Waves of foot-and-mouth disease in East Africa and advances in practical surveillance


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FMD studies in interface areas of northern Tanzania

Kenya

Tanzania

Legend:
- National Park
- Game Reserves and Conservation Areas
- Forest Reserves
- Lakes

Agro-pastoralist
- Serengeti
- SNP
- NCA

Pastoralist
- Loliando

Rural smallholder system
- Arusha

Pastoralist
- Monduli

Agro-pastoralist
- Tarangire
- Simanjiro
More intensive studies in the Serengeti ecosystem
FMD impacts in these communities

• Ranked amongst the most important livestock diseases
• Lactating cattle especially affected
• Significantly lower milk yield…
• …with implications for consumption and sales
• Loss of traction capacity
Drivers of infection in cattle

- Cattle more exposed than small ruminants
- Significant predictors in cattle:
  - Age
  - Production system
  - Herd size
  - New acquisitions
- No significant wildlife-related predictors
- Most prevalent serotypes - O in cattle and SAT1 in buffalo
- Least prevalent serotypes - SAT2 in cattle and A in buffalo
Vaccine-based control strategies

• Vaccination provides a potential solution for controlling disease in rural Africa and...

• ...would be culturally and politically acceptable
But many constraints

• Limited capacity locally for field surveillance and serotype-specific diagnostics

• Limited data on circulating strains for vaccine selection:
  » High diversity of viruses and little cross-protection

• Insufficient understanding of temporal and spatial patterns of virus circulation to devise strategies for vaccine delivery

• Lack of effective polyvalent vaccines against such a large range of serotypes
Northern Tanzania (2011-2015)

Bayesian model inference from SPCE results

Virus isolation results

Km North Jittered District

N
96 sera
60 herds
36 villages

85 viruses
37 herds
23 villages
## Northwards direction in Serengeti

Days since first outbreak ~Km north

<table>
<thead>
<tr>
<th></th>
<th>Dependent variable</th>
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<tbody>
<tr>
<td></td>
<td>Days (SAT2)</td>
</tr>
<tr>
<td>Km North</td>
<td>6.553***</td>
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<tr>
<td>(SE)</td>
<td>(1.211)</td>
</tr>
<tr>
<td>Constant</td>
<td>-21.923</td>
</tr>
<tr>
<td>(SE)</td>
<td>(16.104)</td>
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<tr>
<td>Observations</td>
<td>13</td>
</tr>
<tr>
<td>R²</td>
<td>0.727</td>
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<tr>
<td>Adjusted R²</td>
<td>0.702</td>
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<tr>
<td>Residual Std Error</td>
<td>26.912 (df = 11)</td>
</tr>
<tr>
<td>F Statistic</td>
<td>29.290*** (df = 1; 11)</td>
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</tbody>
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*p<0.1; **p<0.05; ***p<0.01
Frequency of outbreaks

• Median time between outbreaks - 489 days (IQR: 351-859 days) in 34 longitudinally tracked herds

• Four herds tracked through 4 outbreaks over < 3 years

• Sequential outbreaks caused by different serotypes
What does this mean in terms of FMD control and further research needs?

• Temporal patterns of antigenic dominance in Tanzania
• Serotype-specific (monovalent) vaccination in advance of expected waves of infection

• BUT…

• Can we improve surveillance and viral characterisation across Africa to determine if…
• …this pattern is consistent across broader geographical scales?
Field-based solutions for surveillance and high-resolution molecular epidemiology

• Nucleic acid recovered from 20 lateral-flow devices (LFDs) from clinical cattle two years after collection

• Typing successful on all samples (various % of genome recovered)
Research priorities – grassroots-level surveillance and in-country diagnostics

- Local-level information networks (mobile phone technologies? WhatsApp?)
- Strategies for deployment and recovery of LFDs
- Serotype-specific LFDs
- Diagnostic and molecular platforms in the field and local laboratories
- Sharing connections across Africa to characterise large-scale circulation patterns