Urban Perspectives on Zoonotic Diseases in Livestock

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Our context: role of urbanization in the emergence of zoonotic pathogens

Understanding the mechanisms leading to the introduction of pathogens into urban environments and their subsequent spread

The focus is on livestock as sources of these pathogens, but where livestock are part of wider ecological networks

Focus on *Escherichia coli*, as an exemplar emerging pathogen, which exists in a diversity of hosts, in the environment, on food, in waste, etc

The geographical focus is the city of Nairobi, Kenya, and its hinterlands

Several components in an interdisciplinary team
- Livestock commodity value chains/food system economics
- Studies on actors and organisation of the food system
- Mapping: geographical, institutional, genetic
- Microbiology and landscape genetics analyses
- Urban planning
- Child health and nutrition
Interface

• “A point at which independent systems or diverse groups interact”
• In ecology, it is a physical place: edge, boundary.
• Interface
  - Zone of disturbance
  - Zone of interaction
  - Zone of genetic exchange
  - Zone of competition for resources
  - Zone of pathogen transmission
  - Odum (1971): “…the tendency for increased variety and diversity at community junctions…”

In sociology: it may not be a physical place: “…the PUI (peri-urban interface) not a place, it is a very dynamic process…”

• Physical: Rural/urban, livestock/human, human/food, points of socioeconomic, cultural environmental interaction
The practical interface
Interface with livestock and the food system
Complex, but therefore interesting

- Physical and biological interfaces exist within the context of societal and policy interfaces

- The physical world we are measuring is influenced by the non-physical interfaces

- Disease transmission may be facilitated or hindered by interventions at any of these interfaces
  - Understanding how they are related matters

*PNAS 2013; Zoonosis emergence linked to agricultural intensification and environmental change, by Delia Grace and others, May 2013.*
Simplify the complexity of urban systems by considering them as a network of interfaces across which pathogens can be transmitted.

Networks of interfaces exist at different scales

Local-scale: Households within urban communities linked by local movement of people, livestock and their products, and wildlife

Landscape scale: Evolving interfaces driven by the urbanization trends
Urbanisation

- Massive increases in the population of urban and peri-urban (UPU) zones in Africa
  - From 35% of total population 2007 to 51% by 2030

- Impacts on
  - human welfare
  - healthcare provision and delivery
  - sanitation
  - demography
  - economics
  - trade
  - development
  - food production
  - planning

- Impacts of these diverse issues on disease transmission?
Urbanisation: Demographic trends

Trajectories in African animal source food consumption


Value chains – key element

Legend:
- Movement of animals and products
- Movement of payments
- Movement of public health inspection/information
- Physical location of animals and products
- Business people
- Business people and ownership
- Public health people

1. you can...
2. you can’t...
3. you can...
4. you can’t
• Value chains are the means of connectivity between urban residents and livestock

• The chain itself crosses ecosystems and is itself an ecological network

• Each node of the chain is an opportunity for generating microbial diversity

• The city is a meta-population (Hanski & Gaggiotti, 2004) connected by people, livestock, livestock products peri-domestic species

• The geography of the city’s ecosystems and the way people relate and use their environment helps shape the type of interactions
Landscape genetics approach

• Value chains and household interviews help us understand the socio-economic factors, the contacts, the flows and patterns of trade and consumption

• This is not enough: we need to ground truth our sociological understanding through epidemiology and genetics: landscape genetics

  • *E. coli* as an exemplar microbe
  • Multi-host
  • Excellent tools for landscape genetics
  • Large datasets on microbial diversity from multiple environments/patches/niches within the urban landscape
Microbiological isolations

99 households: 
~30 sublocations (n=70)
Across 10 socioeconomic classes
3 households per unit

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Summary

The urban landscape is a complex ecological system.

Individual behaviours and decisions influence transmission risks at the interface.

The managers of the urban landscape – individuals, communities, local councils, devolved political structures, national governments, private landowners, corporations, developers, et al – can influence the shape and form of interface.

Management of interfaces ought to be pro-active.

Elements of the system can be carefully understood, allowing prediction of current and future risks (eg through landscape genetics).