Biosecurity:
Enhancing Security in an Increasingly Unsecure World

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Guest Lecture
Biology and Society: Bio 311/HPS 340
Arizona State University
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Biosecurity and Global Health: Understanding the Implications of Major Economic Disparities and Environmental Dislocations
Seeking Security in an Unsecure World: The Military and National Security Calculus

Expanding Conflict Zones, Political Instabilities and Terrorism

WMD Proliferation

New Power Centers

US Retrenchment: Geopolitical/Fiscal
The VUCA World

- Volatility
- Uncertainty
- Complexity
- Ambiguity
The Biosecurity Triad

Infectious Diseases of Natural Origin

Urbanization, Environmental and Ecological Impacts on Disease Emergence

Bioterrorism and Dual-Use Technologies
The Multi-Dimensional Complexity of Biosecurity

- host-pathogen interactions
- ecosystem shifts and new host-pathogen interactions
- human health, animal and plant health, ecosystem health
- trade and transport: every local incident is a potential global threat
- poverty, illiteracy and inadequate biosurveillance and public health systems in DCs
- out of sight and out of mind: complacency and neglect of Western public health systems for infection control
- conflicts and terrorism: from accelerated spread of natural disease to bioterrorism
Preparedness:
The “All Hazards” Challenge and Building Resilient Systems
OUTBREAK: Deadliest Pandemics in History

What is a Pandemic?
Derived from the Greek word "pandemias" meaning "pertaining to all people," a pandemic is a widespread disease that affects humans over a wide geographic area.

Key:
- PANDEMIC
- DEATH TOLL

1. MEASLES
   - 7th Century BC - 1963
   - 200 million

2. SMALLPOX
   - 10,000 BC - 1979
   - 300+ million

3. BLACK DEATH
   - 1340 - 1371
   - 75 million

4. HIV/AIDS
   - 1981 - TODAY
   - 25+ million

5. PLAGUE OF JUSTINIAN
   - 541 - 750
   - 25 million

6. SPANISH FLU
   - 1918 - 1919
   - 50-100 million

7. TYPHUS
   - 450 BC - TODAY
   - 4 million

8. CHOLERA
   - 1850 - TODAY
   - 3 million

9. THIRD PANDEMIC
   - 1885
   - 12 million

10. HONG KONG FLU
    - 1968 - 1969
    - 1 million

11. MALARIA
    - 1500 - TODAY
    - Common Symptoms: Chills, Headache, Fever, Jaundice, Muscle Pain, Nausea, Vomiting, Seizures
    - Death Toll: According to the World Health Organization's 2020 "World Malaria Report," an estimated 781,000 people are killed by the virus every year.

12. TUBERCULOSIS
    - 700 BC - TODAY
    - Common Symptoms: Chest Pain, Cough, Fever, Chills, Fatigue
    - Death Toll: There are almost 2 million tuberculosis-related deaths worldwide every year.

13. YELLOW FEVER
    - 16th Century - TODAY
    - Common Symptoms: Bleeding, Fever, Nausea, Vomiting, Delirium, Seizures
    - Death Toll: Worldwide, 30,000 deaths are caused by the infection every year.

Honorable Mentions:
- Ring Around the Rosie, a Pocket Full of Plague
  - Legend says the Black Death plaque inspired the children's rhyme "Ring Around the Rosie," which alluded to the rash-like rings and other of the deceased victims.

Sources:
- Mayo Clinic
- Centers for Disease Control and Prevention
- World Health Organization
- New York Times
- National Center for Biotechnology Information

A collaboration between Good and Column Five
The Major Infectious Disease Pathogens

- malaria
- TB
- HIV/AIDS
- cholera
- enteric diarrhea pathogens
- Leishmaniasis

Today

EIDs of Concern

- pandemic (avian) influenza
- dengue
- chikungunya
- engineered agents (bioterrorism)
- antibiotic resistance and HAI
"I will show you fear in a handful of dust"
T.S. Elliot
The FSU Covert Biopreparat Program in Violation of 1972 BWC
Asymmetric Warfare and
The Appeal of CBW to Extremists

Cult of Doom
A poison-gas attack triggers fears about extremists using homemade weapons of mass death

