

ARS-APHIS Partnerships For Model Parameter Development; Avoiding Garbage-in-Garbage Out

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Aim: Improving national disease models for FMD (and other FAD) by use of new and real data

- Filling data gaps with ongoing collaborative projects (IAAs) between:
 - **Center for Epidemiology and Animal Health (CEAH; USDA-APHIS)**
 - Mission: *to promote and safeguard U.S. agriculture by providing timely and accurate information and analysis about animal health*
 - **Foreign Animal Disease Research Unit (FADRU; USDA-ARS)**
 - Mission: *to carry out the research needed to understand the pathogenesis of FADs and the host response to them, and to translate this knowledge into useful interventions and diagnostic tools for an effective response.*

Modeling is dependent on data

- Modeling tools for exploring disease spread or control options benefit from a detailed understanding of pathogenesis and transmission
- Development of the national FMD model identified numerous data needs
 - Disease states and infectivity for multiple FMD viruses in various species
 - Impact of carrier animals or prolonged viral shedding on control/surveillance
 - Probability of detection in different species using different diagnostic criteria
 - Impact of vaccination on viral shedding and infectivity at the herd level
 - Survival of FMD virus in the environment under varying climate conditions and role in disease spread
 - Probability of transmission associated with indirect contacts, contaminated environments or equipment, etc.

Data sources to support optimization of models for FMD

Leveraging data from recent and ongoing activities at FADRU

1. FMD studies (pathogenesis, transmission, vaccine efficacy, disinfection)
2. Studies of endemic FMD epidemiology and ecology
3. Prospective (targeted) animal experiments to fill identified knowledge gaps

Leveraging data from Clinical Studies on FMD

- Over 60 distinct animal experiments including 100s of animals
 - Infection dynamics in Cattle, Pigs and Sheep
 - Various serotypes and subtypes of FMDV
 - Differing experimental objectives but similar sampling approach and data availability
- Data Availability:
 - FMDV shedding / detection
 - Time course (onset, quantities and duration)
 - Sample types (saliva, nasal swabs, blood, air samples, tissues, probangs)
 - Onset and severity of clinical FMD
 - Serology
 - Vaccine / biotherapeutic efficacy
 - Transmission within and between species

