

- Models are just one tool for providing scientific advice, and their results should be evaluated in conjunction with experience from experimental studies, field studies and scientific wisdom.

- International collaborations such as those supported by the World Organisation for Animal Health (OIE) and the European Commission for the Control of Foot-and-Mouth Disease (EUFMD) can help address validation issues and improve the utility of models for emergency disease management.

"Knowing is not enough; we must apply.
Willing is not enough; we must do."
—Goethe

We have learned a lot from modelling of FMD –

now it is time to put that knowledge into practical use

We need not only accept and be willing to use models –

all countries should start modelling activities to support their contingency planning and emergency preparedness