Science-guided evaluation of FMD control policies: disposal of the 5th quarter under the microscope

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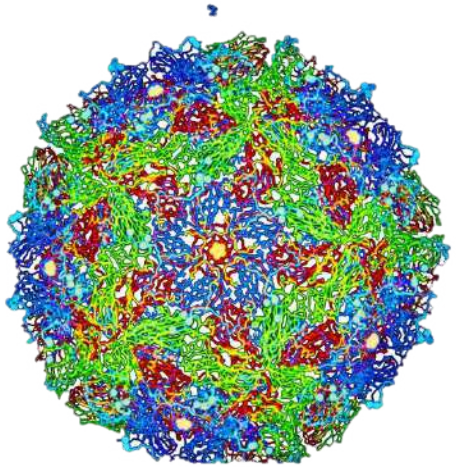
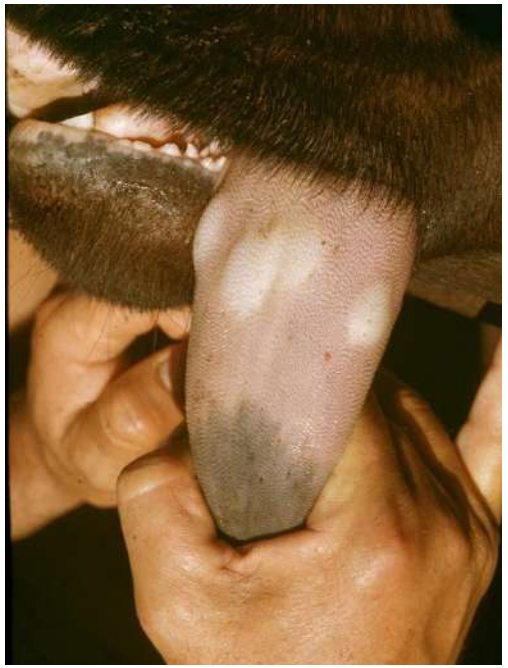
The SAT serotypes of FMD are different



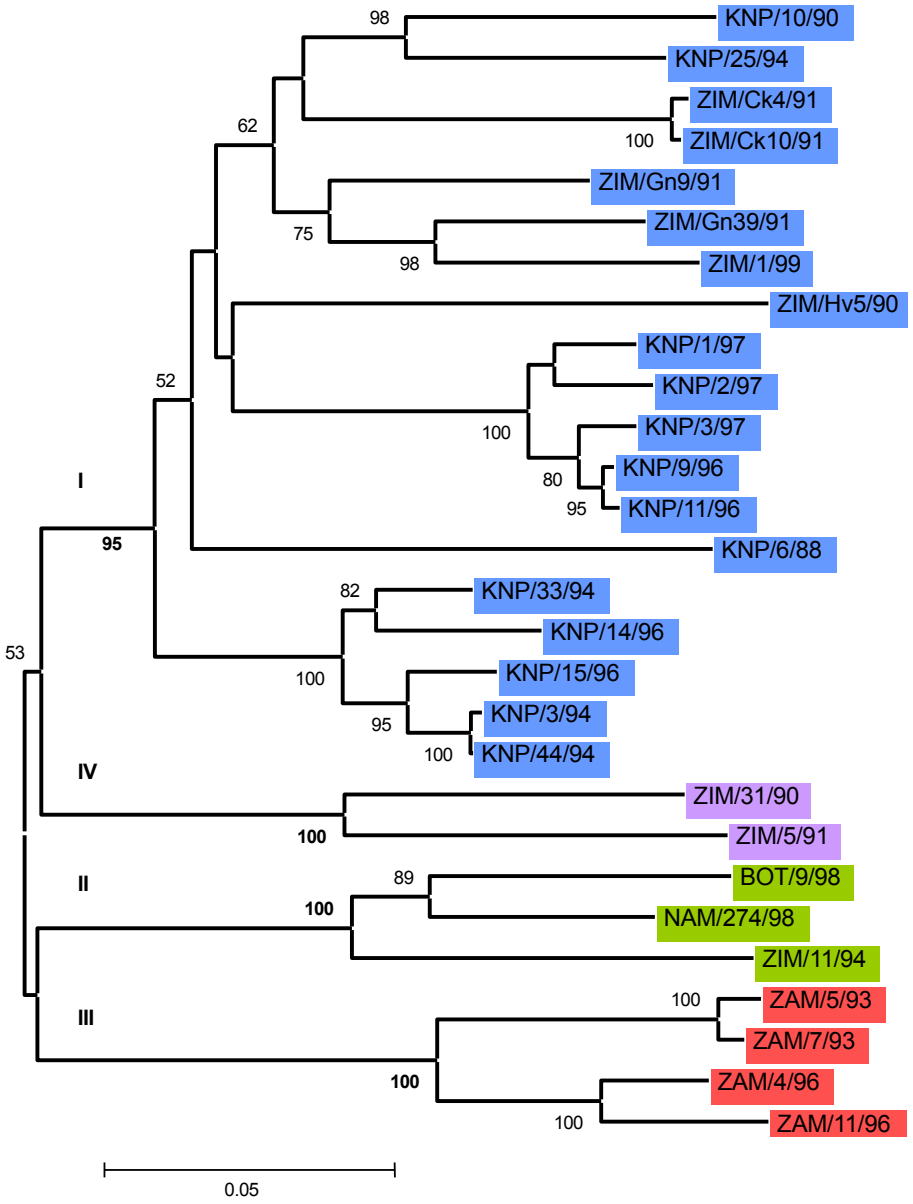
Seven FMD serotypes:

- Eurasian strains: A, O, C, Asia-1
- South African Territories (SAT) types 1, 2 and 3
- Acid labile, thermolabile, UV-sensitive, RH < 60%

