A World In Motion

Martin Cetron, M.D.
Global Migration and Emerging Infections
War on Disease

Just a few years ago medicine seemed to be winning the fight against disease. But now old adversaries are coming back and new infections are emerging, exposing us all to serious, sometimes unexpected, threats.
Cholera in New York City, 1892

Figure 4.1. “They Come Arm in Arm.” Judge 23 (1892).
Typhus Fever Epidemic, 1892

Figure 1.3. SS Massilia. Collection of the Peabody Essex Museum, Salem, Mass.
Speed of Global Travel in Relation to World Population Growth

“Today, diseases as common as the cold and as rare as Ebola are circling the globe with near telephonic speed, making long-distance connections and intercontinental infections as if by satellite. You needn’t even bother to reach out and touch someone. If you’re homeothermic biomass, you will be reached and touched.”

Natalie Angier
New York Times Magazine
6 May 2001
Unexpected outbreaks
Examples of emerging and re-emerging infectious diseases 1994-1999

WHO Report on Infectious Diseases 1999
“Removing Obstacles to Healthy Development”
Frequent flyers
Most popular air routes between continents, 1997

Percentage increase in international arrivals, 1993 to 1997

32% Americas
27% Europe
44% Africa
46% Middle East
32% South Asia
29% East Asia & Pacific

Source: World Tourism Organization/International Civil Aviation Organization

WHO Report on Infectious Diseases 1999
“Removing Obstacles to Healthy Development”
Human Migration

BY MICHAEL FARHI

PHOTOGRAPHS BY KAREN KASMAUSKI

Leaving home to dwell in an unfamiliar world—more than a million rural Bangladeshis have done it, seeking jobs in Dhaka (below). So too have tens of millions of others, whose movements endlessly transform the planet’s human face.
Human Migration

• “… the dynamic undertow of population change; everyone’s solution, everyone’s conflict.”
  – Michael Parfit
  National Geographic, October 1998

Congolese refugees arriving on shore of Lake Tanganyika, 1998
photo by Karen Kasmauski
Human Migration: “Push” <------> “Pull”

• Origin
  – War, strife, persecution, famine

• Destination
  – peace, freedom, sustenance, economic opportunity, pleasure
Refugees, IDPs, Immigrants, Temporary Migrants- 1990’s

Making Tracks: Migration 1990’s
Mobile Populations

Making tracks: migration in the 1990s

What drives migration? Demographers point to the interaction of two forces: the lure of a distant place—hope of a job, for instance—and the negatives of life at home, such as political unrest or a natural disaster.

While men and women in, say, the Philippines are often motivated by both impulses—the “push” of an anemic economy at home plus the “pull” of jobs in the Middle East—other migrants are uprooted involuntarily, often at gunpoint, and become refugees. Legally defined as a person who has “a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion,” a refugee must reside outside his own country. Otherwise he is considered “internally displaced.”

Native Americans and similarly uprooted indigenous groups are often missing from official statistics because the UN and other organizations use the post-World War II political map as a baseline. People displaced prior to that era are generally not tallied.

COUNTING HEADS
Estimates of the total number of “internally displaced” persons vary widely. Some experts believe this group might be as large as 50 million.

*National Geographic Oct. 1998*
Major Migration Flows: 1990s

4 x increase in volume as compared to 1960-75

Source: Population Action International 1994
Est. Annual International Arrivals, U.S.A. Year 2000

- Refugees 90,000
- Immigrants 450,000 x 2
- Travelers
- Foreign 60 M / U.S. 60 M
- U.S.-Mexico Border Crossings 400M?
Refugee Migrations

• Arriving on the Congolese shore of Lake Tanganyika in spring 1998, a woman tends her grandchild in the homeland he may no longer remember. “You might die in the Congo of a bullet,” said one mother leaving a camp. “But here your children will die of hunger.”