Not a single Arab country refrained from producing chemical and biological weapons.
Designing Agent X
“It is time to close the book in infectious diseases and declare the war against pestilence won”


“The future of humanity and microbes will likely evolve as episodes of our wits versus their genes”

Dr. Joshua Lederberg, Nobel Laureate
Science (2000) 6, 427-30
The Relentless Challenge of Natural Infectious (and Parasitic) Diseases

The Constantly Changing Dynamics of Global Infectious Diseases

Host-Pathogen Interactions as Classical Example of Evolutionary Dynamics (variation, adaption, selection)
Outpacing Infectious Diseases

- urbanization, climate change and new patterns of exposure and disease spread
- growing resistance to existing Rx and vaccines
- emerging infectious diseases (EIDs)
The Ever Shifting Dimension of EIDs

West Nile Virus, New York 2001

Monkeypox, USA May-June 2003

West Nile Virus, Dallas, TX 2012

African Swine Fever, Russia 2012
Human Coronaviruses

Emergence of SARS-CoV (PRC 2003)

Emergence of MERS-CoV (KSA 2012)
Pandemic Influenza: Still the Largest EID Threat?

- **H1N1**: high transmissibility - low virulence/mortality
- **H5N1**: low transmissibility – high virulence/mortality
- **H5N1 x (H1N1) or (X)**: potential for devastating pandemic
Understanding Animal to Human Transmission
The Shifting Geographic Range of Pathogens and Their Vectors

Global Trade and Travel

Ecosystem and Climate-Shifts
The Most Lethal Animal Species (Except Humans): Major Mosquito Classes for Vector-Borne Disease

- **Anopheles gambiae**
- **Aedes albopictus**
- **Culex pipiens**
Chikungunya

Nature (2014) 512, 125

Tropical Transfer
Chikungunya virus has spread around the Caribbean since December 2013 (suspected plus confirmed cases shown).

- Bahamas 13
- Dominican Republic 370,212
- Haiti 64,709
- Puerto Rico 1,982
- St Martin 4,553
- Guadeloupe 71,068
- Dominica 3,700
- Martinique 54,075
- El Salvador 2,353
- Panama 1
- Costa Rica 1
- Venezuela 35
- Guyana 16
- French Guiana 1,283
- Suriname 24
Common Features of Urban Epidemic Transmission of Dengue and Chikungunya Viruses

- same vectors: *Aedes aegypti* and *Ae.albopictus*
- anthroponosis: does not require a non-human amplifier host
- estimated 3.6 billion people in 124 countries now at risk
- no vaccines or therapies
- public health focus on vector control
- potential need to initiate screening of US blood supply (cf. HIV, Hep. C)
No Shortage of Vectors for Infectious and Parasitic Diseases

<table>
<thead>
<tr>
<th>Aedes aegypti</th>
<th>Aedes albopictus</th>
<th>Culex pipiens</th>
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<tr>
<td><img src="image1" alt="Aedes aegypti" /></td>
<td><img src="image2" alt="Aedes albopictus" /></td>
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<tr>
<th>Sand Flies (Psychodidae)</th>
<th>Triatominae Bugs</th>
<th>Ixodes Ticks</th>
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<tr>
<td><img src="image4" alt="Sand Flies" /></td>
<td><img src="image5" alt="Triatominae Bugs" /></td>
<td><img src="image6" alt="Ixodes Ticks" /></td>
</tr>
</tbody>
</table>
Will Citrus Greening Eliminate the Florida Citrus Industry?

- transmission of *Candidatus liberibacter* by Psyllid insects
- $4.6 billion cost and loss of 6000 jobs since 2006
<table>
<thead>
<tr>
<th>High Disease Transmission</th>
<th>Lack of Safe Water</th>
<th>Bush Meat Food Chain</th>
</tr>
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<tbody>
<tr>
<td>Major Deficits in Health Infrastructure</td>
<td>Expanded Eco-niches and Increased Zoonotic Risks</td>
<td></td>
</tr>
</tbody>
</table>
Fruit Bats: Growing Recognition as Reservoir for Novel Zoonoses: SARS, MERS, Hendra, Nipah and Ebola
Ebola Virus Disease: West Africa 2014

