Causal inference and One Health interventions: the need for epidemiologic methods

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Introduction and Background

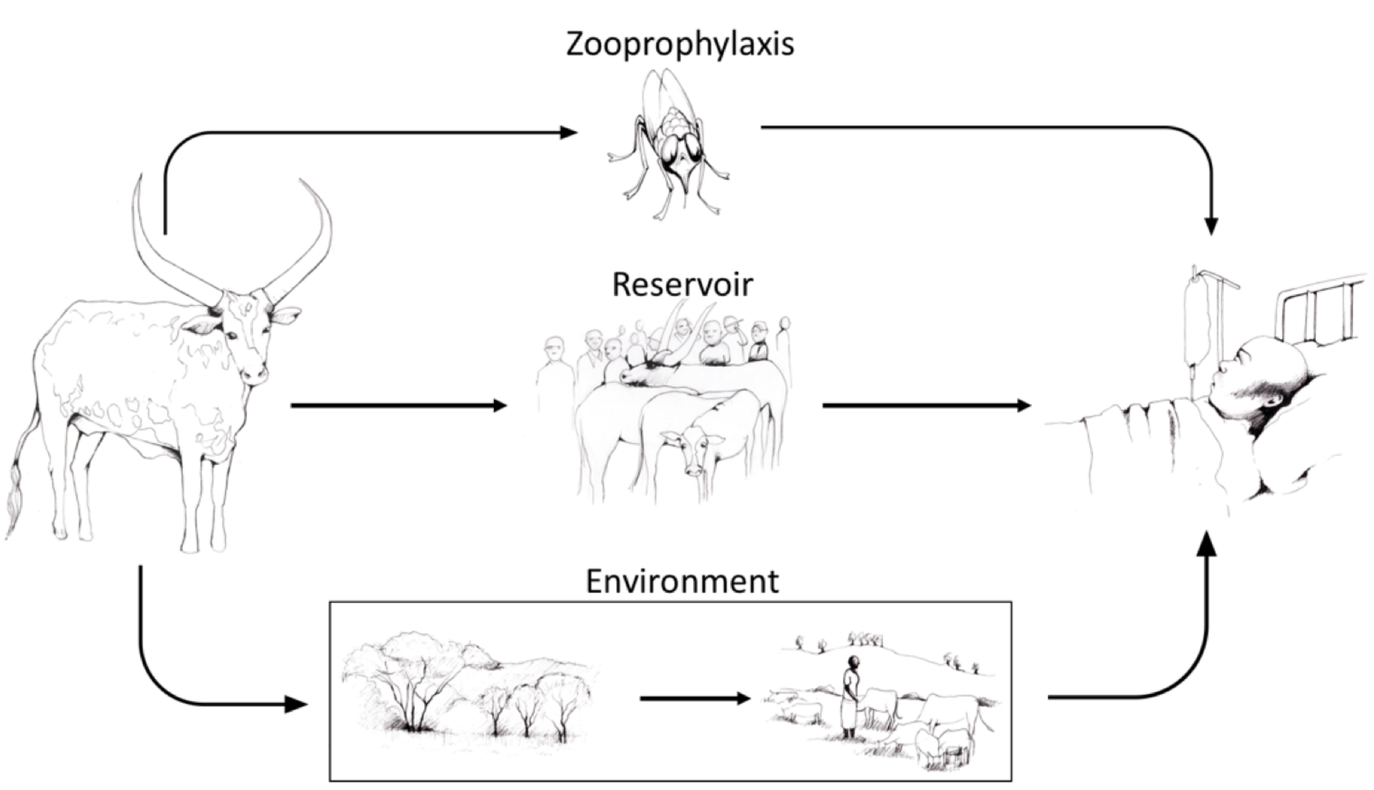
- Reporting guidelines for One Health (COHERE) strengthen application.
- Little attention has been paid to appropriate epidemiologic methods
- Causal inference holds promise for design and evaluation of One Health interventions: **underlying any intervention is a causal hypothesis.**
- Gambiense human African trypanosomiasis (gHAT) is targeted for elimination in 2020. These goals are threatened by uncertainty regarding animal reservoirs.
- Rhodesiense HAT (rHAT) is excluded from these goals due to its animal reservoir.
- We reviewed epidemiologic methods required to estimate the effect of One Health interventions on HAT

Methods

- **Identified hypothesized causal pathways** for HAT of One Health relevance.
- **Constructed a Directed Acyclic Graph (DAG)** to reflect these hypothesized relationships.
- **Identified which pathway-specific effects are estimable** using observation data using this DAG, and which require advanced methods.