Source: Michael Parfit and Karen Kasmauski
National Geographic, October 1998
Hungry children receive porridge in Congolese refugee camp

National Geographic Oct 1998
Global Enemies
6 maladies account for 90% of deaths from Inf. Diseases

Influenza
HIV/AIDS
Diarrhea
TB
Malaria
Measles

**Influenza**
Prone to mutate, influenza viruses continually appear in different forms, requiring the production of a new vaccine each flu season. In some years the symptoms are mild; in others they can be lethal. Three episodes were especially virulent: the influenza pandemic in 1918-19, the Asian flu in 1957-58, and the Hong Kong flu in 1968-69.

**HIV / AIDS**
Passed on through bodily fluids, human immunodeficiency virus, or HIV, almost invariably leaves the body defenseless against the infections that define full-blown acquired immunodeficiency syndrome, or AIDS. Sub-Saharan Africa, with one-tenth of the world's population, has more than 70 percent of all HIV cases.

**Diarrheal Diseases**
Waterborne bacteria, viruses, and parasites produce about four billion cases of diarrhea a year. Those at highest risk include the 1.1 billion people lacking access to safe drinking water and the 2.4 billion without adequate sanitation facilities. Cholera, an acute diarrheal disease, claims more than 5,000 lives a year.

**Tuberculosis**
Propelled by a cough or sneeze from an infected person, tuberculosis bacteria can begin to grow in the lungs and throat of anyone who breathes them in. Drugs discovered in the 1940s beat back the disease, but the bacteria have recently begun to develop resistance, and tuberculosis has reappeared with a vengeance.

**Malaria**
Caused by microscopic parasites transmitted by the bites of infected mosquitoes, malaria attacks red blood cells. Global warming has expanded the range of malaria-carrying mosquitoes, putting more than 40 percent of the world's population at risk. In addition, warmer weather makes mosquitoes breed faster and bite more often.

**Measles**
A highly contagious viral disease that can lead to pneumonia or encephalitis, measles was an inevitable rite of childhood until an effective vaccine became available in 1963. Still striking more than 30 million a year and killing some 900,000, it is the world's leading cause of vaccine-preventable death in children.
Newly Arriving Refugees & Immigrants

Immigrants (source DOJ)
Refugees (source DOS)

Thousands

Annual U.S. Bound New Arrivals

0 100 200 300 400 500 600 700

87 89 91 93 95 97
Immigrants: Percent of U.S. Population

*Camarota SA January 1999. Center for Immigration Studies*
Number of Foreign-Born Persons Living in the U.S.

Source: Center for Immigration Studies, 2000
Impact of Immigration on U.S. Population

- Number of foreign-born persons - *unprecedented*
  - Number tripled in last 30 years
  - March 2000: 28.4 M, 10.4% U.S. population
    - 51% Latin America, 25% Asia, 15% Europe, 9% Other
  - Early 20th century peak: 14.2 M

- Immigration strong factor in population growth
  - 70% in past 10 years
    - 11.2 M immigrants
    - 6.4 M children born to immigrants

Source: Center for Immigration Studies, 2000
Estimates of annual new drug-resistant tuberculosis cases

Countries at risk:

- Russia: 11,430
- China: 158,813
- South Korea: 1,233
- India*: 238,806
- Nepal: 524
- Zimbabwe: 1,508
- Sierra Leone: 586
- Ivory Coast: 2,190
- Argentina: 1,598
- Brazil: 1,591
- Dominican Republic: 794
- Romania: 985
- Peru: 2,906

*highest
Trends in Global Travel
Tourist Arrivals by Region

Year

Tourist Arrivals (millions)
0 50 100 150 200 250 300 350 400 450 500

Europe
Americas
Asia/Pacific
Africa/Middle
U.S. INTERNATIONAL TRAVELERS (OUTBOUND), 1987-97

MILLIONS

International Passenger Arrivals,
NY Airports
N = 4,850,090
Cruise ship passengers 2000: 7 million/year, North America
Grand Princess vs U.S. Capitol
The Cruise Ship

