Scientific Opportunities and Emerging Public Health Issues at the NIH: A View from NIAID

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Paradigm for NIH Research

- Basic Research
- Scientific Opportunities
- New Technologies
- Public Health Needs

NIH Institute or Center

New Interventions to Improve Health

Discoveries
Paradigm for NIAID Research

Scientific Opportunities

New Technologies

Basic Research

Discoveries

NIAID Research in:
- Immunology
- Microbiology
- Infectious Diseases

Public Health Needs

New Interventions to Improve Health
New Institutes/Centers

Scientific Opportunities

Public Health Needs

Expanded Mandate and/or Resources for Existing Institutes/Centers

New Institutes/Centers
Evolving Public Health Challenges

- Shift from Acute to Chronic Conditions
- Aging Population
- Health Disparities
- Emerging and Re-emerging Infectious Diseases
- Emerging Non-communicable Diseases - Obesity
Examples of Key Issues that Have Shaped Individual ICs

- **NIDDK**: Obesity epidemic
- **NHLBI**: Discovery of modifiable risk factors for heart disease
- **NCI**: Genomics to understand molecular basis of cancer
- **NIAMS**: Arthritis in an aging population
- **NIA**: Alzheimer’s disease
- **NINR**: Increase in chronic diseases and need for improved symptom management
- **NICHD**: Understanding early developmental processes
- **NIBIB**: Convergence between engineering and life sciences
- **FIC**: Global Health
- **NIDCR**: Relationship of oral health to overall health and well-being
- **NCRR**: Clinical and Translational Science Award program to move research results rapidly from discovery to practice
- **NINDS**: Identification of disease genes and their role in pathology
- **NIDA**: Drug abuse treatment in criminal justice settings to improve public health/safety
Growth of the National Institutes of Health

- 1948: 6 Institutes
- 1950: 8 Institutes & Divisions
- 1960: 11 Institutes, Centers & Divisions
- 1965: 14 Institutes, Centers & Divisions
- 1975: 20 Institutes, Centers & Divisions
- 1990: 22 Institutes, Centers & Divisions
- 2009: 27 Institutes & Centers
NIAID in 1980

- Budget: ~$215 million
- Sixth largest IC

- Microbiology & Infectious Diseases
  - $128M
  - 60%

- Immunology, Allergic & Immunologic Diseases
  - $87M
  - 40%

Total Budget: $215M
A Premature Declaration of Victory Over Infectious Diseases

"We can look forward with confidence to a considerable degree of freedom from infectious diseases at a time not too far in the future. Indeed... it seems reasonable to anticipate that within some measurable time... all the major infections will have disappeared."

Infectious Diseases Cause ~24% of All Deaths Worldwide

**Total Deaths: ~58.8 Million**

Source: WHO, 10/2008
NIAID: Transforming Issues Since 1980

- HIV/AIDS
- Global Health
- Biodefense
- Other emerging/re-emerging infectious disease issues
Examples of Technologies and Disciplines that Have Transformed Infectious and Immunological Disease Research

- Genomics and other “omics”
- Array technologies
- Nanotechnology
- Synthetic chemistry
- Robotics
- Computer modeling
- Imaging
- Molecular and genetic epidemiology
- Monoclonal antibodies/fusion proteins/recombinant cytokines
- MHC tetramers
- FACS analysis/cell surface markers/CD antigens
- Systems biology
- Bioinformatics
Evolution of the NIAID Budget

- **1980**: $215M
- **1998**: $1.35B
- **2008**: $4.58B

- **HIV/AIDS**
  - 1980: 52%
  - 1998: 33%
  - 2008: 32%

- **Non-AIDS**
  - 1980: 48%
  - 1998: 48%
  - 2008: 32%
Note: FY 2008 includes $22M Emergency Supplement for NIAID.
**June 5, 1981**

**Pneumocystis Pneumonia - Los Angeles**

In the period October 1980 - May 1981, 5 young men, all active homosexuals, were treated for biopsy-confirmed *Pneumocystis carinii* pneumonia at 3 different hospitals in Los Angeles, California. Two of the patients died. All 5 patients had laboratory-confirmed previous or current cytomegalovirus (CMV) infection and candidal mucosal infection. Case reports of these patients follow.