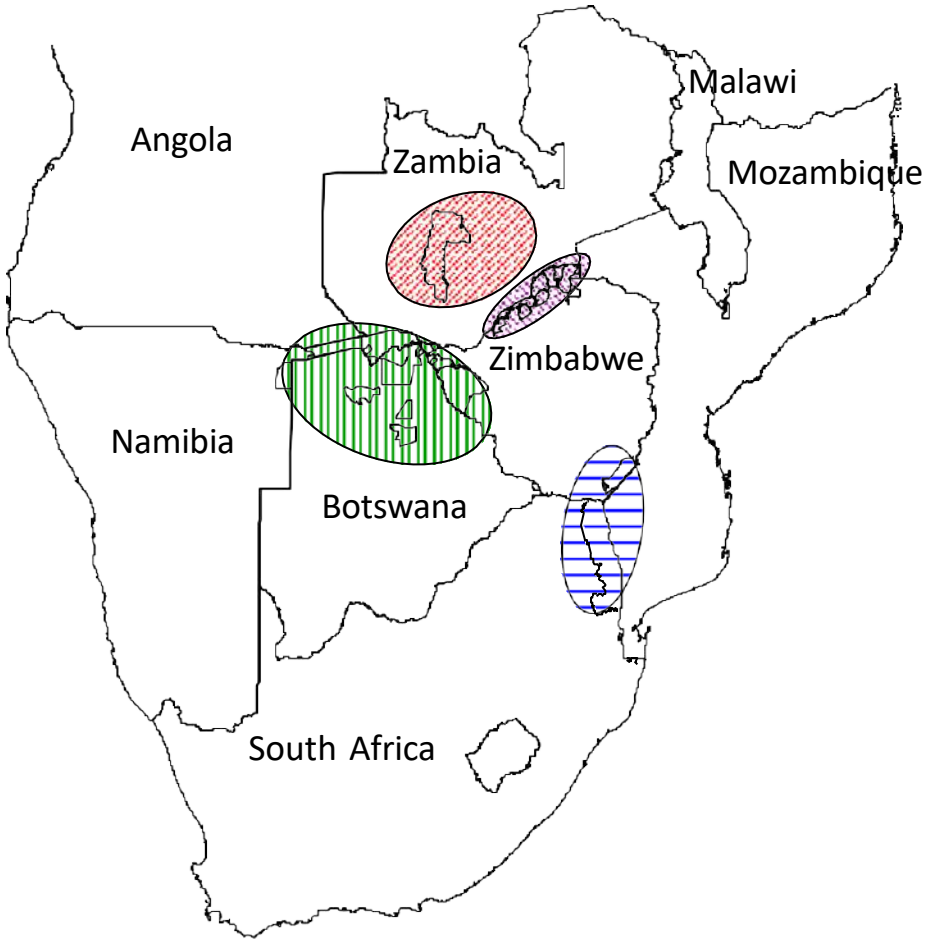


SAT types (sub-Saharan Africa, African buffalo):

- Subclinical infections → clinical surveillance?
- Low mortality rates (<5%)
- Thermolability: SAT-1 > SAT-2 > SAT-3 > O > C > Asia-1 > A (Doel & Baccarini, 1981)
- Genetically and antigenically more heterogeneous



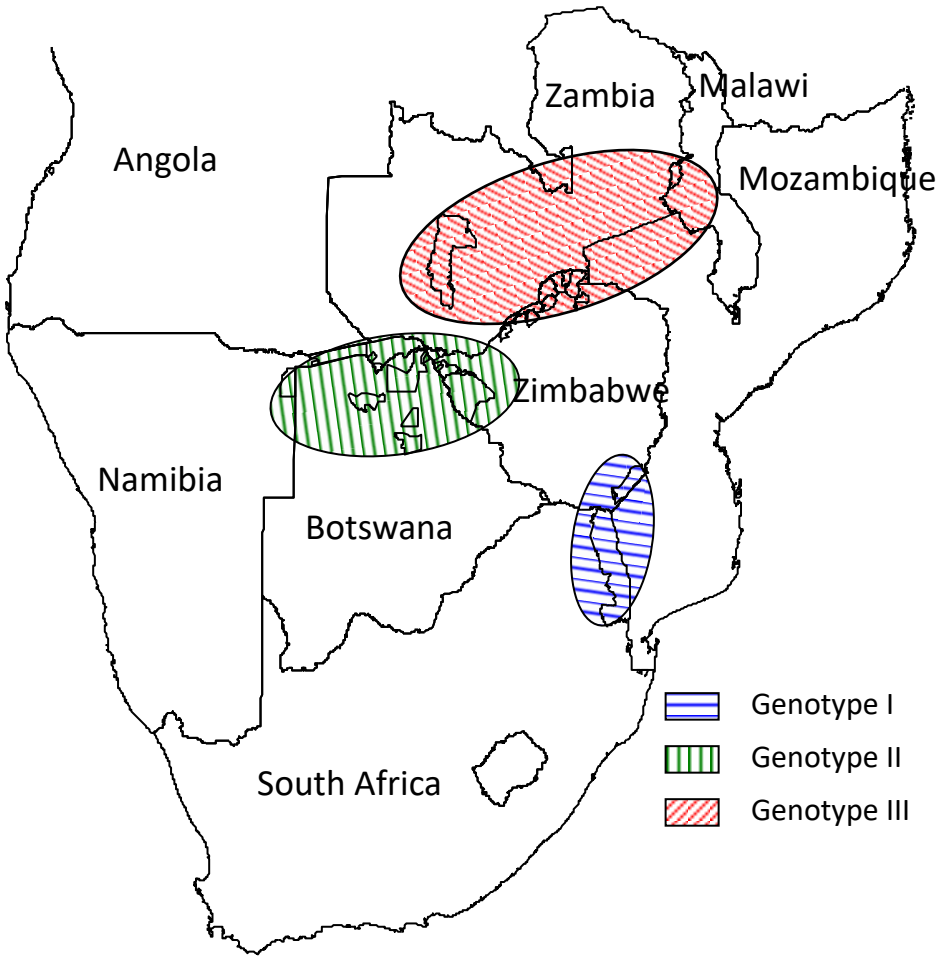
SAT-3 (Thomson & Bastos, 2004)



