Infectious Diseases in the 21st Century: Challenges and Opportunities

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NIAID Mission

NIAID conducts and supports basic and applied research to better understand, treat, and ultimately prevent infectious, immunologic, and allergic diseases.

NIAID Global Health Research: Driving Factors

- Public Health Need
- Scientific Opportunity

Infectious Diseases Cause ~19% of All Deaths Worldwide

Total Deaths (2010): ~52.8 Million

Global Health and Infectious Diseases

Established Infectious Diseases

+ Emerging and Re-Emerging Infectious Diseases
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Selected Established Infectious Diseases of Global Public Health Importance

<table>
<thead>
<tr>
<th>Disease</th>
<th>Estimated 2010 Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Infections</td>
<td>2.8 million</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>1.5 million</td>
</tr>
<tr>
<td>Diarrheal Infections</td>
<td>1.5 million</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1.2 million</td>
</tr>
<tr>
<td>Vaccine Preventable Childhood Diseases (measles, polio, tetanus, etc.)</td>
<td>277,800</td>
</tr>
<tr>
<td>Hepatitis (A, B, C, E)</td>
<td>307,700</td>
</tr>
<tr>
<td>Malaria</td>
<td>1.2 million</td>
</tr>
<tr>
<td>Neglected Tropical Diseases</td>
<td>155,000</td>
</tr>
</tbody>
</table>

Source: Lancet, Murray et al., Lancet 2012

The “Big Three”

- HIV/AIDS
- Tuberculosis
- Malaria

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Global Summary of the HIV/AIDS Pandemic, November, 2012

- 34.0 million people living with HIV
- 2.5 million new HIV infections in 2011
- 1.7 million deaths due to AIDS in 2011

Toward an AIDS-Free Generation

Secretary Hillary Rodham Clinton
National Institutes of Health, November 8, 2011
Ending the HIV/AIDS Pandemic

- Interventions: Treatment and Prevention
- Implementation of Interventions
- Basic and Clinical Research
- The End of AIDS

Advances in HIV Science

- Etiology
- Molecular Virology and Epidemiology
- Pathogenesis
- Basic and Clinical Research
- Vaccine Development
- Diagnosis
- Treatment
- Prevention

Global Summary of the HIV/AIDS Pandemic, November, 2012

- 34.0 million people living with HIV
- 2.5 million new HIV infections in 2011
  ↓ 22% since 2001
- 1.7 million deaths due to AIDS in 2011
  ↓ 24% since 2005

The “Big Three”

- HIV/AIDS
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The Global Burden of Tuberculosis

- One-third of the world’s population is infected with *Mycobacterium tuberculosis* (Mtba)
- In 2011
  - 8.7 million new cases, incl. 1.1 million among HIV+
  - 1.4 million deaths, incl. 430,000 among HIV+
  - 310,000 cases of MDR-TB
- As of October 2012, XDR-TB reported in 84 countries

Source: WHO, 2012
Major Challenges in Tuberculosis Research

- Our understanding of TB pathogenesis is limited
- Available vaccine is not effective in preventing adult pulmonary TB
- Standard diagnostics are antiquated, insensitive and slow
- Current drug regimens are complex and lengthy

FDA-Approved Anti-TB Drugs

- 1943 Isoniazid
- 1952 Streptomycin
- 1954 Pyrimidines
- 1955 Ethambutol
- 1957 Ethionamide
- 1960 Ethambutol
- 1962 Capreomycin
- 1963 Rifampin
- 2012 Bedaquiline


The “Big Three”

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Multidrug-Resistant and Extensively Drug-Resistant Tuberculosis: The National Institute of Allergy and Infectious Diseases Research Agenda and Recommendations for Priority Research

Anthony S. Fauci and the NIAID Tuberculosis Working Group

The Global Burden of Malaria, 2010

- 660,000 malaria deaths, 90% in Africa
- 219 million malaria cases
- Malaria present in 104 countries and territories
  - Half the world’s population is at risk
- Every 60 seconds a child dies from malaria

Source: WHO, World Malaria Report 2012

The Research Path to Malaria Control

- New drugs to expand treatment armamentarium and combat resistance
- New and improved approaches to vector control
- Rapid, field-applicable diagnostic tests for parasite detection and drug resistance
- Safe, highly effective vaccines against multiple parasite species responsible for human malaria
Global Health and Infectious Diseases

Established Infectious Diseases

+ Emerging and Re-Emerging Infectious Diseases

Global Examples of Emerging and Re-Emerging Infectious Diseases

Methicillin-Resistant Staphylococcus aureus (MRSA)

- MRSA accounts for 8.5% of all hospital-acquired infections (HAIs)
- Once confined to hospitals, in the past decade community-associated strains have emerged in schools, athletic facilities, and homes

NIAID Scientists Identify MRSA Virulence Determinants and Potential New Drug Targets

The Journal of Infectious Diseases

The Research Agenda of the National Institute of Allergy and Infectious Diseases for Antimicrobial Resistance

NK Peters, DM Dixon, SM Holland, AS Fauci
Global Examples of Emerging and Re-Emerging Infectious Diseases

Building a Better Influenza Vaccine
- Improved production and surge capacity
- Vaccine platforms that allow for more efficient manufacturing and potentially better efficacy
- Dose optimization strategies
- A "universal" vaccine

NIAID Research: A Dual Mandate
Maintain and “grow” a robust basic and applied research portfolio in microbiology, infectious diseases, immunology and immune-mediated diseases
Respond rapidly to new and emerging disease threats

New/Improved Interventions