- first outbreak outside East and Central Africa
- simultaneous spread across multiple borders
- fragile health systems ill-equipped to implement surveillance and containment measures
- mistrust and violence against healthcare workers
- mistrust exacerbated by military enforcement of quarantine zones
- orphans, food shortages
- 28 million children already orphaned in region due to conflict and HIV/AIDS
many of the few available treatment centers and clinics closed

shortage of biohazard control materials

families hide stricken individuals

corpses buried in rural villages without adequate containment

health workers attacked as perceived Ebola carriers

community resistance, lack of personnel and vehicles hinder both investigation and containment in the “shadow zones”
The five co-authors of a *Science* study who contracted Ebola and died.
Ebola in West Africa (2014)

- traditional cultural beliefs in shamanic medicine
- fear of sending loved ones to treatment centers to die alone
- rumors and hostility to role of health workers (particularly westerners) in disease spread
- denials about existence and cause of infection
• Shaman’s claim of plague created when a white snake was killed but all could be cured by sacrificing seven cows
• myth created by President Condé to delay pending elections
• President Condé introduced the virus to kill the Kissi tribe
• white foreigners in yellow space suits had brought the disease
• yellow suited aliens at the treatment clinics were harvesting organs and limbs
Aliens in Our Midst!
Health workers in Liberia Push an Ebola Patient Who Escaped from Quarantine Into an Ambulance

Reuters Sept. 18, 2014
Notice the Resemblance?
Hygiene and Quarantine as the Only Controls
Absent Drugs or Vaccines

Bubonic Plague
Physician 15th Century

Ebola, Liberia
21st Century
The Vital Importance of Biosurveillance

Early Detection Saves Lives!
Ebola in West Africa (2013-2014)

- **patient zero:** a child’s death in the jungle (Meliandou, Guinea, Dec. 2013)
- **last known outbreaks** more than 2000 miles away
  - Uganda and DRC in 2012
- **January 2014**
  - more Meliandou deaths but spread to Gueckeddon by member of patient zero
  - Gueckeddon major trading post with Liberia and Sierra Leone
  - Doctor from Gueckeddon dies but body shipped to Kissdougon for funeral (town of 100,000 people)
• Guinea, Sierra Leone and Liberia have world’s highest incidence of Lassa Fever

• 3.5 months into the epidemic no one suspected Ebola

• February 2014 suspicion discounted when 9 patients had positive malaria test
• for reasons unknown hiccups are feature of Ebola
  – Medecins sans Frontiéres physician in Geneva sensed the clue in March 2014
• blood sample flown to Institut Pasteur March 20 tested positive for Ebola
Ebola in West Africa (2014)

- Early May 2014 number of cases declined dramatically and Guinea MoH reported no cases in mid-May
- President of Guinea announced ‘worst is over’
- CDC team cycled out back to Atlanta
- May 27-June 2 new cases arriving at the main treatment center in Conakry from hundreds of miles away
- Spread to Sierra Leone, Liberia and Nigeria (Senegal)
- August 2014 WHO declares ‘public health, emergency of international concern’
Predicting (Modeling) the Scale of the Epidemic

Ebola cases could reach 1.4 million in 4 months, CDC estimates

September 27

**WEST AFRICA OUTBREAK** *

- Guinea: 1022 cases, 635 deaths
- Sierra Leone: 1940 cases, 597 deaths
- Senegal: 1 case
- Liberia: 3280 cases, 1677 deaths
- Nigeria: 20 cases, 8 deaths

**DR CONGO OUTBREAK** *

- 68 cases, 41 deaths

* Suspected case and death counts reported by WHO. To view case counts reported by other official and news media sources, visit HealthMap.org.

Liberia: Chief medical officer places herself under Ebola quarantine after... – Newser

* "Liberia's chief medical officer is placing herself under quarantine for 21 days after her office assistant died of Ebola."
Ebola in West Africa
Declaration of International Health Emergency
August 2014

- reverse case numbers within 3 months
- stop transmission in cities and major ports
- stop all transmission within 6-9 months
- stop all transmission with 8 weeks of an index case in any affected new countries
- invoke IHR to prevent international spread
  - exit screening at airports, seaports and major land crossing
  - SOP for travelers arriving overseas from ‘hot zone’ with unexplained febrile illness
The Logistical Complexity of Large Scale Disinfection and Decontamination

How do you go from decontaminating a few ambulatory, protected responders…

…to hundreds of incapacitated, unprotected civilians?

