Combining network analysis with epidemiological data to support the development of risk-based surveillance strategies of hepatitis E virus in swine population

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Context and aims. Animal movements between farms influence pathogen spread in the pig production sector. Hepatitis E virus (HEV) is an emerging and worrying foodborne zoonotic agent highly prevalent in pig farms. The aim of this study is to **combine network analysis of pig trade in France with epidemiological data to assess the HEV risk related to animal movements at farm and area scales**.

DATA

- Prevalence data: 6,565 sera randomly sampled in 2009 from 172 pig farms located in 49 French *départements* (Rose *et al.*, 2011)
- Movement data: all pig movements systematically recorded in 2013 in the French official movement database (BDporc) and modeled as a one-mode directed network (Salines *et al.*, 2017)

FARM SCALE

$$Within\ farm\ HEV\ seroprevalence = \frac{no.\ of\ HEV\ seropositive\ pigs}{no.\ of\ pigs\ sampled\ in\ the\ farm}$$

GEE logistic regression to evaluate the link between within-farm HEV seroprevalence and 8 centrality measures.

Centrality measures	Odds Ratio [CI 95%]	p-value
In-degree	**1.07 [1.01 - 1.13]**	**< 0.05***
Out-degree	0.99 [0.98 - 1.01]	> 0.1
Ingoing closeness	**1.91 [1.08 - 3.38]**	**< 0.05***
Outgoing closeness	0.54 [0.18 - 1.60]	> 0.1
Betweenness	0.99 [0.99 - 1.01]	> 0.1
Monthly ingoing contact chain	1.23 [0.96 - 1.58]	> 0.1
Monthly outgoing contact chain	0.98 [0.92 - 1.04]	> 0.1
Node loyalty	0.72 [0.37 - 1.38]	> 0.1

Farm's HEV seroprevalence increases with the number of incoming shipments (from different sources).

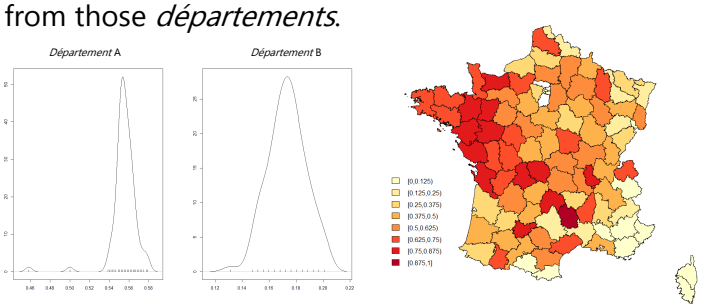
The closer a farm to its trade partners (no. of nodes between them), the higher its HEV seroprevalence.

LOCAL SCALE

$$Farm\ level\ HEV\ prevalence\ in\ a\ département = \frac{no.\ farms\ having\ at\ least\ one\ HEV\ seropositive\ pig}{no.\ of\ farms\ sampled\ in\ the\ département}$$

→ fitted to a beta distribution to take into account the low sampling precision in some *départements*

The risk of a French *département* being exposed to HEV through in-going movements was evaluated by combining HEV prevalence distribution in source *départements* with the no. of movements coming from those *départements*.



Examples of risk distributions and map of the median risk of French *départements* being exposed to HEV (10,000 simulations)

CONCLUSIONS & PERSPECTIVES

- Intensity of farms' supply and farm centrality in the network appear to be factors of vulnerability to HEV.
- Some areas are more at risk to HEV because of their pig movements.
- Movement-derived parameters can support the development of differentiated surveillance strategies.
- Risk-based epidemiological approaches benefiting from network analysis should be fostered in pig sector.

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