Towards Epidemic Prediction: Federal Efforts and Opportunities in Outbreak Modeling

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The White House Complex

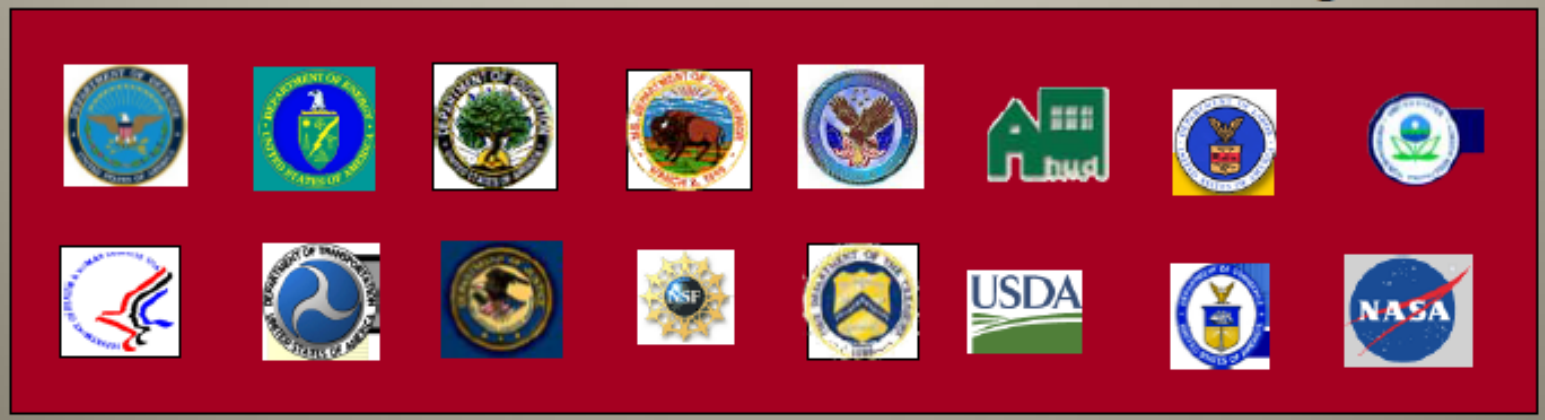
Executive Office of the President

The President of the United States

Executive Office of the President

- Office of Management and Budget
- Office of Science and Technology Policy
- National Security Staff
- Other Offices: OVP, NSC, etc

Federal S&T Organizations



Joint Program Executive Office for Chemical Biological Defense

Provide Research, Development, Acquisition Fielding and Life Cycle Support of Chemical, Biological, Radiological and Nuclear Defense Equipment, Medical Countermeasures Capabilities