- $750 million
- deploy up to 3000 US military personnel under US Africa Command
- build Ebola treatment centers
- recruit and train medical personnel and healthcare workers
Ebola in West Africa (2014):

- poverty, illiteracy and dysfunctional health services
- impact of decades of war and political corruption
- domestic problems compounded by delayed international mobilization
- reinforces vital role of biosurveillance
- no therapy or vaccines
- dependence on isolation and quarantine
- dislocation of fragile agriculture and future threat to food supply
- long-term adverse economic, social and political impacts
Ebola Containment Challenges

- Scale of 2014 W. Africa epidemic creates risk of endemic disease reservoir

- Mutational drift
  - Over 300 mutations in last five months
  - No major shifts in transmission/virulence
  - Implications for future vaccine coverage

- The game changer: shift to aerosol person-to-person transmission
Out of Sight: Out of Mind!

The Cocoon of Protection: How Quickly We Forget Past Epidemics and Their Toll

Reduced Investment in Public Health and Biosecurity: A False Economic Gain
Comfort and Complacency: The Enemies of Vigilance and Preparedness
The Evolving Nature of Human Infectious and Parasitic Diseases

1407 species of human pathogens

- 538 bacteria
- 57 protozoa
- 60% are zoonoses
- over 70% zoonoses arise from interactions with wildlife
- Emerging Infectious Diseases (EIDs)
  - 58 in last 25 years
  - viruses significantly over-represented
  - RNA viruses most variable and rapidly changing
  - helminths under-represented
One Health

The Need for a Holistic View of Host-Pathogen Ecology
One Health: The Need for Holistic Approaches to Address the Complexity of Biosecurity Challenges

Anthropogenic Effects

- urbanization
- travel
- trade
- intensive agriculture
- food security

- conflict
- refugees

- climate change
- weather
- urbanization
- deforestation
- desertification
- water use
- water contamination
- invasive species

- altered human behavior
- eco-shifts

humans
animals
plants
ecosystems

Note: The image contains a diagram illustrating the interconnections between humans, animals, plants, and ecosystems, highlighting the impact of anthropogenic effects on biosecurity challenges.
Asleep at the Switch and Pay the Consequences or Proactive Preparedness?

Growing Number of Wakeup Calls That Biosecurity Matters!
Detection and Management of a Major Bioincident

Trade and Transport Make Every ‘Local’ Event a Potential ‘Global’ Risk

Need for Similar Response Capabilities Irrespective of Whether Incident of Natural or Nefarious Origin (Terrorism)
Preparedness: Building Resilient Systems

- are the risks known and analyzed?
- are there actions for meaningful intervention?
  - tractable, measurable
- if not, how can these be developed and implemented (resources, infrastructure, logistics, cost)?
- what are the principal risks and obstacles to success? (technical, economic, political, social, legal)
- how are these barriers being addressed and, if not, what is needed to reduce/eliminate them? (vulnerability assessment and mitigation)
Comfort, Complacency and Consequences
Versus Proactive Preparedness

“But I must go and meet the danger there, or it will seek me in another place, and find me worse provided.”

- William Shakespeare, Henry IV
Biosurveillance: the Value of Early Detection

Early Detection Saves Lives!

POC Diagnostic Tests, Population Triage and Managing the Worried Well
Surveillance Systems for the Rapid Detection and Control of Infectious and Parasitic Diseases

- **Profile**: Signatures of Pathogenic Organisms
- **Sense**: Global Network of Surveillance and Diagnostic Testing Systems
- **Act**: Rapid Analysis and Response to Diagnostic and Surveillance Information
Global Disease Surveillance

QUARantine Activity Reporting System (QARS).

