Understanding zoonotic and pandemic risk in relation to swine production systems in Cambodia

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Background

- Pigs play a key role in pandemic influenza emergence
- Limited knowledge on ecology and evolution of influenza viruses in pigs
- In Cambodia:
  - Fertile conditions for interspecies transmission and virus reassortment
  - Livestock sector undergoing rapid change
  - No routine/systematic surveillance for influenza among swine
  - No influenza virus sequence data from swine


Objectives

1. Characterise the live pig trading network in Cambodia
   a. Describe the epidemiology and diversity of swine influenza in pig systems
   b. Investigate how anticipated changes may influence influenza transmission risk among pigs/pig farms

2. Identify how rates of zoonotic influenza transmission vary across demographic and occupational groups

3. Develop models of influenza transmission dynamics at the swine-human interface, to inform strategies for early detection and reduction of zoonotic and pandemic risk

4. Enhance capacity for One Health research, surveillance, and collaboration
Funder
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Epidemiological surveys

- Interviews with actors in the pig network (demographics, management and trade)
- Sampling of pigs at slaughterhouses
- Non-invasive sampling in pig farms
- Serological surveillance of influenza in human cohort
### Questionnaires – pig network

#### 1. Producers
(Smallholders, boar service, farms)

- Recall period: 6 months
- Pig trade (inc. boar hire): Actor; Location; Company affiliation; Pigs traded; # and types; Trade frequency; Relationship; Contact details
- GPS: ✔
- Demographics: ✔
- Management: ✔
- Pig health: ✔
- Longitudinal: ✗

#### 2. Exchangers
(Middlemen, traders, butchers)

- Recall period: 14 days
- Pig trade (inc. boar hire): Actor; Location; Company affiliation; Pigs traded; # and types; Trade frequency; Relationship; Contact details
- GPS: ✗
- Demographics: ✔
- Management: ✔
- Pig health: ✔
- Longitudinal: ✔

#### 3. Slaughter houses
- Recall period: 7 days
- Pig trade (inc. boar hire): Actor; Location; Company affiliation; Pigs traded; # and types; Trade frequency; Relationship; Contact details
- GPS: ✔
- Demographics: ✔
- Management: ✔
- Pig health: ✔
- Longitudinal: ✔

#### B. Pig Trading/Exchange and other contacts

**B1. Do you keep records of the farm’s purchases and sales of pigs?**

- Yes
- No
- Unsure

**B2. In the past 6 months, have you purchased (or otherwise acquired) any LIVE pigs?**

- Yes
- No
- Unsure
Human cohort surveys

ILI case (Influenza-like-illness)

baseline recruitment

12-months Follow-up

24-months Follow-up

Study procedures

Consent
✓ Interview
✓ Blood sample

Household Questionnaire
✓ GPS
✓ Demographics
✓ Sanitation
✓ Asset index
✓ Animals

Individual Questionnaire
✓ Demographics
✓ Exposure to pig
✓ Exposure to poultry
✓ Travel
✓ Health status

Sample Collection
✓ 5 ml of blood
Pig production landscape

Smallholders (N = 173)

Commercial farms (N = 91)

Breeding farms

Growing farms

Boar Service Providers (N = 19)

Measure in place

- no
- yes
Pig network

Network degree

- Most actors have few suppliers and repeat transactions
- Some outward flow from slaughterhouses
- Boar service providers: hubs

William Leung (PhD Student)

Tornimbene and Drew (2012)
Trade distances

- Most trades occurred at short distances
- Exchangers facilitate longer trades
- Farms commonly trade at larger distances

William Leung (PhD Student)
Pig network

Next step: simulate complete network using exponential random graph models

(Locations jittered within district/commune)
Pig slaughterhouse surveillance

- Samples collected from ~4000 pigs at slaughterhouse
- 2% PCR positive for influenza A M-gene / 34% seropositive by ELISA
- Smallholders had 0.15 (95% CI: 0.02 to 0.81) odds of testing positive
Influenza surveillance in pigs

- NGS sequencing yielded 29 complete genomes
- Majority of the viruses belong to human H1N1 pandemic virus. Eight human H3 sequences were also detected.
- Phylogenetic analysis ongoing.
- Next step: Luminex assays using antigens developed from the sequence data and test all pig and human sera
Despite significant delays due to COVID-19 pandemic, baseline recruitment has been completed.

12-month follow-up surveys have been completed in 417 (67.8%) of households.
Frequency of pig contacts of individuals recruited according to type of household.

One Health Network & Training

- Post-graduate students (1 PhD student, 3 LSHTM MSc students, 2 UHS MSc students)
- **Training workshops:**
  - Field biosafety and biosecurity (with ACIAR – P Selleck)
  - Field epidemiology
  - **Spatio-Temporal** analysis (with RVC – G. Fournie & D. Pfeiffer)
  - Qualitative interview methods
- One Health online training course (LSHTM Open Study online platform)
- Statistical analysis with R (starting tomorrow)