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**July 4, 1981**

**Kaposi's Sarcoma and Pneumocystis Pneumonia Among Homosexual Men - New York City and California**

During the past 30 months, Kaposi's sarcoma (KS), an uncommonly reported malignancy in the United States, has been diagnosed in 26 homosexual men (20 in New York City (NYC), 6 in California). The 26 patients range in age from 26-51 years (mean 39 years). Eight of these patients died (7 in NYC, 1 in California) - all 8 within 24 months after KS was diagnosed.
Adults and Children Estimated to be Living with HIV, 2007

Global Total: ~33 million

Source: UNAIDS, 7/2008
NIAID HIV/AIDS Research Funding

Fiscal Year

Dollars in Millions


$1.56B (est.) (P.B.)
Advances in AIDS Research, 1981-2009

- Etiology
- Diagnosis
- Molecular Virology and Epidemiology
- Pathogenesis
- Natural History
- Treatment
- Prevention
- Vaccine Development
## FDA-Approved Antiretroviral Drugs

### NRTI
- Zidovudine
- Didanosine
- Zalcitabine
- Stavudine
- Lamivudine
- Abacavir
- Tenofovir
- Emtricitabine

### NNRTI
- Nevirapine
- Delavirdine
- Efavirenz
- Etravirine

### PI
- Saquinavir
- Ritonavir
- Indinavir
- Nelfinavir
- Amprenavir
- Lopinavir
- Atazanavir
- Fosamprenavir

### Entry Inhibitor
- Maraviroc

### Integrase Inhibitor
- Raltegravir

### Combinations
- 6 available, combining 2 or 3 drugs

### Fusion Inhibitor
- Enfuvirtide (T-20)
Antiretroviral Therapy Dramatically Increases Life Expectancy for HIV-Infected Individuals

Life Expectancy of Individuals on Combination Antiretroviral Therapy in High-Income Countries: a Collaborative Analysis of 14 Cohort Studies

Antiretroviral Therapy Cohort Collaboration

An HIV-infected 20-year-old appropriately treated with ART can expect to live to >69 years in high-income countries
<table>
<thead>
<tr>
<th>Decade</th>
<th>Number</th>
</tr>
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<tbody>
<tr>
<td>1960s</td>
<td>3</td>
</tr>
<tr>
<td>1970s</td>
<td>1</td>
</tr>
<tr>
<td>1980s</td>
<td>5</td>
</tr>
<tr>
<td>1990s</td>
<td>30</td>
</tr>
<tr>
<td>2000s</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>63</strong></td>
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</tbody>
</table>
The AIDS Research Model
Implications for Other Infectious Diseases of Global Health Importance

Gregory K. Folkers, MS, MPH and Anthony S. Fauci, MD
## Selected Infectious Diseases of Global Public Health Importance

<table>
<thead>
<tr>
<th>Disease</th>
<th>Estimated Annual Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Infections</td>
<td>4.3 million</td>
</tr>
<tr>
<td>Diarrheal Diseases</td>
<td>2.2 million</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>2.0 million</td>
</tr>
<tr>
<td><strong>Tuberculosis</strong></td>
<td><strong>1.7 million</strong></td>
</tr>
<tr>
<td><strong>Malaria</strong></td>
<td><strong>881,000</strong></td>
</tr>
<tr>
<td>Vaccine Preventable Childhood Diseases</td>
<td>847,000</td>
</tr>
<tr>
<td>(measles, pertussis, tetanus, etc.)</td>
<td></td>
</tr>
<tr>
<td>“Neglected” Tropical Diseases</td>
<td>530,000</td>
</tr>
<tr>
<td>(schistosomiasis, hookworm infection, leishmaniasis, trypanosomiasis, etc.)</td>
<td></td>
</tr>
</tbody>
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Global Health Research at NIAID