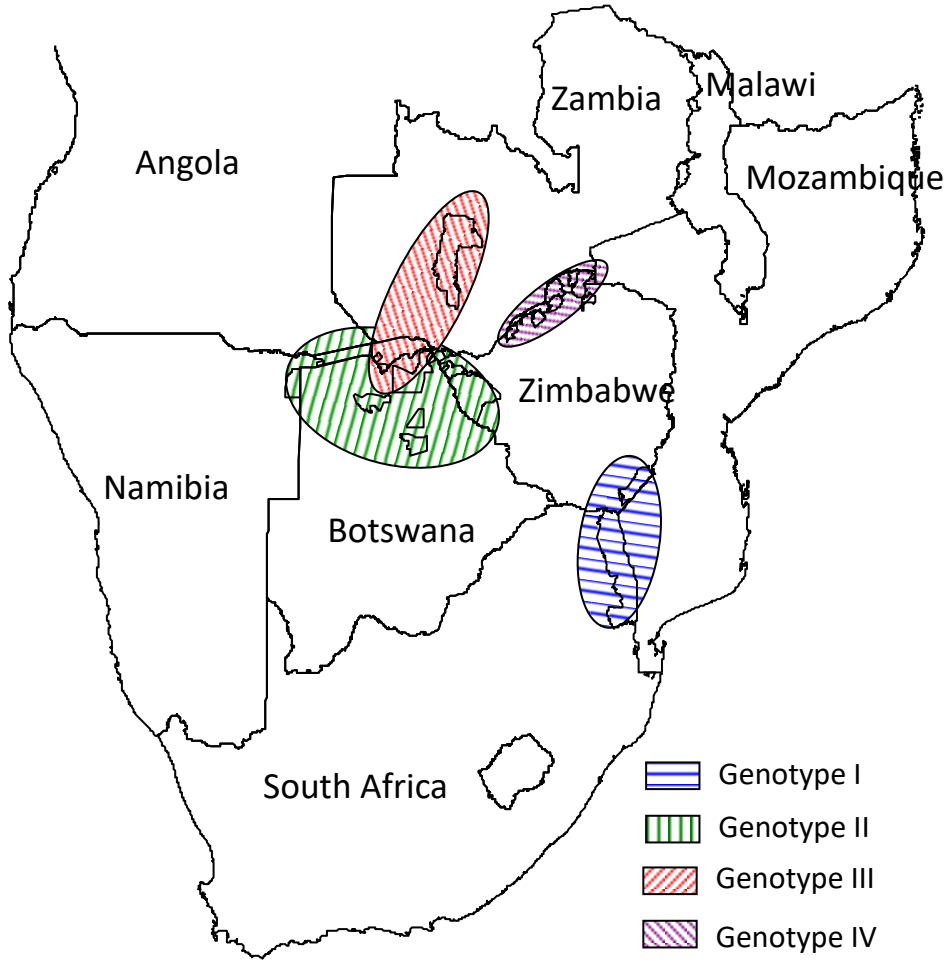
Temporal versus geographical structuring

Implications for vaccination

The South African viruses are distinct

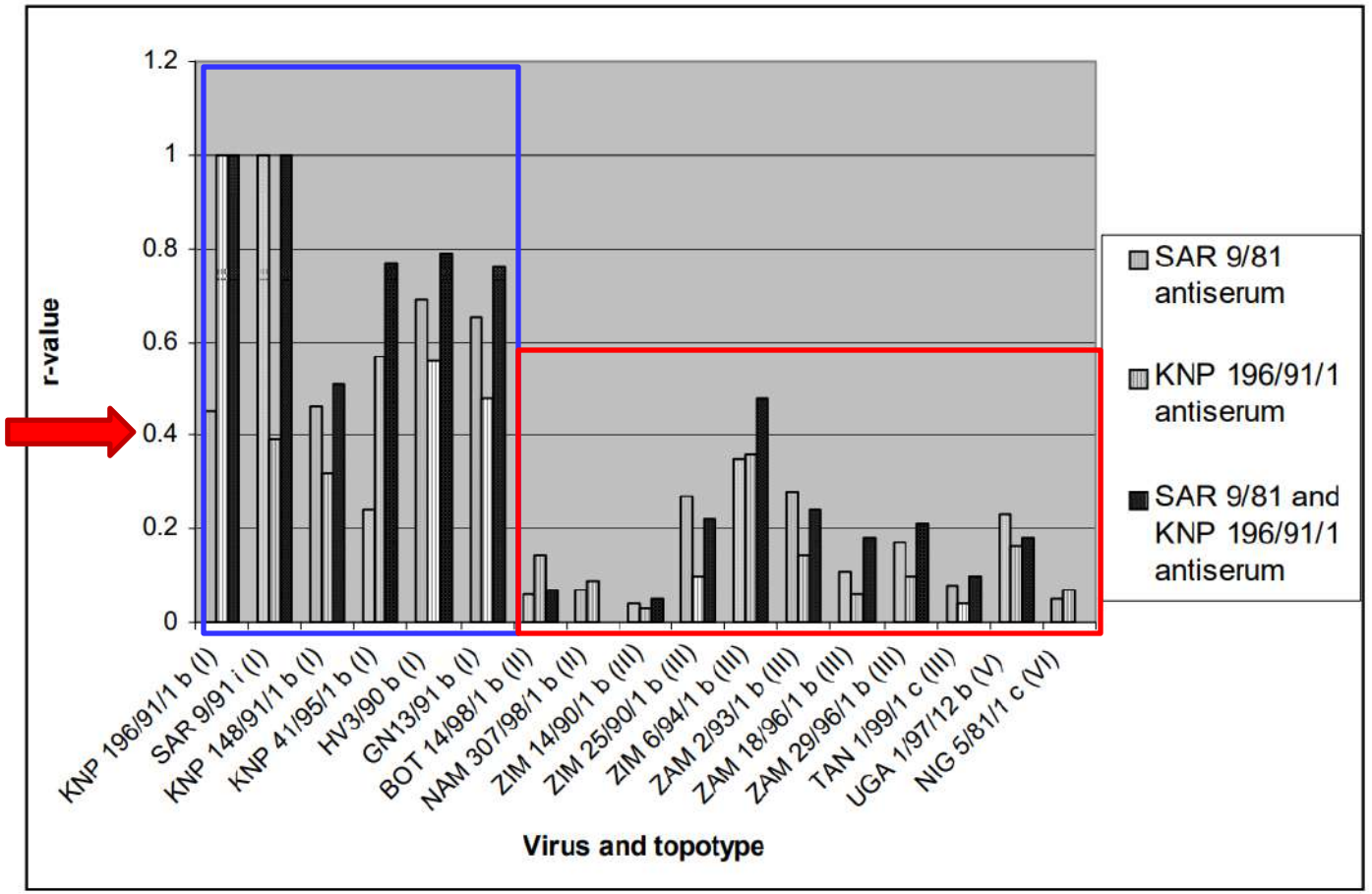


SAT-1



SAT-2

Antigenic variation mirrors genetic variation



SAT-1 vaccine strains

r-values (serum titre of field strain/serum titre of vaccine strain):

0.00 – 0.19 (field and vaccine strains are poorly matched)

0.20 - 0.39 (not well matched, but a potent vaccine may provide protection)