Example of novel clinical studies to improve data for modeling

Estimation vs. Determination of Transmission

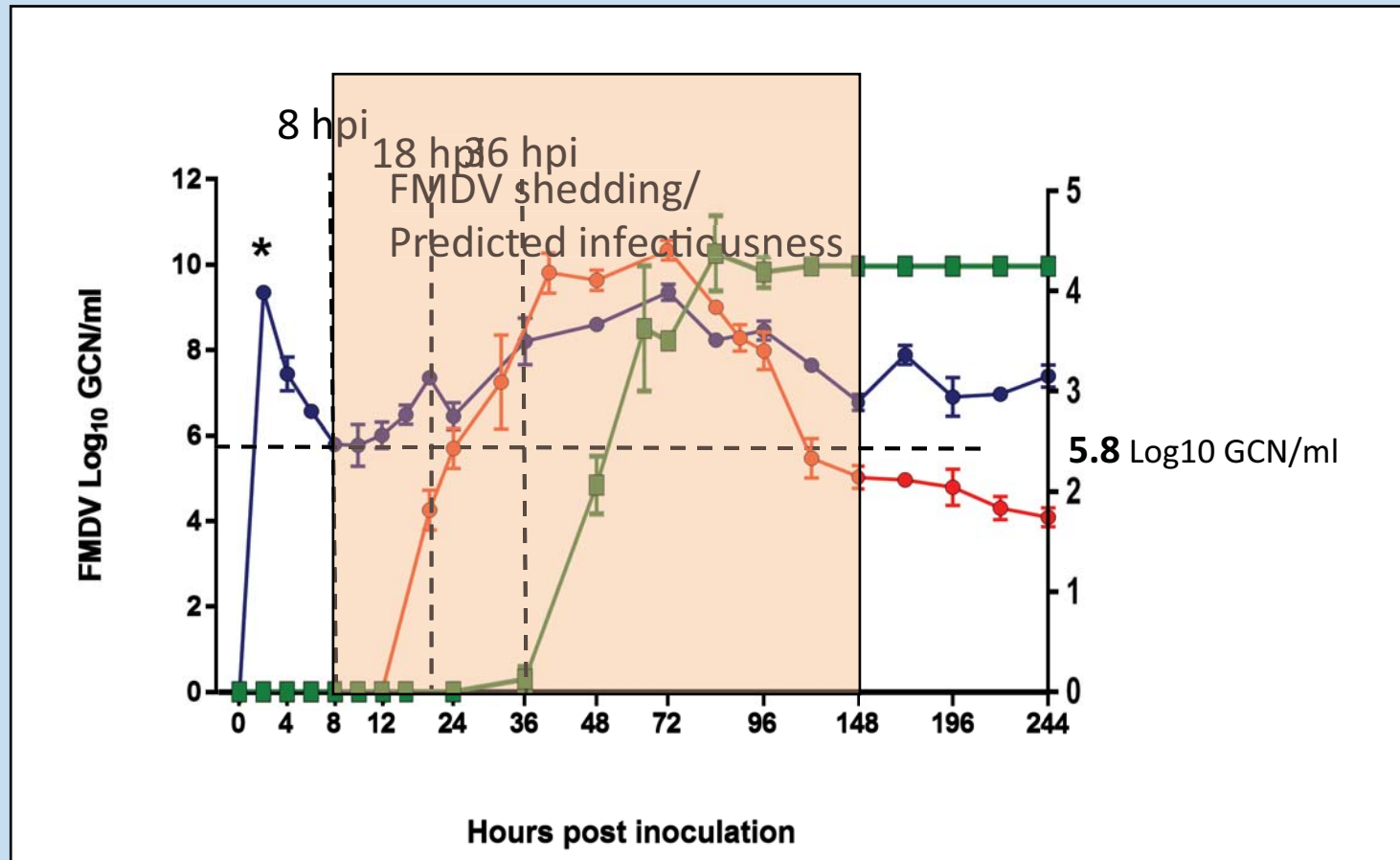
Estimation of transmission parameters

FMDV RNA in:

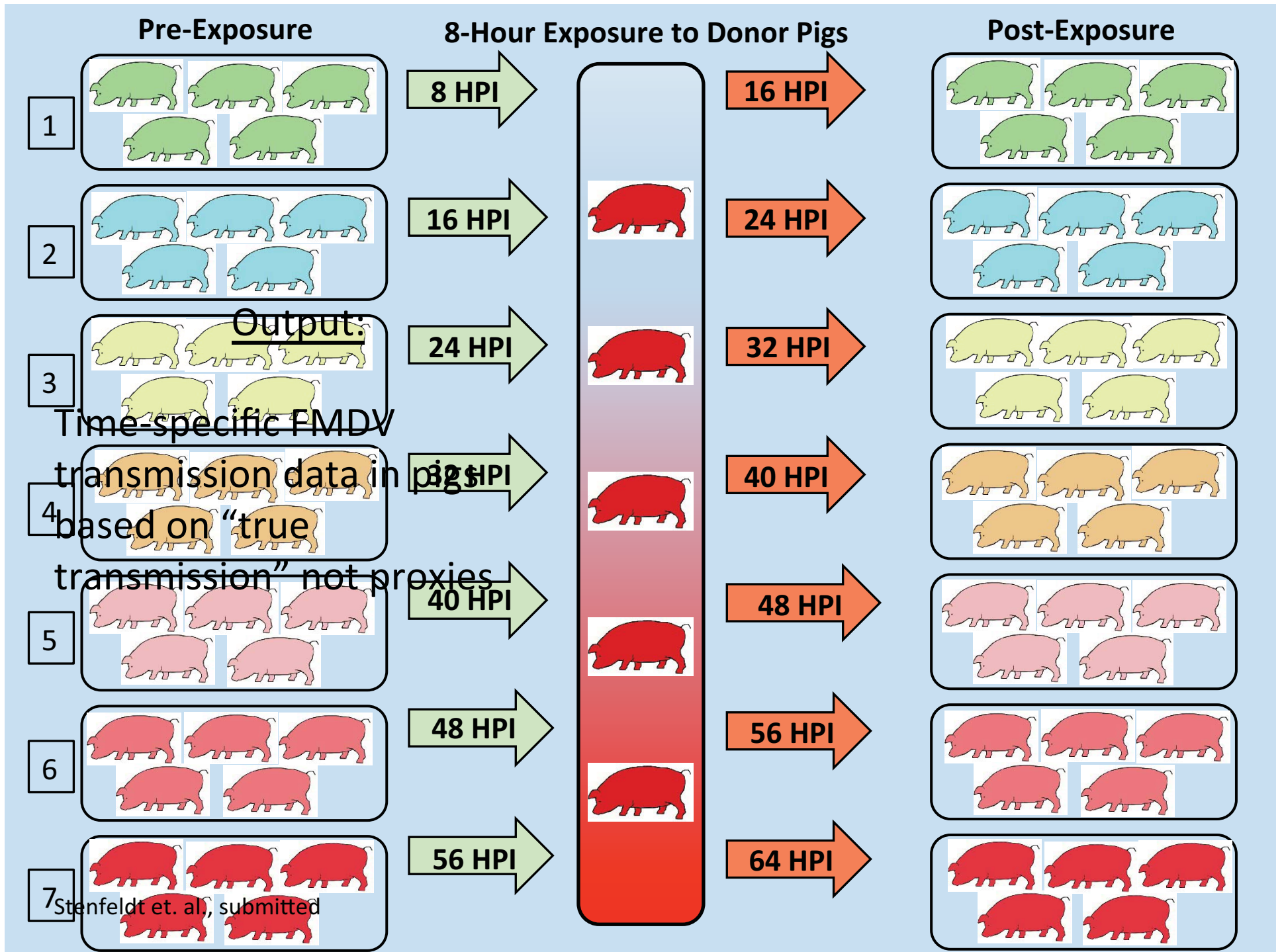
Oropharyngeal swabs (OPF)

