A framework for understanding zoonoses at the livestock-human interface in western Kenya

Dr Eric Fèvre
www.zoonotic-diseases.org

Centre for Immunity, Infection and Evolution, University of Edinburgh
and
International Livestock Research Institute, Nairobi

In collaboration with: KEMRI, Centre for Microbiology Research
Department of Veterinary Services, Kenya

Acknowledgements

Funded by:
- Wellcome Trust (UK)
- BBSRC (UK)
- MRC (UK)

Thanks to
- Lian Thomas (University of Edinburgh)
- William de Glanville (University of Edinburgh)
- Annie Cook (University of Edinburgh)
- The 15-strong PAZ team
  - James Akoko, Omoto Lazarus, Lorren Alumasa, Daniel Cheriyot, Jenipher Ambaka, Fred Opinya, John Mwaniki, Hannah Kariuki, Gideon Mwali, George Omondi, Alice Kiyong’a, Lilian Abonyo, Maseno Cleophas, Fred Ambaka, Velma Kivali
- Phil Toye (ILRI)
- Sam Kariuki (Kenya Medical Research Institute, KEMRI)
- Njeri Wamae (Kenya Medical Research Institute, KEMRI)
- Bernard “Risky” Agwanda (NMK)
- Mark Bronsvoort (Roslin Institute)
- Mark Woolhouse (University of Edinburgh)
- Claire Okell (Royal Veterinary College)
- The DVOs, Western Province
What research is needed? - WHO

- Field epidemiological studies in humans and livestock
  - the number of cases and number of deaths
  - number of new infections
  - age-and sex-specific disability weights for zoonoses

- Estimates/models of under-reporting
  - Much recent progress: rabies, sleeping sickness
  - Case studies to gather an evidence-base

- Multi-disease studies – what is the overall burden of zoonoses as a group on communities
  - Public health
  - Economics

- Field-level diagnostics

- Cost-effectiveness studies – dual medical/veterinary benefits

- Pathogen and host ecology
People, Animals and their Zoonoses (PAZ)

- Integrated project that addresses this lack of data and these scientific aims
- Aims to address both (veterinary) public health and ‘biological’ questions
- Epidemiology – population scale
- Framework that can be repeated elsewhere in different communities and ecologies
Aims of study

- Acquire basic field epidemiological data on zoonotic diseases in both humans and animals
- Enumerate co-infections/co-exposure with zoonoses amongst humans and livestock (with 1+ zoonosis; with all pathogens)
- Quantify the human burden of zoonoses and other infections in the study area
- Investigate links between zoonoses and non-zoonotic infections – co-factors (eg – are sick animals better reservoirs?)
- Understand/model the extent to which co-factors predict exposure to zoonoses
- What is the impact of zoonoses on production losses in livestock?
- Understand the role of the wider ecosystem on disease transmission
- Investigate the potential of simple livestock-targeted interventions as a means of improving human public health
Study site

- Field site is the Western Province of Kenya
- 2000 km² zone (500,000 cattle, 67,000 pigs, ~1 million people)
- Small-holder crop-livestock production system in the Lake Victoria Crescent (highest human and livestock densities in East Africa)
- Intensively and comprehensively sampled over 2.5 years
- Cluster design (random household), organised by sub-location units
- All sublocations in the study site to be sampled, proportionally by cattle population distribution
The project is focused on…
Livestock cross sectional survey

- Infections with zoonotic diseases and other pathogens in cattle, pigs, goats
- Sampling 1100 cattle in ~ 450 households
- All cattle, pigs, goats in each home sampled
- Comprehensive individual level questionnaire covering a diversity of socio-economic, spatial and biological risk factors (c.100 item questionnaire)