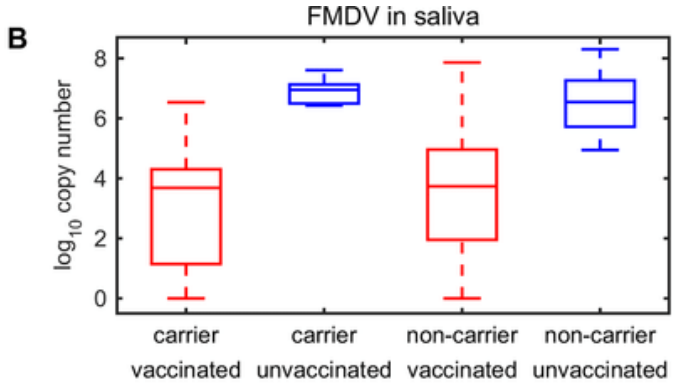
0.40 – 1.0 (good match, vaccine should provide good protection)

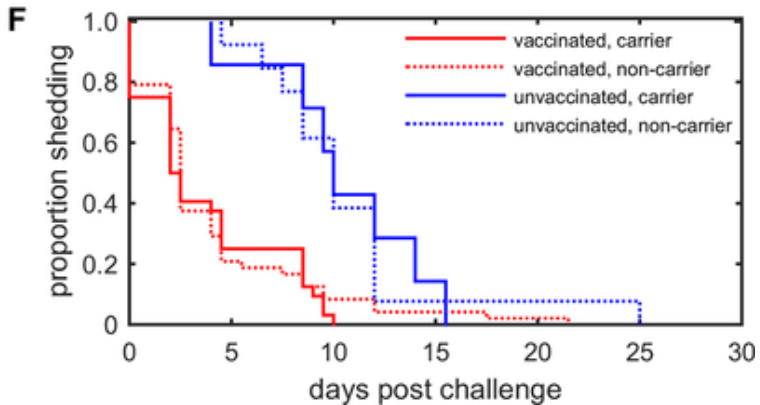
FMD outbreaks

- Main route of transmission is by inhalation of **aerosolised** virus particles
  - direct transmission (close contact between naive and infected animal)
  - indirect/airborne transmission ("low probability–high consequence" event)

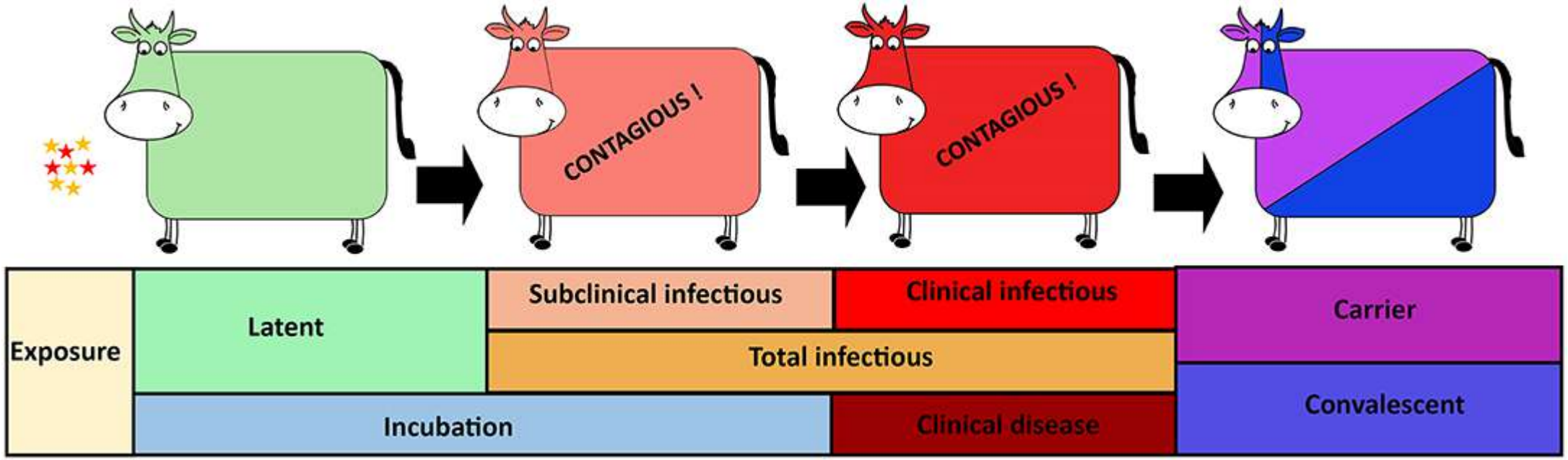
- Variation in the infectious dose needed to establish an infection:
  - for cattle and sheep, it is low (10-25 $TCID_{50}$)
  - for pigs it is high (>300 $TCID_{50}$) Alexandersen et al., 2002

- Successfully controlled with quarantine and targeted **vaccination** (for slaughter)
  - Vaccination does not prevent infection
  - Vaccination reduces the levels and duration of viraemia (Parthiban et al., 2015)





Serotypes O, A and Asia-1 (Yadav et al. 2019)



Latent phase = 1.5 days (1.1–2.1)
Subclinical infectious phase = 2.2 days (1.5–3.5)
Clinical infectious phase = 8.5 days (6.2–11.6)

14-21 days from infection to recovery
Day 28: Cleared the virus or carrier/persistence (estimates range from 20-60%)

Foot-and-Mouth Disease (FMD) Biosecurity and Risk Mitigation at Abattoirs (19 June 2025)