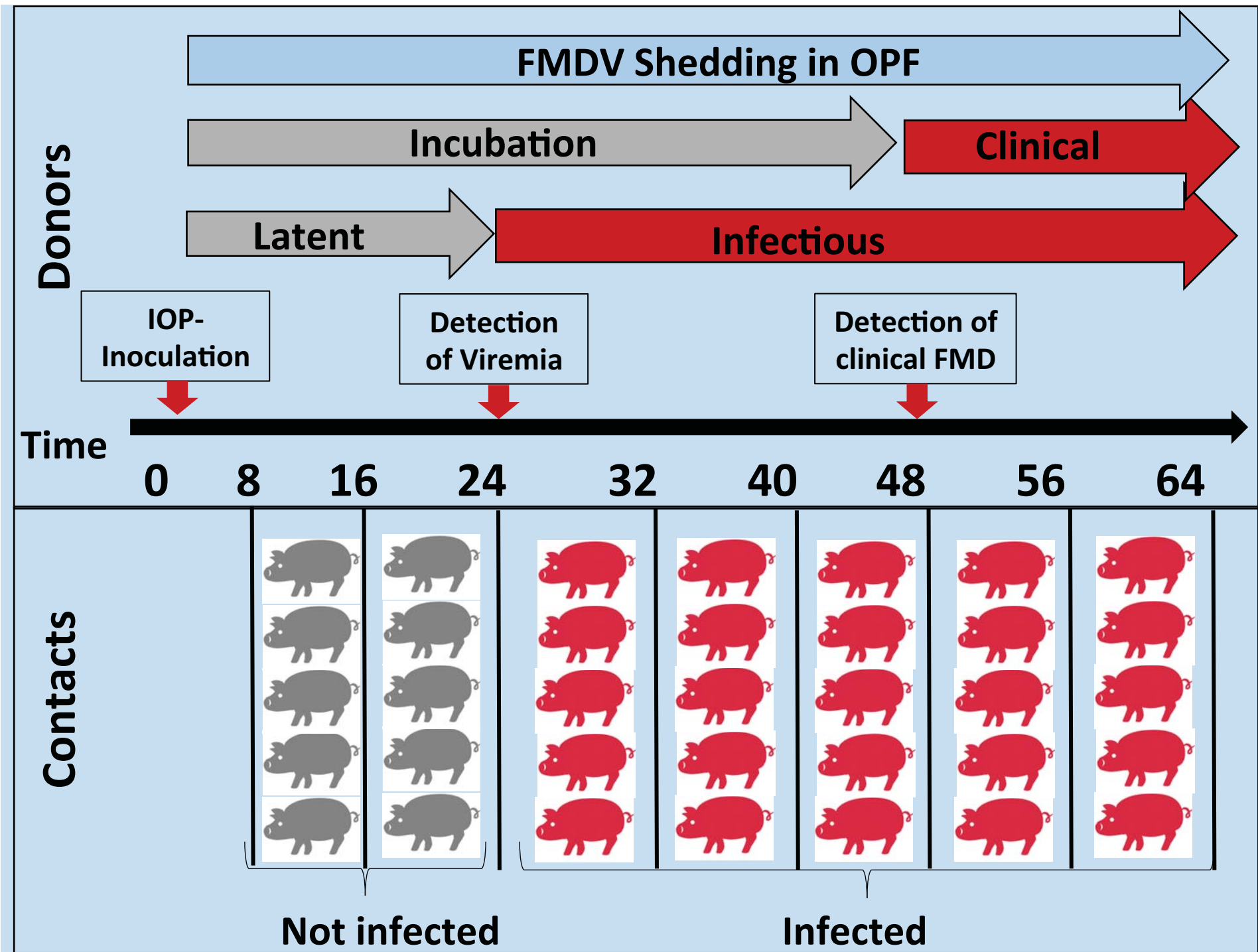
Serum

Lesion score



(preliminary experiments)





