Rapid Urbanization and Social Inequity as Drivers of Infectious Disease Emergence: Leptospirosis in Urban Slums

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Overview

• Global demographic transition, the urbanization of poverty, and impact on infectious disease emergence

• Leptospirosis in Brazil as case study of an emerging slum health problem

• Approaches to understand the role of slum environment in transmission and identify community-based interventions

• Lessons learned and challenges to addressing emerging infections in slum environment
Global Demographic Transition, 1950-2050

Figure 1

World urban and rural population for developed and developing regions (% of total)

Source: Population Division of Department of Economic and Social Affairs of the United Nations Secretariat, Credit Suisse
The Urbanization of Poverty in Brazil and the Developing World

Slums: UN-HABITAT Definition
- Insecure tenure
- Poor structural quality of housing
- Overcrowding
- Inadequate access to safe water, sanitation and other infrastructure

1 billion slum dwellers worldwide
- 43% of world’s urban population
- 78% of urban population in least developed countries
- Double to 2 billion by 2030

The UN pledged “significant improvement in the lives of at least 100 million slum dwellers by 2020.” (MDG 7)
"Migrants from impoverished hinterlands, living without security, public health, and, often, clean water in the shantytowns of São Paulo, Lagos, Karachi, Dhaka, and Jakarta, have as much in common with each other as "People Like Us"—the global class of businessmen, journalists, academics, and anti-terrorism experts—do among themselves."

Processes and Diseases Whose Health Impacts are Influenced by Urbanization and Urban Poverty

• Unhealthy cities and changing demographics:
  ➢ Projected epidemic of non-communicable diseases

• Changing ecosystem, breakdown of control programs:
  ➢ Dengue in Latin America

• Expansion of peri-urban slums and deforestation:
  ➢ Visceral leishmaniasis

• Over-crowding and human movement:
  ➢ Meningogoccal B and C outbreaks, acute rheumatic fever
  ➢ TB and minibus transportation in South African shantytowns

• Migration, increased access to diagnosis and screening
  ➢ Pseudo-epidemics of leprosy in Brazil

• Increased yet inadequate access to health services:
  ➢ Drug-resistant TB
**Leptospirosis**

- **Spirochetal agent**
  - 9 *Leptospira* spp.
  - >200 serovars

- **Zoonotic disease**
  - Mammalian reservoirs
  - Colonize renal tubules
  - Survive in environment for weeks to months

- **Life-threatening disease in humans**
  - Penetrate abraded skin or mucous membranes
  - Weil’s disease
  - Pulmonary haemorrhage syndrome

*Scanning EM of infected rat renal tubule*
Changing Epidemiology of Leptospirosis

**Traditional**
- Occupational disease
- Subsistence farmers

**Emerging**
- Recreation, water sports
  - Lake Springfield Triathlon, 1998
- Travel and globalization:
  - Borneo EcoChallenge, 2000
- Disasters, extreme climate events
- Large, sustained regional emergence
  - Thailand 1990s, Sri Lanka 2008

*Lake Springfield, Illinois*

*Participants in the Iron Horse Triathlon begin the swimming portion of the event in Lake Springfield in this June 21 photo.*

*Mumbai, BMJ 2005*

*Participants brace itself for leptospirosis and waterborne infections.*

Fears of leptospirosis and waterborne infections intensified in Mumbai after unprecedented monsoon rains last week killed nearly 400 people in the city, choked water and sewage systems, and left hundreds of animal carcasses on the streets. Health officials have asked the public to drink boiled water, avoid consuming fresh fruit and salads, and consult doctors even for minor illnesses.
Annual Urban Epidemics of Severe Leptospirosis: Active Population-Based Surveillance in Salvador, Brazil, 1996-2006 (N=2,336)
Leptospirosis as a Emerging Slum Health Problem

• New epidemiological pattern
  ▪ Annual epidemics
  ▪ Attacks the same *favela* communities each year
  ▪ Single serovar, Copenhageni
  ▪ Domestic rat reservoir

• Identification of leptospirosis outbreaks confounded by concomitant dengue epidemics

• Same conditions of poverty and climate throughout the developing world.
  ▪ >12,000 cases in Brazil alone
  ▪ Case fatality rate >10%
  ▪ No effective control measures

Reservoir investigation, 1998 Salvador Outbreak:

- 142 *Rattus norvegicus* captured at case households.
- Leptospires isolated from 76% of the rats.
- Same serovar Copenhageni clone as isolated from patients.
Pau da Lima Community, Salvador, Brazil
Pau da Lima Cohort Study

Census: 14,122 inhabitants in 0.52km² area

Cohort population: 11,620 subjects with >5 years of age and informed consent

Outcome measurements:
- **Infection**: annual serosurveys
- **Mild disease**: outpatient case finding
- **Severe disease**: hospital-based surveillance

Exposure measurements:
- Annual house visits and interviews on demographics and risk exposures
- Surveys of household environment
- GIS surveys for environmental sources

Leptospirosis Cases (N=1,753), 1996-2006
• Three-year follow-up: 1,300 of 2,003 subject sub-cohort

• Infection rate of 3.6% per year
  Defined as seroconversion or four-fold rise in agglutinating antibody titre

• Highest attack rates in adult males but women and children also exposed

• Adult males have >10 times the risk for developing severe leptospirosis.

• Mortality risk increases with age.
Pau da Lima Cohort Study on Urban Leptospirosis: Summary

• Transmission due to the interaction of poverty, geography and climate.

• Interface of exposed soil and water is the key source of exposure in slum environment

• Work-in-Progress: Contribution of pathogen dynamics in rat and environmental reservoirs and role in human infection

• Social gradient of risk within populations with high levels of absolute poverty, independent of poor environment.

• Defined infrastructure deficiencies (open sewers/drainage) which serve as transmission sources.
Urban living has a comparative health advantage,
But urbanization magnifies health disparities

Infant Mortality Rate

Ratio of Child and Infant Mortality Rates

N=90 countries

N=22 surveys in 17 countries

Research and Community-Driven Initiative for Equity and Prevention

- Multilevel interventions for treatment and prevention of leptospirosis
  - Early warning and response
  - Health education
  - Targeted rodent control

- Community leaders and Fiocruz convinced the Brazilian government to invest US$36 million to build closed sewage systems for the periphery of Salvador

- Four-fold decrease in leptospirosis during program
Lessons Learned from Leptospirosis and Challenges in Addressing Health Needs of Slum Communities

- Another “Sanitation Revolution” or new paradigm?

- Interdisciplinary approaches to address inherently complex slum health problems
  - Ecological drivers
  - Social determinants

- Framework to include:
  - Community as a lead actor in research and policy
  - Governance committed to social cohesion
  - Central role for social justice in mobilizing effective responses
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