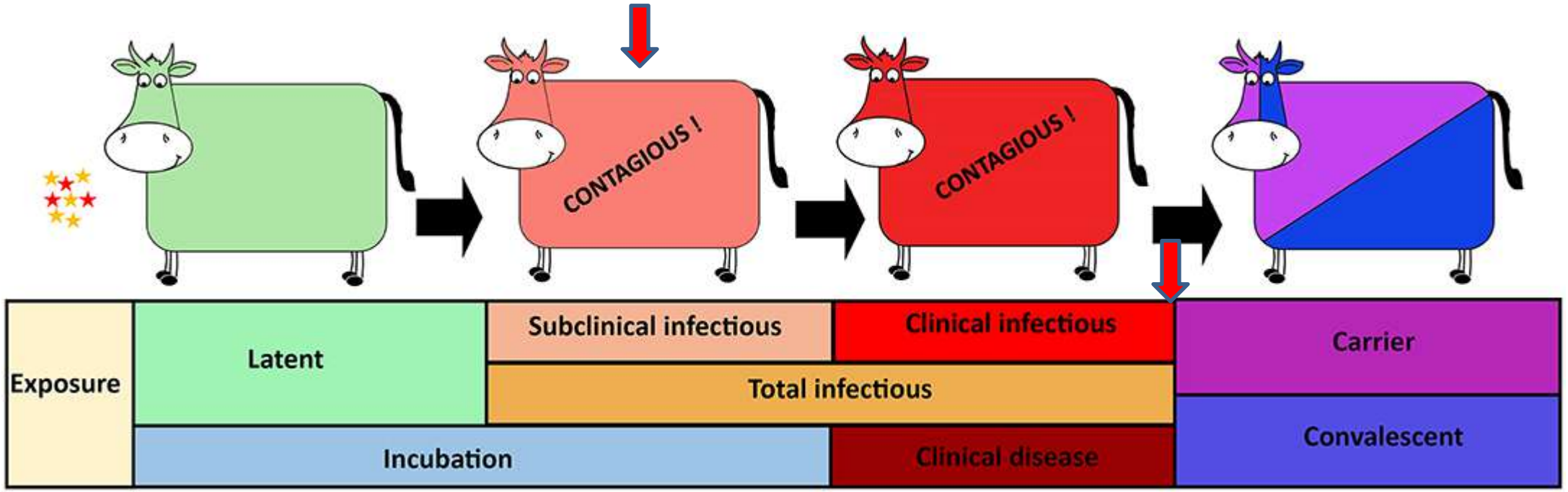
Heads (including tongues) and feet have to be removed and either processed to inactivate the virus or disposed of safely from any animal slaughtered up to 6 months after **Day zero**.
Day zero is defined as the date that:
- the last animal received its first FMD vaccination
- last day of new clinical symptoms, whichever comes last

Additional risk mitigation measures include carcass maturation (and confirmation of pH drop below 6), deboning and deglanding of carcass, removal and treatment/disposal of **5th quarter derivatives** (head & tongue, feet, and offal).

Offal destruction, and the deboning and deglanding of the carcass are required up until 6 weeks after day 0; all other requirements apply until 6 months after **Day zero**.

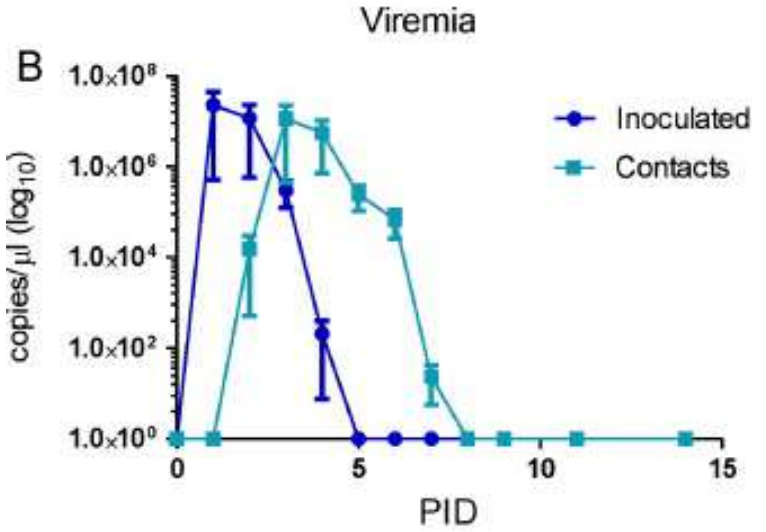
Skins can be salted and released after 28 days

Where is the risk?



Outbreak: quarantine with vaccination of <u>all animals</u>

Vaccination removes the risk:
Day 0 is properly defined
Only the “carrier risk” remains post day 14
% carriers (20-60%) – strain dependent?



Carrier concerns

- The carrier state of FMDV was first described in 1958 (van Bekkum *et al.* 1959).
- Defined as an animal where infectious FMDV can be detected for at least 28 days after infection (Sutmoller *et al.*, 1968).
- The epidemiological relevance of subclinical FMDV persistence is controversial (Sutmoller & Casas, 2002; Garland & de Clercq, 2011; Babu *et al.* 2015).
    - Experimental studies (Moonen *et al.*, 2004; Golde *et al.*, 2005; Tenzin *et al.*, 2008; Parthiban *et al.*, 2015)
    - Field studies (Bertram *et al.*, 2018)

have failed to demonstrate transmission from carrier cattle to naive cattle

- More recently, the carrier status was defined as the point an animal clears the infection, and the virus can only be detected in sites of persistence (Stenfeldt *et al.*, 2016)
    - → 10 days in vaccinated cattle
    - → 21 days in unvaccinated cattle

Virus persistence (carriers)

FMDV can be recovered from the naso-pharyngeal region (dorsal soft palate and nasopharynx) at **28 days post-infection** (Zhang & Alexandersen, 2004; Pacheco et al. 2015).

FMDV is cleared from peripheral sites (lungs, interdigital cleft, coronary band and hilar, renal and popliteal lymph nodes) by **10 days post-infection**.