Public Health Department's Surveillance

DoD-GEISWeb

Global Emerging Infections System

BioPortal

GIDEON

TropNet Europ

google.org

EUNiD

EMPRES WATCH

Human and Animal Rabies

Welcome to RABNET

GeoSentinel

The Global Surveillance Network of the ISTM and CDC

a worldwide communications & data collection network of travel/tropical medicine clinics

EMERGEncy ID NET

HealthMap

Global Disease Alert Map

U.S. Influenza Sentinel Provider Surveillance Network

IDSA

Infectious Diseases Society of America

ProMED-mail

GPHIN RMISP

biocaster

ARGUS Research Operations Center

World Health Organization

CDC

Centers for Disease Control and Prevention

Global Disease Surveillance
Geodemographic Information Systems (GIS): Real-Time, Front Line, Ground Zero Data from Field Sampling and Sentinels
Geodemographic Information Systems: Mapping Disease Patterns and Modeling Trends

<table>
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<tr>
<th>Anomaly Detection and Early Alert</th>
<th>Disease Progression</th>
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</thead>
</table>

Satellite Surveillance and Predictive Modeling of Disease Trends
Global Transport and Trade: New Interactions of People, Animals and Product Supply Chains

The Super Vector

World Container Traffic Doubled Since 1997

Billion Cross-Border Travelers

Global Food Networks
Coming to an Airport Near You:

Modeling Airport Connectivities, Traffic and Distance Relationships and Implications for Epidemic Spread via the Global Aviation Network

Tracking Arrivals from Chikungunya ‘Hot Spots’ in the Caribbean

[Map showing arrivals from Chikungunya 'hot spots' in the Caribbean, with cities and numbers indicating traveler volume.]

<table>
<thead>
<tr>
<th>State</th>
<th>Temperature °C</th>
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<tbody>
<tr>
<td>Texas</td>
<td>28.2</td>
</tr>
<tr>
<td>Louisiana</td>
<td>27.7</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>27.7</td>
</tr>
<tr>
<td>Florida</td>
<td>27.6</td>
</tr>
<tr>
<td>Arizona</td>
<td>27.0</td>
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<tr>
<td>Mississippi</td>
<td>26.8</td>
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<td>Arkansas</td>
<td>26.8</td>
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<tr>
<td>Georgia</td>
<td>26.6</td>
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<td>South Carolina</td>
<td>26.6</td>
</tr>
<tr>
<td>Alabama</td>
<td>26.4</td>
</tr>
</tbody>
</table>
Global Surveillance Against Infectious Disease Outbreaks
E.H. Chen et. al. (2010) PNAS 107, 21701

- 398 WHO-verified outbreaks 1996-2009
- Median times
  - 23 days for event detection
  - 32 days for public communication
  - 35 days for official laboratory confirmation
  - 48 days for inclusion in WHO Disease Outbreak News
US States Poorly Prepared to Manage Infectious Disease Threats: Trust for America’s Health and Robert Wood Johnson Foundation*

- 33 states scored 5 or lower on scale of 10
- failure to ID select agent pathogens
- lack of common data reporting formats and/or obligations
- one-third do not have mandatory reporting of HAI
- failure to meet vaccination herd immunity levels (>90%)
- impact of fiscal austerity (State, Federal)
- 40,000 jobs lost in last 5 years
Infectious Diseases (Natural) and Bioterrorism (Nefarious)

Shared Features: Stealth and Spread
Updated Preparedness and Response Framework for Influenza Pandemics

Are We Really Ready for a Major Bioincident?
Detection of Infectious Disease Threats:

Not A Hazmat or Wide Area Sensor Network Solution

Emergency Rooms and Farms Will be the Front Line
The Three Core Components of Bioincident Management

- Command and Decision Authorities
- Healthcare System and Public Health Capabilities
- Maintenance of Civil Order and Public Trust

- robust inter-operable communication networks for real-time situational awareness and rapid actions
- managing the media and the ‘worried well’
- transparency, credibility and public trust
The Lag Phase in Bioincident Detection

- Primary Care Physicians and Pharmacists
- Hospitals
- Social Media and m. Health
- unusual illness patterns
- BIOINCIDENT CONFIRMATION
- ER Walk-ins

initial non-specific illness

progressive illness
Consequence and Crisis Control in a Bioincident

COMMAND CENTER

- public health
- logistics
- communications

- medical
- law enforcement
- coordination

- local
- national
- regional
- international

Primary Care Physicians and Pharmacists

“The Worried Well”

