Meta-analysis on the efficacy of foot-and-mouth disease emergency vaccination

Tariq Halasa
Anette Boklund
Sarah Cox
Claes Enøe
Conclusions

• Emergency vaccination provided clinical and virological protection against FMD in cattle, swine and sheep.

• No significant publication bias was identified in the analyses.

• The outcomes of the meta-analysis can be used for further epidemiologic and economic assessment of emergency vaccination.
Objective

- Conduct a comprehensive assessment of the efficacy of emergency vaccination using meta-analysis of available literature.

- The outcome parameters can be used to assess the epidemiologic and economic consequences of emergency vaccination.
Definition of efficacy

- Determine the efficacy of FMD emergency vaccination in terms of:
  - Clinical protection.
  - Virological protection.
Outcome parameters

• Parameters to represent protection:
  
  – Relative risk (RR) of clinical disease.
  
  – RR of virological infection.
RR of clinical disease

- RR = the incidence of clinical disease in the vaccinated group divided by the incidence in the non-vaccinated group.

- Incidence of clinical disease = number of clinically diseased animals divided by the total number of animals per group.
Virological infection

• Several tests were used to diagnose infection.
  – When an animal was positive to any of the tests, the animal was considered infected.

• The tests were:
  – Virus isolation from the blood, oral, nasal, or esophageal-pharyngeal fluid.
  – Presence of antibodies to non-structural proteins.
  – RT-PCR of oral, nasal, or esophageal-pharyngeal fluid.
RR of virological infection

- The RR of virological infection = the incidence of FMD infection in the vaccinated group divided by the incidence in the non-vaccinated group.

- The incidence = the number of FMD infected animals divided by the total number of animals per group.
Meta-analysis procedure

• A statistical technique that summarize the results of different studies that address a related hypothesis.

• A pooled RR was calculated for the clinical and virological protection for
  – Cattle
  – Swine
  – Sheep

• Checked for publication bias.
Results - descriptive

- 28 published studies fitted the criteria.
- 27 were included in the analyses.
- 10 conducted using cattle.
- 9 conducted using swine.
- 5 conducted using sheep.
- 3 had more than 1 species.
- 4 unpublished studies conducted on swine.
Results – Clinical protection in cattle

<table>
<thead>
<tr>
<th>Virus serotype</th>
<th>Study</th>
<th>RR</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>RR and 95% CI</th>
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<tbody>
<tr>
<td>A</td>
<td>Brehm, 2008</td>
<td>0.051</td>
<td>0.003</td>
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<td>A</td>
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<td>0.071</td>
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<td>A</td>
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<td>Pooled RR A</td>
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<td><strong>0.079</strong></td>
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<td>Asia 1</td>
<td>Salt, 1995</td>
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<td>0.052</td>
<td>0.295</td>
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<tr>
<td>Pooled RR Asia 1</td>
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<td><strong>0.124</strong></td>
<td><strong>0.052</strong></td>
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<tr>
<td>O</td>
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<tr>
<td>O</td>
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<tr>
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<tr>
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<tr>
<td>O</td>
<td>Orsel, 2005</td>
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<td>0.008</td>
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<tr>
<td>Pooled RR O</td>
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<td><strong>0.118</strong></td>
<td><strong>0.062</strong></td>
<td><strong>0.226</strong></td>
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<tr>
<td>Overall Pooled RR</td>
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<td><strong>0.123</strong></td>
<td><strong>0.087</strong></td>
<td><strong>0.175</strong></td>
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</table>
Results – Clinical protection in cattle - publication bias
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Duval and Tweedie trim and fill method
Results – Virological protection in cattle

- Vaccinated cattle
  - 0.65 (0.53 – 0.81) lower chance of FMD infection

- No significant publication bias was identified.
Results – Protection in pigs and sheep

• In pigs:
  • Clinical protection: 0.47 (0.36-0.62).
  • Virological protection: 0.68 (0.53-0.87).

• In sheep:
  • Clinical protection: 0.31 (0.18-0.53).
  • Virological protection: 0.57 (0.39-0.82).

• No significant publication bias was identified in the analyses.
Conclusions

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• The outcomes of the meta-analysis can be used for further epidemiologic and economic assessment of emergency vaccination.
THANK YOU
Characteristics of an emergency vaccine?

- Contain no residues of a live virus and have minimal side effects to newborns and adults
- After a single application with the recommended dose, achieve a potency dose 50 (PD50) of $\geq 6$
- Be compatible with serological tests that identify infection in vaccinated animals
- Induce reasonably long lasting immunity and provide a broad spectrum of antigenic protection
- Be stable under storage once formulated
- Provide a rapid protection after vaccination
- Reduce the reproduction ratio (R0) to below 1
What is meta-analysis?

• Statistical technique.

• Summarize the results of different studies that address a related hypothesis.

• Controls for study characteristics

• Results in an overall average are more powerful than outcomes of individual studies.
Inclusion criteria

• Experimental challenge with FMD emergency vaccination using cattle, swine, and/or sheep.

• Research or symposium papers published in English language.

• Report the number of protected animals and the total number of animals in
  – vaccinated group
  – non-vaccinated control group.

• Both groups should be challenged with a homologous virus.