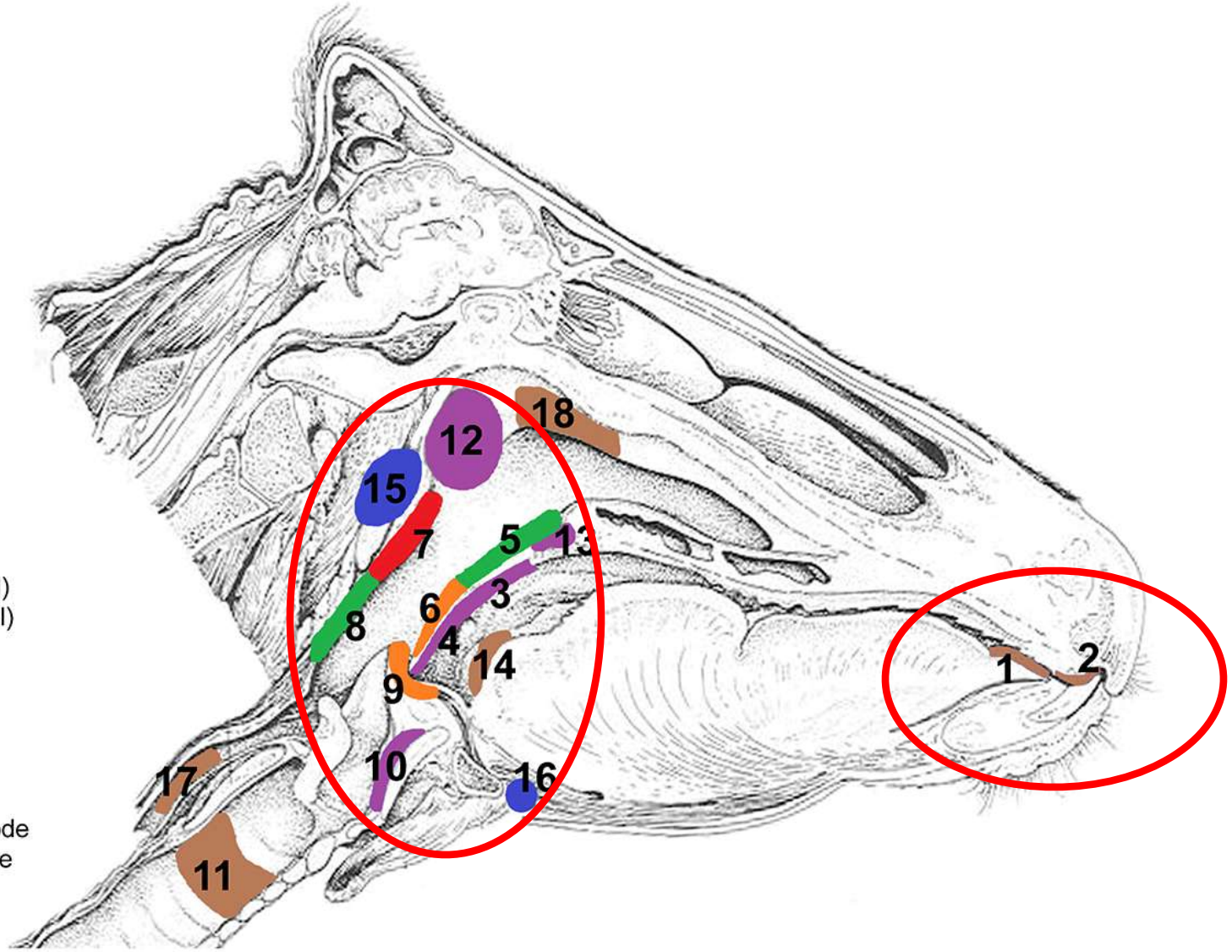
FMDV is cleared from the lungs and kidneys **21 days post-infection** (Prato Murphy et al. 1994).

Very **low levels** of detectable virus present in the naso-pharynx after **28 dpi** (Stenfeldt & Belsham 2012).

The science to guide the 5th quarter disposal requirement

Color coding of prevalence
80-100%
60-80%
40-60%
20-40%
0.1-20 %
Negative

Tissue identification key
1. Tongue (rostral)
2. Dental pad
3. Ventral soft palate (rostral)
4. Ventral soft palate (caudal)
5. Dorsal soft palate (rostral)
6. Dorsal soft palate (caudal)
7. Dorsal nasopharynx (rostral)
8. Dorsal nasopharynx (caudal)
9. Epiglotis
10. Ventral larynx
11. Trachea
12. Nasopharyngeal tonsil
13. Palatine tonsil
14. Lingual tonsil
15. Retropharyngeal lymph node
16. Submandibular lymph node
17. Esophagus
18. Nasal septum

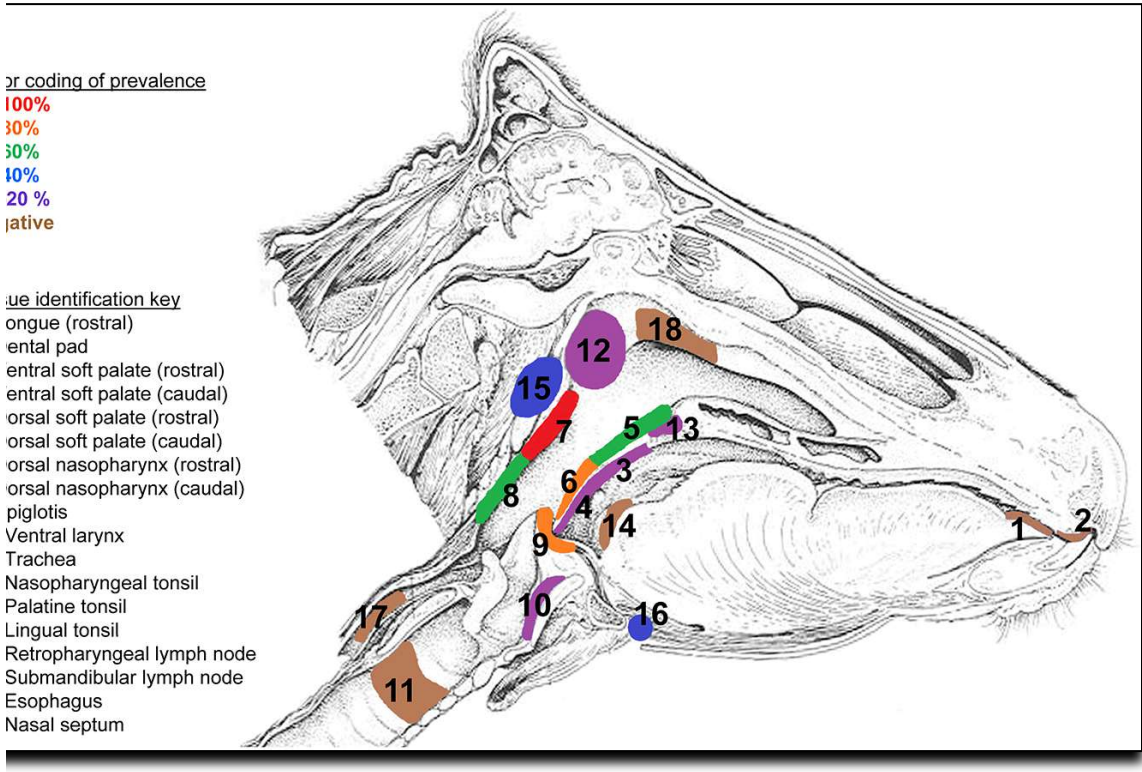


Pacheco et al. (2015). Persistent foot-and-mouth disease virus infection in the nasopharynx of cattle; tissue-specific distribution… *PLoS ONE* 10(5): e0125698. doi:10.1371/journal.pone.0125698