Implications/Impact of the work

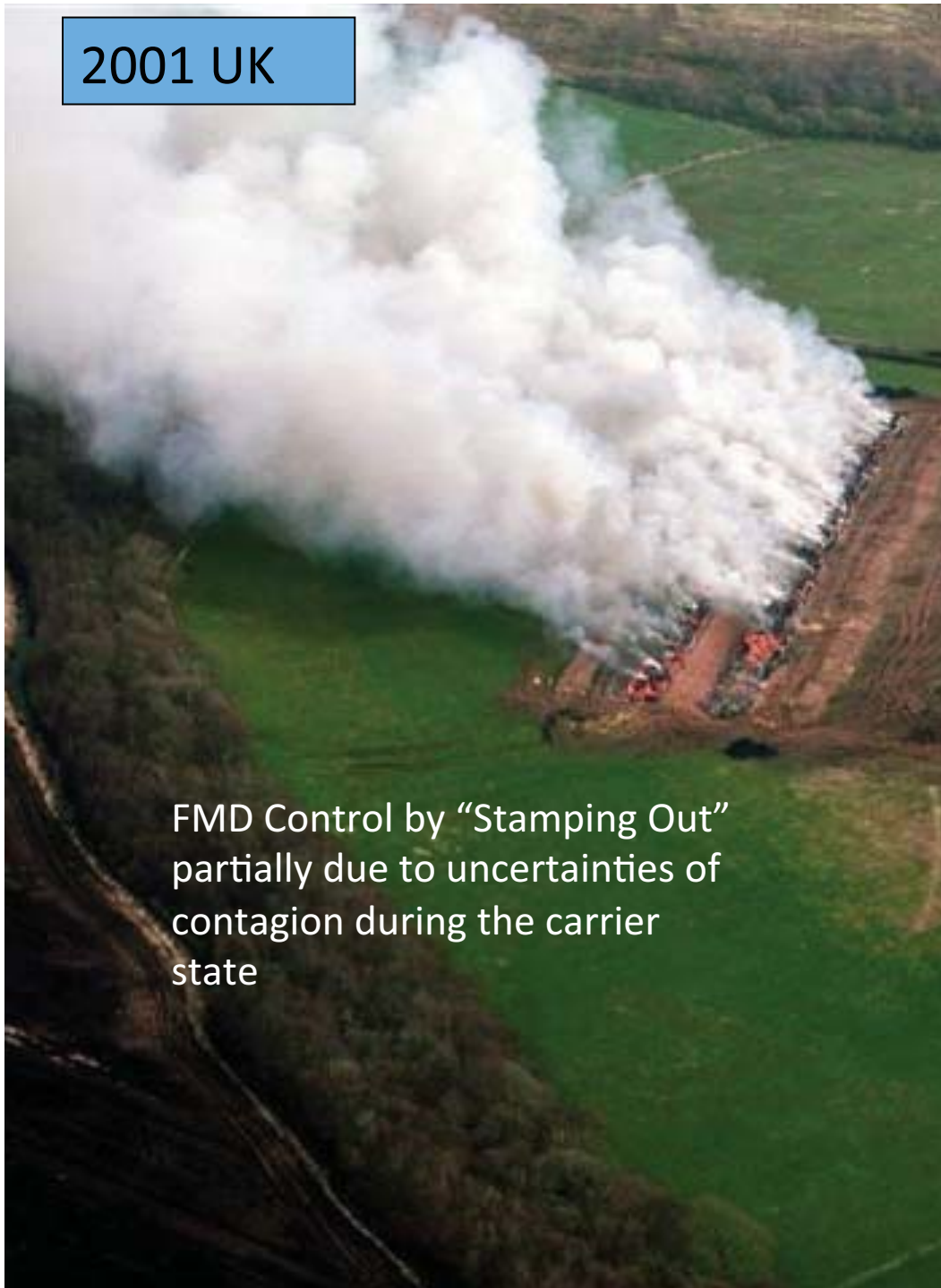
- Ability to evaluate the risk of moving animals or animal products in the absence of clinical signs
 - Ability to more accurately model the spread of disease associated with movements of animals
- Diagnostic test interpretation related to infectiousness and the design of surveillance plans
 - How typical samples and diagnostic test results relate to transmission potential