Social Media and m.Health

Hospitals

- acute care
- triage
- mortuary

Neighborhood Emergency Help Centers

- patient registration
- Dx triage
- transport logistics
- mass Rx/vaccination

Community Outreach and Citizen Mobilization

- police, EMS
- volunteers
- military

Media

Social Media and m.Health
Sufficient Care

- provide the most good for greatest number of people under adverse conditions and constrained resources
- clinical triage
- rationing of health resources/pharmaceutical
- omnipresent vulnerabilities and risks from public panic and civil disorder
Use of GIS for Management of Population Movement, Healthcare Facilities and Supply Chains for Optimum Bioincident Control
Vulnerability of Global, National and Local Supply Chains in a Major Epidemic/Pandemic

Medicines

- “just-in-time” supply networks
  - major hospitals 2 or 3 deliveries per day
- out-patient prescription drugs
  - insurance company limits on prescription volume (USA)
- majority of drug intermediates, excipients and final products sourced off-shore
- 95% generic drugs used in US (64% of total Rx) are made off-shore, primarily in PRC and India
- no national stockpile for routine prescriptions
Medical Countermeasures (MCMs) for Special Populations:
Emergency Use Authorization

- Children
- Pregnant
- Aged
- Immunosuppressed
- Impaired Major Organ Function
- ICU-Critical Care
Building Resilience: Complex Systems-Based Integration of Diverse Functions and Organization
Informing the Public: A Critical and Unenviable Challenge

- media sensationalism and public panic
- pressure on governments to make illogical but politically expedient decisions
- in a severe outbreak the shock factor from any major level of fatalities will be unprecedented in modern peace times with unpredictable consequences for public responses
- unpredictable unilateral decisions by other governments, restricting trade, travel and shipment of goods
- extended supply chains might break down completely
The Likely Real Picture!

“FOG”

“FUBAR”

Ill-Defined Responsibilities and Accountabilities

Lack of Well-Rehearsed Master Plans: Federal, State and Local
“For most of us design is invisible until it fails”
Bruce Mau
The ‘Fog of Disaster’: Crisis Standards of Care and Proliferation of Unanticipated Events and Consequences
Failure of Power Generators in Major NYC Hospitals During Superstorm Sandy 1 November 2012
Legal Aspects of Public Health and Counter-Terrorism Actions to Contain Bioincidents

- suspension of civil liberties
- imposition of quarantine
- triage decisions and rationing
- mandatory medical examination and treatment
- mandatory treatment with unapproved drugs and vaccines
  - informed consent
  - indemnification
  - special populations
Control of Population Movement and Supply Chain Networks
Compromising Critical Systems
Vulnerability of Global, National and Local Supply Chains in a Major Epidemic/Pandemic

Energy

Net Power Generation in the US by Fuel Source, 2007

Other Renewables, 2.50%
Petroleum, 1.60%
Hydroelectric, 6%
Natural Gas, 21.50%
Nuclear, 19.40%
Coal, 48.70%
Other, 0.30%
Other Gas, 0.40%

Energy infrastructure and fuel sources in the United States.
Bad Bugs and Few New Drugs
NO ESKAPE!: Resistant Bugs and Few New Drugs

- increasing resistance in G<sup>+</sup> and G<sup>-</sup> pathogens in hospital and community settings

- the **ESKAPE** pathogens
  - *Enterococcus faecium*
  - *Staphylococcus aureus*
  - *Klebsiella pneumoniae*
  - *Acinetobacter baumanii*
  - *Pseudomonas aeruginosa*
  - *Enterobacter species*
Antibiotic Resistance (Rx<sup>r</sup>)

- adds estimated $35 billion in healthcare costs
- 8 million additional hospital days per year
- Relentless rise in lethal Rx<sup>r</sup>
- major gaps in new Rx pipeline
Drug Discovery and Development:
One of the Most Complex Intellectual and Logistical Exercises Undertaken by Modern Industry

- $750 million to $2 billion R&D cost/drug
- 9-15 year R&D cycle

“Fewer countries have discovered, developed and registered drugs to an international standard, than have developed atomic bombs”