Summary of cattle tissue predilection sites of FMD virus (Pacheco et al. 2015 study)

Site No	Sampling site	SAT-type positivity (%)	Prevalence (%) - all serotypes	SAT-type positivity relative to total positivity/ prevalence
1	Tongue (rostral)	0	0.00	0
2	Dental pad	0	0.00	0
3	Ventral Soft palate (rostral)	0	5.26	0
4	Ventral Soft palate (caudal)	25	19.05	1.3125
5	Dorsal Soft palate (rostral)	50	47.62	1.05
6	Dorsal Soft palate (caudal)	75	57.14	1.3125
7	Dorsal Nasopharynx (rostral)	100	71.43	1.4
8	Dorsal nasopharynx (caudal)	50	52.38	0.954545455
9	Epiglotis	50	60.00	0.833333333
10	Ventral larynx	0	15.00	0
11	Trachea 10cm	0	0.00	0
12	Nasopharyngeal tonsil	0	9.52	0
13	Palatine tonsil	0	9.52	0
14	Lingual tonsil	0	0.00	0
15	Retropharyngeal lymph node	0	30.00	0
16	Submandibular lymph node	0	23.81	0
	Bronchial bifurcation	0	0.00	0
	Distal Cranial lobe	0	0.00	0

13 of the 16 sites of concern were positive for European serotypes A and O, whereas only 6 sites were positive for cattle persistently infected with SAT-2 type virus



Only 4 animals were infected with FMD SAT-2 (strain unknown), of which 3 were vaccinated and one was unvaccinated

Study to guide disposal of 5th quarter derivatives

Phase 1: 5th quarter derivative risk assessment (vaccinated - BVI vaccine)

From day 18-**21** (post-vaccination of the last animal in the feedlot)

(a) Evaluate sites of persistence

- Sample 6 known sites of virus persistence in the head
- Bone marrow
- Lymph nodes
- Blood/serum (serology to confirm vaccination and infection status)

(b) Evaluate treatment options for rendering heads safe for sale

- Remove **specified risk material** (naso-pharyngeal tissue, including lymph nodes) → proof-of-concept concluded (Prof. Lieza Odendaal)
- Treat the head tissue after removal (and test for virus)

→ Rapid turnaround to guide policy adjustments

Phase 2: Repeat (BVI versus OVR vaccine), sample at **day 15**

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KARAN BEEF

Media Statement: SAHRC notes alarming levels of food insecurity in South Africa

Monday, 14 October 2024
Attention: Editors and Reporters

The South African Human Rights Commission (SAHRC) acknowledges the findings of the **National Food and Nutrition Security Survey (NFNSS)** report and welcomes its detailed insights into the critical issues of food security and malnutrition across South Africa. The report highlights the alarming levels of food insecurity affecting 63.5% of households and underscores the growing threat of severe food insecurity for vulnerable populations, particularly children.