Process
- Field examination/full clinical exam, collection of blood, serum, faeces
- Parasitological screening, sample processing, some serologic diagnostic assays in field lab
- ELISA and PCR at central lab
- Biobanking + material for livestock genetics
<table>
<thead>
<tr>
<th>Organism/condition</th>
<th>Test type</th>
<th>Sample type</th>
<th>Sample volume</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State of health</strong></td>
<td>Clinical examination</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Blood-borne parasites</strong> (<em>Plasmodium</em>, <em>Rickettsia</em>, <em>Trypanosoma</em> <em>microfilariaem</em>, <em>microfilariae</em>, <em>Theileria</em>, <em>Anaplasm</em> etc)</td>
<td><strong>Microscopy</strong></td>
<td><strong>Thick and think blood smears; possibility of testing some rapid tests</strong></td>
<td><strong>100µl</strong></td>
</tr>
<tr>
<td><strong>Various intestinal parasites</strong> (<em>Ancylostoma</em>, <em>Trichuris</em>, <em>Strongologides</em>, <em>Ascaris</em>, <em>Necator</em>, <em>Hymenolepis</em>, <em>Taenia</em>, <em>Schistosoma</em>, <em>Coccidia</em>, <em>Crypto</em>, <em>Giardia</em>, <em>Fasiola</em>, <em>Entamoeba</em>…)</td>
<td><strong>Kato-Katz concentration, formol-ether concentration, microscopy</strong></td>
<td>Fresh faeces</td>
<td><strong>10g</strong></td>
</tr>
<tr>
<td><strong>Haemoglobin</strong></td>
<td><strong>PCV and direct measurement</strong></td>
<td>Whole blood</td>
<td><strong>10µl</strong></td>
</tr>
<tr>
<td><strong>Coxiella burnetii</strong> (Q-fever)</td>
<td><strong>Serology</strong></td>
<td>Serum</td>
<td>****</td>
</tr>
<tr>
<td><strong>Brucella</strong> spp. (Brucellosis)</td>
<td><strong>Serology</strong></td>
<td>Whole blood in anticoagulant</td>
<td>****</td>
</tr>
<tr>
<td><strong>Mycobacterium bovis</strong> (Bovine TB)</td>
<td><strong>Serology (Gamma-interferon)</strong></td>
<td>Peripheral Blood Mononuclear Cells from whole blood</td>
<td>8mls</td>
</tr>
<tr>
<td><strong>Rift Valley Fever</strong></td>
<td><strong>Serology</strong></td>
<td>Serum</td>
<td>****</td>
</tr>
<tr>
<td><strong>Trypanosoma brucei rhodesiense</strong> (sleeping sickness)</td>
<td><strong>Microscopy and PCR</strong></td>
<td>Whole blood in anticoagulant</td>
<td>****</td>
</tr>
<tr>
<td><strong>Taenia solium</strong> (pork tapeworm)</td>
<td><strong>Copro-PCR, serology and microscopy</strong></td>
<td>Stool, serum</td>
<td><strong>Faeces – 10g</strong></td>
</tr>
<tr>
<td><strong>Taenia saginata</strong> (beef tapeworm)</td>
<td><strong>Microscopy, serology and Copro-PCR</strong></td>
<td>Stool</td>
<td><strong>10g</strong></td>
</tr>
<tr>
<td><strong>HIV</strong></td>
<td><strong>Serology</strong></td>
<td>Whole blood in anticoagulant</td>
<td>****</td>
</tr>
<tr>
<td><strong>Leptospirosis (?)</strong></td>
<td><strong>Serology</strong></td>
<td>Serum and whole blood in anticoagulant</td>
<td>****</td>
</tr>
</tbody>
</table>
Human cross sectional survey

- Same principle as livestock element, but in humans; 120 item questionnaire
- Collaboration with Centre for Microbiology Research, KEMRI
- Two strata - households that keep cattle and those that do not – target 2500 patients sampled
- KEMRI ethical approval

Process
- Field examination and clinical exam, collection of blood, serum, faeces
- Sample processing, parasitology, some serologic diagnostic assays in field lab
- ELISA tests and PCR at central labs
- Biobanking of serum and blood for further analysis

Reporting back and free treatment of parasites
Scientific data on epidemiological parameters in the study population and design of targeted interventions

Mapping disease distributions and risk

Modelling transmission and the role of co-factors in zoonotic disease spread

Co-investigation of all humans and livestock in the sampling unit gives a uniquely comprehensive understanding

Will provide data to address gaps in NZD knowledge identified by WHÓ

Country- and regional- scale policy outputs with a wider regional relevance
Fin

Thanks for your attention!

Eric Fèvre
Email: Eric.Fevre@ed.ac.uk
Web: www.zoonotic-diseases.org

tel: +44 (0)131 208 32 35
tel: +254 (0) 722 545 345

Centre for Infection, Immunity and Evolution
School of Biological Sciences
University of Edinburgh
Ashworth Labs
West Mains Road
Edinburgh EH9 3JT
UK

International Livestock Research Institute
Old Naivasha Road
Po Box 30709-00100
Nairobi
Kenya
Good Practice in Quantitative Veterinary Epidemiology


http://www.qve-goodpracticeguide.org.uk/
Data management
Facilities

- Full scale “district level” parasitology and microbiology **diagnostic lab** for human and animal samples
- **Post-mortem room** for animals (pathology)
- International Livestock Research Institute Health and Safety and equipment **laboratory maintenance standards**
- International **supply chain** and cold chain
- Water, electricity, **broadband internet**
- **Excellent relations** with DVS, local leaders, government officials and the wider community
- **Access to field** (incl 4x4 transport)
  - among highest human and livestock population densities in Eastern Africa
  - geographical gradation from the Lake Victoria in the south to the lower slopes of the Mt Elgon uplands in the north
List of current equipment

- 3x long wheelbase land cruisers for fieldwork
- Large refrigerated centrifuges x2
- 37C incubators x3
- Water bath
- Incubator shaker
- Stomacher
- Shakers
- Micro-Haematocrit centrifuges
- Autoclave
- Deionizer
- Dissecting microscopes
- Compound microscopes
- Balances
- Automated haematology analyser
- Hemocue
- 2x Laminar air flow hoods
- 2x UV cabinets
- Fridges
- Biomedical freezers to -40 and -80
- Computing facilities and wireless internet access
- Large generator
- Robust real-time PCR machine
- ELISA reader
- LAMP PCR equipment
- Various standard equipment for parasitology processing
Studies currently under way

- Large cross-sectional survey of 450 households investigating epidemiology of endemic zoonoses and co-infections
- Zoonoses risk amongst slaughterhouse workers
- **MRSA** in pigs and people
- Food chain risk assessment of porcine cysticercosis and brucellosis
- Molecular epidemiology of brucellosis
- Development of pen-side diagnostics for cysticercosis
- **Pathogen discovery** in peridomestic rodents and bats