Leveraging data from International Studies on Endemic FMD

- Study sites:
 - Asia (Vietnam, India, Pakistan)
 - Africa (Uganda, Cameroon, Kenya)
- Data Categories:
 - Outbreaks (clinical virus isolates)
 - Vaccine matching
 - Carriers (subclinical virus isolates, serology, extinction studies)
 - Transmission studies (limited)
 - Tissue-based studies (pathogenesis / meat residues)

Example of using international studies to improve data for modeling

2001 UK



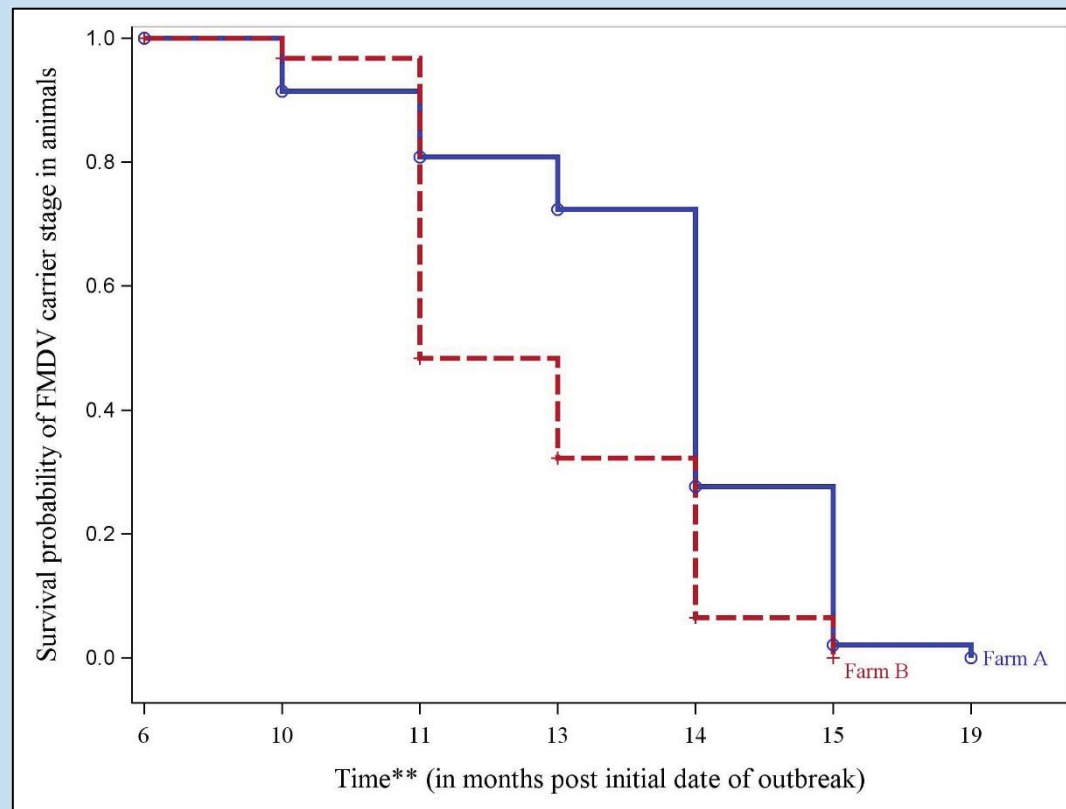
FMD Control by “Stamping Out”
partially due to uncertainties of
contagion during the carrier
state

Japan 2010



AFP

Tools for evaluating FMDV carrier extinction under natural conditions*



Carrier state extinction curves in two cattle herds in Uttarakhand, India

*for use in endemic settings.....or in USA after an outbreak

Implications/Impact of the work

- Ability to evaluate the risk of keeping animals alive after an outbreak
- Specific forms of monitoring (diagnostics) could be used to mitigate risk
- A small step towards “Vaccinate-to-live” policy

Moving forward; next steps

- Increased collaboration on study design and data analysis (CEAH-FADRU):
- FMD:
 - Further analyses of compiled data
 - Parameterization, modeling of shedding and transmission
 - Design & execute experiments to fill specific gaps
- ASF
 - Design & execute experiments to fill specific gaps
- CSF
 - Evaluation of experimental data already collected and development of national model parameters

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- Jonathan Arzt

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Homeland
Security