NIAID Funding for International Research, 1980-2008

Countries with NIAID-Funded Activities, FY2008 (n = 90)
The Global Community is Faced with Numerous Health Challenges

- Infectious Diseases
- Heart Disease
- Obesity
- Mental Health
- Accidents/Injuries
- Cancer
- Diabetes
- Aging
- Child Health
- Many Others

Total annual deaths > 57 million
Total annual DALYs > 1.4 billion
Emerging Infections: A Perpetual Challenge

DM Morens, GK Folkers & AS Fauci

“For centuries a fundamental challenge to the existence and well-being of societies -- as reflected by scientific attention, as well as in art, religion, and culture -- emerging infections remain among the principal challenges to human survival.”
Global Examples of Emerging and Re-Emerging Infectious Diseases

- Typhoid fever
- Monkeypox
- Adenovirus 14
- Anthrax
- Bioterrorism
- Nipah virus
- Hantavirus pulmonary syndrome
- PLAGUE
- New Emerging
- Re-emerging/resurging
- Deliberately emerging

Global Examples of Emerging and Re-Emerging Infectious Diseases

- West Nile virus
- Cryptosporidiosis
- MRSA
- Cyclosporiasis
- E. coli O157:H7
- Human monkeypox
- Adenovirus 14
- Anthrax
- Bioterrorism
- Hantavirus pulmonary syndrome
- Dengue
- Yellow fever
- Human African trypanosomiasis
- Cholera
- Marburg hemorrhagic fever
- MDR/XDR tuberculosis
- HIV
- Nipah virus
- Hendra virus
- Enterovirus 71
- Human monkeypox
- Plague
- Chikungunya fever

- Newly emerging
- Re-emerging/resurging
- “Deliberately emerging”
Naturally Occurring Infectious Disease Threats

Bioterror Threats
NIAID Funding for Biodefense and Emerging Infectious Diseases Research, 2000-2009

Fiscal Year

Dollars in Millions

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

$32.7M $1.64B

(est.)
http://www.niaid.nih.gov/biodefense
Biodefense and Emerging Infectious Diseases (EID) Research Priorities

- Therapeutics
- Vaccines
- Diagnostics
- Basic Research
- Genomics
- Expansion of Research Capacity
Bioterror Threats ↔ Naturally Occurring Infectious Disease Threats
Influenza

- Re-emerging disease (seasonal flu)
- Newly emerging disease (potential pandemic flu)
The Burden of Seasonal Influenza

- 250,000 to 500,000 deaths globally/yr
- 36,000 deaths and >200,000 hospitalizations/yr in U.S.
- $37.5 billion in economic costs/yr in U.S. related to influenza and pneumonia

Sources: CDC, WHO, Am. Lung. Assoc.
H5N1 Influenza Cases, 2003-2009

Total: 420 WHO laboratory-confirmed cases including 257 deaths

Source: WHO and OIE (World Organization for Animal Health), 4/21/2009
The Influenza Pandemic of 1918-1919

- 25-30% of world’s population (~500 million people) fell ill
- >50 million deaths worldwide; ~60% percent in people ages 20-45
- >500,000 deaths in United States; 196,000 in October, 1918 alone

Source: WHO, 1/2005
Pandemic Influenza Preparedness Strategy and Implementation

- International Surveillance
- Domestic Surveillance
- Vaccines
- Antivirals
- Communications
- State and Local Preparedness
**NIAID Influenza Research Funding**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Dollars in Millions</th>
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<tbody>
<tr>
<td>2001</td>
<td>$15M</td>
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<tr>
<td>2002</td>
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<td>2005</td>
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<td>2006</td>
<td>$196M</td>
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<tr>
<td>2007</td>
<td>$261M</td>
</tr>
<tr>
<td>2008</td>
<td>$268M*</td>
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*Estimate; figure using new RCDC methodology is $186M.
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
Transforming medicine and health through discovery

NIH