Findings

Hypothesized causal pathways:



- Reservoir pathway: wild and domestic animals are reservoirs for rHAT. Modeling and laboratory studies suggest pigs may be competent reservoirs for gHAT.
- Zooprophylaxis pathway: tsetse flies are known to prefer animal hosts.
- Environmental pathway: grazing activities reduce brush, the preferred tsetse fly habitat.

Directed Acyclic Graph: They hypothesized relationships between these pathways at two hypothetical time points is presented in Figure 1.

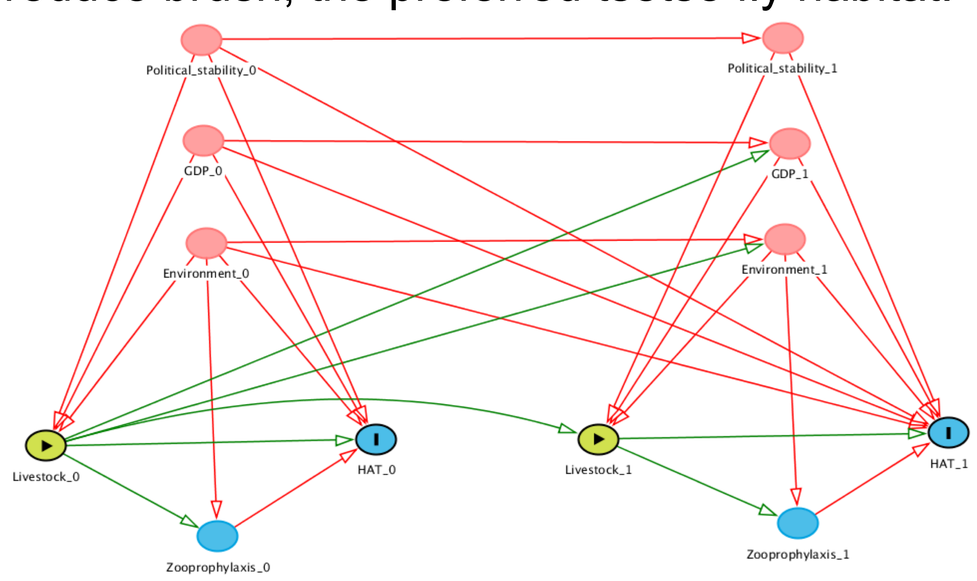


Figure 1: Directed Acyclic Graph depicting the livestock density-HAT relationship at two hypothetical time points, 0 and 1. GDP= gross domestic product; livestock= livestock density; HAT= incidence of HAT; environment= vegetation cover, temperature.

Methods for estimation of pathway-specific effects:

- Livestock density temporally-dynamic exposure → measurement at multiple times and longitudinal design needed.
- Mediation analysis can disentangle environmental pathway from reservoir and zooprophylaxis pathways, however environmental variables are downstream of earlier exposure (Figure 1) → traditional regression methods will fail.
- It is not possible to disentangle the reservoir and zooprophylaxis pathways without making strong assumptions.

Conclusions

- Trypanocidal treatment of domestic animals will only be effective where the animal reservoir pathway dominates
- Insecticidal treatment of domestic animals will be effective where the reservoir and/or zooprophylactic pathways predominate.
- Where the environmental pathway predominates, vector control and interventions on grazing management will be most effective.

Due to the complex and non-linear nature of the livestock distribution-HAT association, understanding of path-specific causal effects is required to identify optimal integrated control strategies, and estimation of these effects requires advanced epidemiologic methods.

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