A unique environment for disease transmission, amplification, and dispersal
Cruise Destinations, 1987

= 500,000 passenger bed-days
Expanding Cruise Destinations, 1997

- 500,000 passenger bed-days
- New destinations (<500,000 passenger bed-days)
Acute Respiratory Illnesses* - Alaska/Yukon, 5/1–9/30/98

* Acute Respiratory Illnesses (ARI) = [ILI (Influenza-like illness)] + [ARI excluding ILI and pneumonia] + [pneumonia]
"The flu is now arriving at gate 4 ..."
Infectious Disease Mortality in the U. S., 1900 to 1996

Source: Armstrong, et al., JAMA ;1999
U.S. Mexico Border
Laredo, Texas - Nuevo Laredo, Coahuila
Vector Surveillance on Planes

検疫所
QUARANTINE

機内衛生害虫の調査
Inspection for pests on board
Aedes aegypti Mosquito
Aedes aegypti Distribution in the Americas

1930

1970

2000
Dengue, DHF

Original image provided by WHO/TDR/STI/Hatz
World Distribution of Dengue 2002

- Areas infested with *Aedes aegypti*
- Areas with *Aedes aegypti* and recent epidemic dengue
Rapid increase of dengue fever

Average number of cases reported annually

1955-59: 908
1960-69: 15,497
1970-79: 122,174
1980-89: 295,591
1990-98: 514,139

Source: WHO

WHO Report on Infectious Diseases 1999
“Removing Obstacles to Healthy Development”
Dengue in the Americas, 1980 - 2001

Cases

0
200,000
400,000
600,000
800,000

2001
Yellow Fever: Re-emergence?
Reported Cases of Yellow Fever by Decade 1950-1998

WHO Report, 2000
Yellow Fever Endemicity * and Presence of *Aedes Aegypti*

*Data are shown at the country level, does not reflect distribution within the country*
Imported Yellow Fever

Tennessee - 1996
California - 1999
Germany - 1999
Switzerland - 1996
2002
Features of the Epicenter, WNV NYC 1999

- Airports
- Marsh Land
- Wildlife Areas
- Queens Ethnic Diversity
Mosquito or Larvae
• Stowaways on planes & ships

• Interspecies contact along migration routes

• Possible bird - bird transmission
Sentinel Chickens for WNV, NYC 2000

Karen Kasmasuki, National Geographic Feb. 2002
Animal Imports By Class

N = 2,873,144

- Mammals: 1%
- Reptiles: 2%
- Birds: 36%
- Amphibians: 61%

N = 123,642

- Mammals: 3%
- Reptiles: 9%
- Birds: 4%
- Amphibians: 84%

All Countries

WNV Endemic Countries
<table>
<thead>
<tr>
<th>Animal Type</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Fish</td>
<td>28,558,788</td>
</tr>
<tr>
<td>Reptiles</td>
<td>1,114,160</td>
</tr>
<tr>
<td>Amphibians</td>
<td>107,842</td>
</tr>
<tr>
<td>Arachnids</td>
<td>69,592</td>
</tr>
<tr>
<td>Mammals</td>
<td>6,943</td>
</tr>
<tr>
<td>Arthropods</td>
<td>2,561</td>
</tr>
<tr>
<td>Birds</td>
<td>1,408</td>
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</tbody>
</table>

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine
<table>
<thead>
<tr>
<th>Animal Group</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Fish</td>
<td>28,558,788</td>
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<tr>
<td>Crustaceans</td>
<td>250,108</td>
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<tr>
<td>Corals</td>
<td>49,442</td>
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<tr>
<td>Other invertebrates</td>
<td>136,723</td>
</tr>
</tbody>
</table>

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine
Selected Animal Imports Miami, 1996
Reptiles, $N=1,114,160$

