Introduction to mathematical modelling of foot-and-mouth disease in livestock

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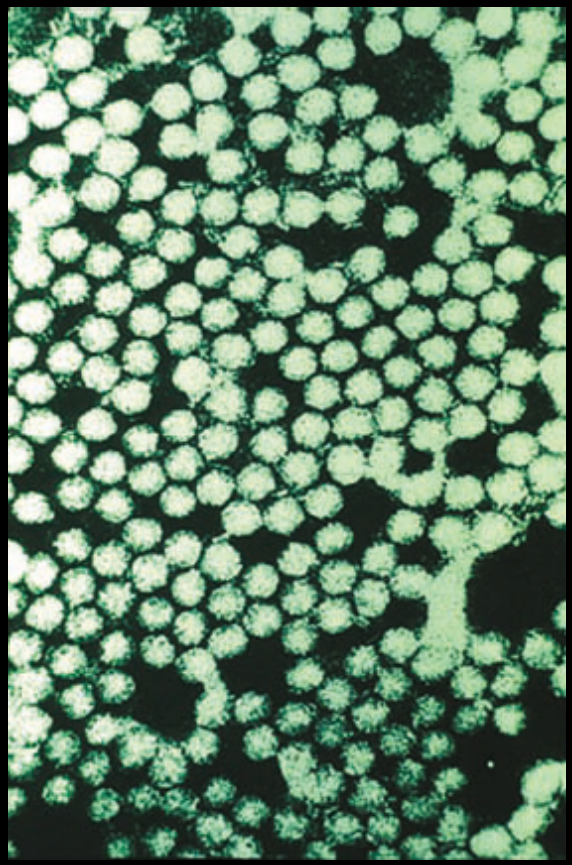
- In these slides, I consider foot-and-mouth disease (FMD) in livestock
- FMD was also called hoof-and-mouth disease (HMD) in the UK, although FMD tends to be used globally now
- I only consider single population aspects here, spatial spread is a later lecture

FMD characteristics

Basic models

Conclusion

Foot-and-mouth disease



- Severe, highly communicable **viral** disease of cattle and swine
- Also affects sheep, goats, deer and other cloven-hoofed ruminants. Horses not affected
- Elephants, hedgehogs and some rodents also susceptible but do not develop clinical signs of the disease

- Fever and blister-like sores on the tongue and lips, in the mouth, on the teats and between the hooves
- Many affected animals recover, but the disease leaves them weakened and debilitated

2001 United Kingdom HMD outbreak

- 2,000 cases of the disease in farms across most of the British countryside
- Over 6 million cows and sheep were killed to control the disease
- Ministry of Agriculture, Fisheries and Food (MAFF) adopted a policy of “contiguous cull” - all sheep within 3,000 metres of known cases slaughtered

More about transmission

J. Comp. Path. 2003, Vol. 129, 1–36
doi: 10.1016/S0021-9975(03)00041-0, available online at http://www.sciencedirect.com on SCIENCE DIRECT®

REVIEW

The Pathogenesis and Diagnosis of Foot-and-Mouth Disease

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Transboundary and Emerging Diseases

Transboundary and Emerging Diseases

REVIEW

The Pathogenesis of Foot-and-Mouth Disease I: Viral Pathways in Cattle

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Research in Veterinary Science 2002, **73**, *195–199*
doi:10.1016/S0034-5288(02)00105-4, available online at http://www.idealibrary.com on IDEAL®

REVIEW

Foot and mouth disease

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SUMMARY

Foot and mouth disease (FMD) affects cloven-footed animals. It is caused by seven species (''types'') of Foot and Mouth virus (FMDV) in the genus aphthovirus, family Picornaviridae (ICTV 2000). FMDV is a single-stranded RNA virus, with a protein coat consisting of four capsid proteins enumerated as VP1, VP2, VP3, and VP4 (Garland and Donaldson 1990).

Available online at www.sciencedirect.com
SCIENCE DIRECT®
The Veterinary Journal 169 (2005) 197–209
The Veterinary Journal
www.elsevier.com/locate/tvjl

Review

A review of foot-and-mouth disease with special consideration for the clinical and epidemiological factors relevant to predictive modelling of the disease

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CLINICAL MICROBIOLOGY REVIEWS, Apr. 2004, p. 465–493 Vol. 17, No. 2
0893-8512/04/$08.00+0 DOI: 10.1128/CMR.17.2.465–493.2004

Foot-and-Mouth Disease

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Transboundary and Emerging Diseases

REVIEW ARTICLE

Epidemiological Patterns of Foot-and-Mouth Disease Worldwide

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Jamal and Belsham *Veterinary Research* 2013, **44**:116
http://www.veterinaryresearch.org/content/44/1/116

VETERINARY RESEARCH

REVIEW Open Access

Foot-and-mouth disease: past, present and future

Syed M Jamal[1] and Graham J Belsham[2*]

Rev. sci. tech. Off. int. Epiz., 2002, **21** (3), 637-644

The economics of foot and mouth disease

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FMD characteristics

Basic models

Conclusion

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MODELING THE INTRINSIC DYNAMICS OF FOOT-AND-MOUTH DISEASE

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journal homepage: www.elsevier.com/locate/prevetmed

Modelling foot and mouth disease

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PROCEEDINGS OF THE ROYAL SOCIETY B

Proc. R. Soc. B (2005) **272**, 1195–1202
doi:10.1098/rspb.2004.3046
Published online 15 June 2005

Review

Models of foot-and-mouth disease

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During the 2001 foot-and-mouth disease outbreak in the UK, three very different models were used in an attempt to predict the disease dynamics and inform control measures. This was one of the first times that models had been used during an epidemic to support the decision-making process. It is probable that models will play a pivotal role in any future livestock epidemics, and it is therefore important that decision makers, veterinarians and farmers understand the uses and limitations of models. This review describes the utility of models in general before focusing on the three foot-and-mouth disease models used in 2001. Finally, the future of modelling is discussed, analysing the advances needed if models are to be successfully applied during any subsequent epidemics.

Keywords: livestock disease; mathematical models; control

From: Foot-and-Mouth Disease: Current Perspectives. Edited by: Francisco Sobrino and Esteban Domingo

Chapter 13

Mathematical Models of the Epidemiology and Control of Foot-and-Mouth Disease

Mark E. J. Woolhouse

IMA Journal of Mathematics Applied in Medicine & Biology (1997) **14**, 1–9

An analysis of foot-and-mouth-disease epidemics in the UK

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Journal of Theoretical Biology 357 (2014) 150–159

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Journal of Theoretical Biology

journal homepage: www.elsevier.com/locate/yjtbi

Dynamics and control of foot-and-mouth disease in endemic countries: A pair approximation model

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HIGHLIGHTS

- Traditional models of FMD focus on control and dynamics in disease-free settings.
- We analyze long-term dynamics and control of FMD in endemic countries.
- Success of vaccination depends on rates of vaccine and natural immunity waning.
- Prophylactic vaccination performs better that ring vaccination.
- More mathematical models applicable to FMD-endemic countries need to be developed.

Epidemics 4 (2012) 158–169

Contents lists available at SciVerse ScienceDirect

Epidemics

journal homepage: www.elsevier.com/locate/epidemics

Within-farm transmission dynamics of foot and mouth disease as revealed by the 2001 epidemic in Great Britain

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FMD characteristics

Basic models

Conclusion

Rev. sci. tech. Off. int. Epiz., 2006, **25** (1), 000-000

Use and abuse of mathematical models: an illustration from the 2001 foot and mouth disease epidemic in the United Kingdom

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Conclusion