

Bushmeat Hunting, Deforestation, and Prediction of Zoonoses Emergence

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Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 11, No. 12, December
2005

Introduction

- 75% of human emerging infectious diseases are caused by zoonotic pathogens
- Because emergence is poorly understood, usually treated with vaccines and drugs once the pathogen has emerged in human populations.
- However, more attempts to empirically analyze the process of emergence and move towards predictive capacity for new zoonoses.

Emerging Zoonoses

- Human/domestic animals + wildlife reservoirs = new zoonotic diseases! Usually viruses.
- Risks for emergence include:
 - Regional zoonotic pool (diversity of microbes)
 - Virologists
 - Effects of environmental change on prevalence of pathogens in wildlife
 - Frequency of interaction
 - wildlife veterinarians, disease ecologists, wildlife population biologists, anthropologists, economists, and geographers

Hunting & Deforestation in Cameroon: A Case Study

- Hunting/eating wildlife a long-standing source
 - But now an even bigger problem due to increased human population density, globalized trade, increased contact between humans and animals
- Deforestation → increased contact
 - Clear cut logging vs. Selective extraction
 - CCL lowers contact rate, but is more harmful to local biodiversity
 - SE less expensive, less destructive to environment (and to zoonotic reservoirs)

Logging Roads & Habitat Fragmentation

- Forest edges along roads are degraded → lowered movement between patches
- 3 Counteractive effects:
 - Smaller patches → lowered reservoir populations below threshold density of zoonotic microbes
 - Loss of diversity → increased density of competent hosts & transmission to humans
 - Fragmentation → increased interface for human/animal interaction

Bushmeat



Anthropology of Bushmeat Hunting, Trade, & Consumption

- Relative risks of different activities associated w/hunting (and type of hunting)
- Indigenous theories on infectious disease and the cultural context in which they emerge
- local perceptions of health or other risks associated with hunting and eating bushmeat
- Extraction rate in Congo Basin
 - Over 282.3 g eaten per day per person
 - 4.5 million tons extracted annually
- Assessing risk will have to include economic and geographic analysis of bushmeat industry

Bushmeat Hunting in Cameroon

- High rates of deforestation: 800 – 1000 km² forest cover lost each year
- Increased road-building and expanding settlements
- Representative of region from which notable infectious diseases have emerged
 - HIV/AIDS
 - Ebola
 - Marburg

Bushmeat Trade in Cameroon

- Growing urban demand
- Construction of World Bank-funded Yaoundé–Douala truck road (1980s) and EU-funded extension (1992)
- Increased access to East Province by bushmeat hunters
- Bushmeat market among households for sauce preparation in Yaoundé alone is ≈\$4 million annually
- Important dietary role in poor households
- The 2 poorest income quantiles spent 16-17% of meat budgets on bushmeat, as opposed to 7-9% spent by 2 richest quantiles

3 Steps to Globalized Emergence

1. Pathogen must go from wild reservoir → humans or their domestic animals
(invasion)
2. Pathogen must go from human → human
(establishment)
3. Pathogen must move from local epidemic → global epidemic
(persistence)

“Viral Chatter”

- Repeated transmission of nonhuman viruses to humans, most of which results in no human-to-human transmission
- Sequence data from HIV-1 and HIV-2 suggest that up to 10 prior transmission events occurred over the last century
- Authors hypothesize that viral chatter is a common mechanism in viral emergence

Potential Mechanism

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- High rates of viral chatter
 - Increased diversity of viruses and sequence variants moving into humans
 - Increased likelihood of transmitting a pathogen that can successfully replicate
 - Increased ability of a human-adapted virus to emerge in a more widespread manner
 - May result in evolution of a new viral strain

Why don't some diseases go global?

- Examples: Monkeypox, Nipah virus epidemics generally fade out before getting big.
- Reproductive Ratio (R_0) measures a pathogen's ability to cause an outbreak
- When $R_0 > 1$, pathogen amplifies within a population and can cause an outbreak.
- Increased human densities in urban centers near bushmeat hunting, increasing rates of movement between cities and villages will increase R_0 and allow new zoonoses to emerge.
- Changes in human behavior that increase human to human infection (sexual contact, injected drug use, fluid contact through unhygienic medical practices) will not only increase R_0 they may also increase probability of emergence as a human disease.
- Increased travel or migration will increase chances of zoonosis going global (i.e. HIV/AIDS)

Conclusions

- Being able to predict emerging zoonoses is an important task for future medical research.
- 3 Criteria help predict which microbes to look out for:
 - Those proven to cause human pandemics
 - Those leading to panzootics in animal populations
 - Those that mutate and recombine at high rates
 - RNA viruses extremely good at this (Simian foamy

Conclusions

- Emergence can be best understood through multidisciplinary approaches
- Some ideas for future research include:
 - How rates of viral chatter respond to anthropogenic land-use changes
 - Which viruses are likely to evolve quickly in humans
 - Modeling multihost disease dynamics in humans and animals