Chris Hentshel
Treatment of US Missionary Healthcare Workers With Experimental Ebola Drug (ZMapp)
Ethical Challenges

- “Should US workers receive an (experimental) drug in scarce supply when Africans are affected in far greater numbers?”
- “Should an experimental drug/vaccine that has not been tested in humans be given to Africans first?”
Compassionate and Emergency Use Exemptions of Investigational Drugs and Vaccines

- “Right to Try” ballot proposition Nov. 2014
- access for patients with terminal illness
Next-Generation Vaccine Technologies

- pan-vaccines
  - protection against diverse strains of a pathogen
  - protection against closely related classes of pathogens

- combating “Agent-X”
  - rapid design and large scale production (weeks versus years) for protection against sudden emergence of an unprecedented pathogen (Agent-X)
Vaccine Safety: Media Sensationalism and Celebrity Quackery
Jihadist Campaign Against Polio Vaccination in Pakistan

- Image of a woman in traditional clothing administering a polio vaccine to a child.
- Image of a protest with a banner reading: "WE CONDEMN THE BRUTAL MURDERS OF HEALTH WORKERS"
Suspicion of Polio Vaccine Campaign in Pakistan Heightened by Use by CIA as Cover in Hunt for Osama bin Laden
Future Trajectory Trends and Threat Expansion

New ‘Dual-Use’ Technologies and Engineered Biothreats
Synthetic Biology
C332,652; H492, 388; N98, 245; O131, 196 P7, 501; S2,340 (a.k.a. poliovirus)

ATTGACTGCAA ........................(design specifications)
The Expanded Dimension of the ‘Bio’ Challenge

- thinking beyond ‘bio’ as just infectious agents

- systems biology
  - targeted disruption of ANY body function
  - novel C and B threats

- synthetic biology
  - exploring biospace: designing new life forms
  - designer organisms to attack materials/infrastructure
Adaptations of avian flu virus are a cause for concern

Members of the US National Science Advisory Board for Biosecurity explain its recommendations on the communication of experimental work on H5N1 influenza.
Biosecurity

- collective term embracing biodefense, public health and dual-use technologies
- fundamental but still politically neglected component in national security
- understanding how changes in biological systems threaten health and societal stability
  - directly and indirectly
  - infectious disease, food production
  - disruption of transportation and supply chains, economic loss and risk of civil disorder
  - ecosystem shifts and new patterns of disease
- chronic social and economic instabilities as triggers of political turmoil and military conflict
Biosecurity

- infectious diseases as dynamic foes
- relentless dynamic shifts in pathogen biology and geography (evolution at work!)
- reality: outpacing infectious diseases versus conquest
- preparedness: surveillance, infrastructure, personnel
- innovation and investment incentives: drugs, diagnostics and vaccines
- new (dual use) technologies and engineered threats
- risk assessment and proactive actions: public health and national security
Biosecurity: A Classic Complex Systems Challenge

- Global perspectives
- Biological, economic, and political ecosystems

Science and Technology

Public Health and Healthcare Delivery

Intelligence, Foreign Policy and Military Strategies

- Societal priorities and cost of biosecurity
- Political and military conflict: ideologies, intents and capabilities
International (Re)Engagement, Commitment and Political Resolve to Address Biosecurity as a Foundational Element of Global Public Health, Diplomacy and National Security
Biosecurity

one health: humans, animals, ecosystems

urbanization, environmental sustainability and depletion of non-renewable resources

economic and political instabilities and escalating conflict risk

terrorism and international security

International Engagement, Commitment and Political Resolve
Building Robust Defenses for Biosecurity

- Governments must accord higher priority to ‘biosecurity’ as a integral component of national security and foreign policy.

- Rebuilding a national and international infrastructure for the surveillance, diagnosis and containment of infectious diseases is fundamental to future protection against major instabilities triggered by infectious agents, whether of natural or malevolent origins.
“Politics is the art of the possible, the calculated science of survival”

Prince Otto von Bismarck

“Survival owes little to the art of politics, but everything to the calculated application of science”.

Professor Rudolph Virchow (in reply)
Slides available @ http://casi.asu.edu/