The importance of vaccination

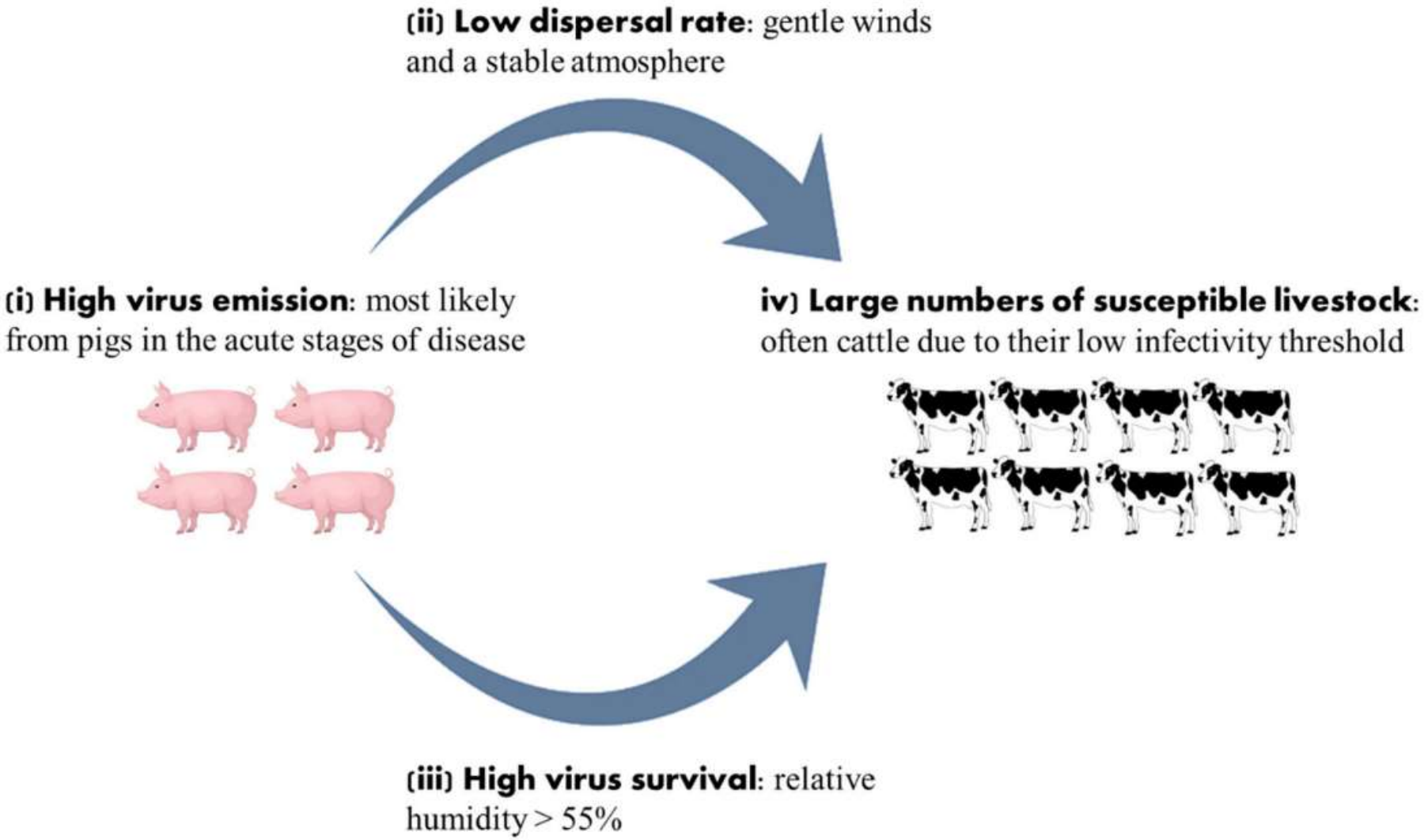
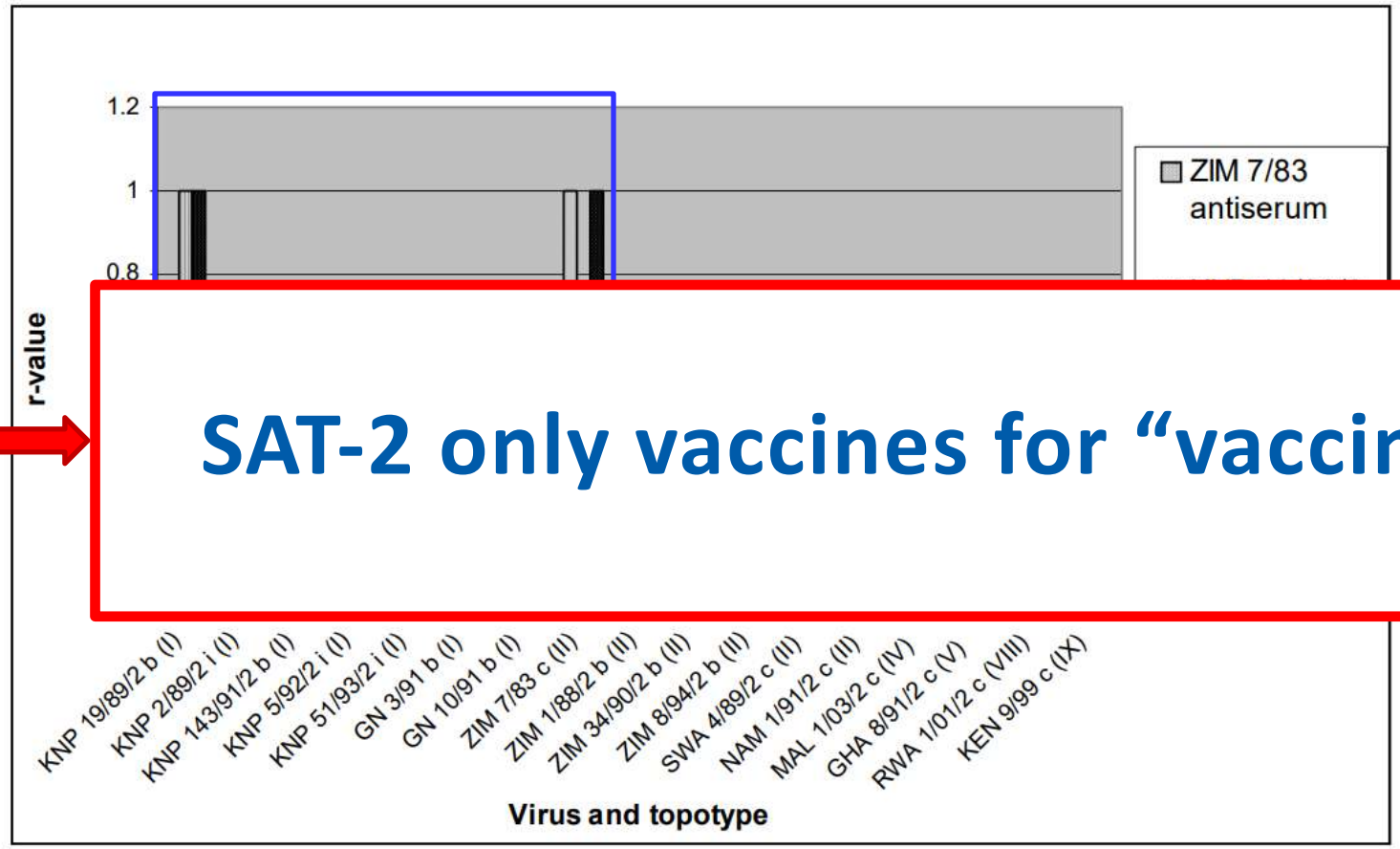


Figure 1. The factors required for airborne transport of foot-and-mouth disease virus aerosols over long distances.

SAT-2 – emergency *versus* preventive



SAT-2 only vaccines for “vaccinate to kill”?

r-values (serum titre of field strain/serum titre of vaccine strain):

0.00 – 0.19 (field and vaccine strains are poorly matched)

0.20 - 0.39 (not well matched, but a potent vaccine may provide protection)

0.40 – 1.0 (good match, vaccine should provide good protection)

Outbreak Response Team for FMD

Let science (on SAT-types) guide policy (on SAT-types)

PLOS | NEGLECTED TROPICAL DISEASES

RESEARCH ARTICLE

South African Ebola diagnostic response in Sierra Leone: A modular high biosafety field laboratory

Janusz T. Paweska[1,2,3]*, Petrus Jansen van Vuren[1,3], Gunther H. Meier[1], Chantel le Roux[1], Ousman S. Conteh[4], Alan Kemp[1], Cardia Fourie[1], Prabha Naidoo[1], Serisha Naicker[1], Phumza Ohaebosim[1], Nadia Storm[1], Orienka Hellferscee[1,2], Lisa K. Ming Sun[1], Busisiwe Mogodi[1], Nishi Prabdial-Sing[1,2], Desiree du Plessis[1], Deidre Greyling[1], Shayne Loubser[1,2], Mark Goosen[1], Stewart D. McCulloch[3], Terence P. Scott[3], Alexandra Moerdyk[1], Wesley Dlamini[1], Kelfala Konneh[4], Idrissa L. Kamara[4], Dauda Sowa[4], Samuel Sorie[4], Brima Kargbo[4], Shabir A. Madhi[1]

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How can SAFA members help

Let science on SAT-types guide policy on SAT-types

Be part of the outbreak response team - we need to learn everything we can about this virus to fight it effectively

- Reference sera for test validation (from onset of clinical signs and/or date of vaccination until clinical resolution / 28 days or more)

- Keep careful records of clinical signs, rate of spread, weather conditions, animal densities and breeds
  - Scientists need data to model and predict, eg. basic reproduction number (R_0) - number of new cases caused by a single, infected individual throughout its infection period)

Thank you

- *Karan Beef Team*
- *TAD Team*
- *UP Team*
- *FMD colleagues (old and new and departed)*

Learn from the past
Leverage the expertise and technologies of the present
Secure the future

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