<table>
<thead>
<tr>
<th>Animal</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lizards</td>
<td>980,141</td>
</tr>
<tr>
<td>Crocodilians</td>
<td>16,351</td>
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<tr>
<td>Snakes</td>
<td>81,620</td>
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<tr>
<td>pythons</td>
<td>46,143</td>
</tr>
<tr>
<td>boas</td>
<td>26,223</td>
</tr>
<tr>
<td>vipers</td>
<td>732</td>
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<tr>
<td>anacondas</td>
<td>555</td>
</tr>
<tr>
<td>adders</td>
<td>213</td>
</tr>
<tr>
<td>cobras</td>
<td>142</td>
</tr>
<tr>
<td>mambas</td>
<td>47</td>
</tr>
<tr>
<td>other snakes</td>
<td>7,565</td>
</tr>
<tr>
<td>Turtles</td>
<td>14,423</td>
</tr>
<tr>
<td>Other Reptiles</td>
<td>21,574</td>
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</table>
## Selected Animal Imports Miami, 1996
### Amphibians, N=107,842

<table>
<thead>
<tr>
<th>Animal</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frogs</td>
<td>77,465</td>
</tr>
<tr>
<td>Caecilian</td>
<td>22,480</td>
</tr>
<tr>
<td>Toads</td>
<td>5,385</td>
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<tr>
<td>Salamanders</td>
<td>684</td>
</tr>
<tr>
<td>Other</td>
<td>1,828</td>
</tr>
</tbody>
</table>

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine
Selected Animal Imports Miami, 1996
Arachnids, N=69,592

Scorpions 37,482
Terantulas 22,480
Spiders 9,630

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine
## Selected Animal Imports Miami, 1996

### Mammals, N=6,943

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>Sugar Gliders</td>
<td>4,442</td>
</tr>
<tr>
<td>Rodents</td>
<td>1,912</td>
</tr>
<tr>
<td>Monkeys</td>
<td>406</td>
</tr>
<tr>
<td>Other</td>
<td>183</td>
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</table>

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine
## Selected Animal Imports Miami, 1996

### Arthropods, N=2,561

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
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<tbody>
<tr>
<td>Millipede</td>
<td>2,440</td>
</tr>
<tr>
<td>Centipede</td>
<td>19</td>
</tr>
<tr>
<td>Other</td>
<td>102</td>
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</tbody>
</table>
Cyclospora

Immature oocysts

Contaminated raspberries
They’re burning animals again
ALL FLIGHTS CANCELLED
USAMRIID practices evacuation of contagious patient
The more things change…. 

Europe, 1350

Uganda, 2001
“As the human immunodeficiency virus (HIV) epidemic surely should have taught us, in the context of infectious diseases, there is nowhere in the world from which we are remote and no one from whom we are disconnected.”

Institute of Medicine, 1992
What is GeoSentinel?

- 25 travel/tropical medicine clinics globally (since 1996)
  - Broader ISTM membership periodically
- Provider based surveillance of international travelers/migrants
- Networking between GeoSentinel, similar networks, and public health agencies
Countries Visited by Travelers, March 2000
Countries of Exposure for *Recent Migrants March 2000

* Immigrants and refugees within last 5 years, includes country of origin
GeoSentinel Dataset, Mar 2001

Number of patients in GeoSentinel

Travel information in GeoSentinel
GeoSentinel Response Capabilities

- Alerts
- Recommendations
- Networking
- Broader inquiries
Yellow Fever: Re-emergence?

Low YF vaccine coverage rates

Increased global travel

Encroachment of humans into sylvatic cycle

Human migration and urbanization

Resurgence of *aedes aegypti* in urban areas
International Tourist Arrivals - East Asia/Pacific

Tourist Arrivals (millions)

Year

International Tourist Arrivals - Africa

Tourist Arrivals (millions)

Year

International Tourist Arrivals - Middle East

Year

Tourist Arrivals (millions)