JPEO
Mr. Doug Bryce

- Army
- Marine Corps
- Navy
- Air Force

Chief of Staff (Acting)
Ms. Lauren Ishmael

DJPEO (Acting)
Mr. Dan McCormick

DJPEO (Acting)
Medical and Operations
Dr. Jason Roos

Our Joint Project Managers

NBC Contamination Avoidance
COL Jeffrey Woods

Information Systems
Mr. Scott White

Protection
Mr. Scott Paris

Medical Countermeasure Systems
COL David Hammer

Guardian
Col Daniel Gerber

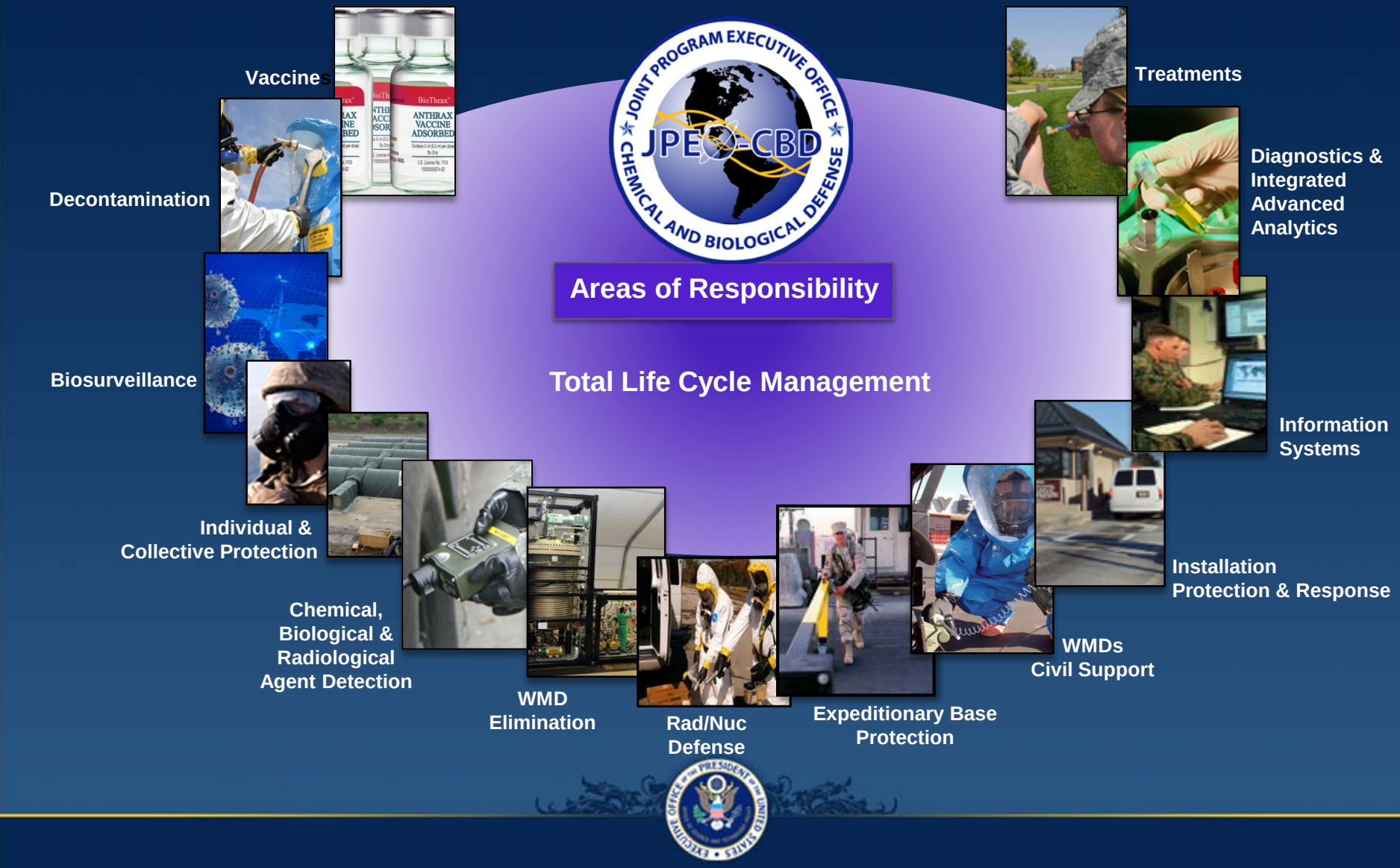
944 personnel | Workforce Composition: Civilians (505)* / Military (42)*

Army:	457	Air Force:	14
Navy:	55	Marines:	22

Contract Support (All Services): 396

** Numbers include Core, Matrixed, and Attached Personnel*

JPEO-CBD


JOINT PROGRAM EXECUTIVE OFFICE
JPEO-CBD
CHEMICAL AND BIOLOGICAL DEFENSE
Areas of Responsibility
Total Life Cycle Management
Vaccines
Treatments
Decontamination
Diagnostics & Integrated Advanced Analytics
Biosurveillance
Information Systems
Individual & Collective Protection
Installation Protection & Response
Chemical, Biological & Radiological Agent Detection
WMDs Civil Support
WMD Elimination
Rad/Nuc Defense
Expeditionary Base Protection

OSTP Mission

- Advise the President and others within the EOP on the impacts of science and technology on domestic and international affairs
- Lead interagency effort to develop and implement sound S&T policies and budgets
- Work with the private sector to ensure Federal investments in science and technology contribute to economic prosperity, environmental quality, and national security
- Build strong partnerships among Federal, State, and local governments, other countries, and the scientific community
- Evaluate the scale, quality, and effectiveness of the Federal effort in science and technology

Launch of the Pandemic Prediction and Forecasting S&T Working Group

The PPFST WG provides departments and agencies a focused forum to coordinate priorities and activities to accelerate the development of infectious disease outbreak prediction and forecasting capabilities both domestically and internationally.

Formally chartered April 24, 2014

Pandemic Prediction and Forecasting S&T Working Group – Why?

- In the 21st century disease emergence is accelerating
- Approximately 1.3M unknown viruses are waiting to emerge
- No technological – or medical - countermeasures available
- Invest in risk prediction and management, move away from reactive planning
- Operationalized modeling may be able to help

  - Chair: Senior Advisor, Biological Threats Defense, OSTP
  - Co-Chairs: CDC, DOD
  - 30 Departments and Agencies
  - 150 D/A representatives

Challenges

The field is poised to transform public health preparedness and response, but faces formidable challenges

Data- and information-sharing:

- Obtaining timely and accurate data and information during outbreaks has long been a major challenge for effective response
- Failure to share data and information

Outbreak response support: The extent of computational modeling during recent, current, and upcoming outbreaks is unprecedented

- Merely keeping track of new computational modeling analyses during an outbreak is a demanding task
- Predictions of future incidence differed 5- to 10-fold early in the outbreak
- Discerning the more valid approaches warranting higher confidence is challenging
- Cross-model comparison during outbreaks also is difficult because source code for the models often is unavailable

Understanding processes that drive disease emergence well enough to predict where and when diseases are likely to emerge, is perhaps the greatest challenge

Emerging Themes

- Data – and sample – sharing results must improve – nationally, internationally
- Much improved coordination, collaboration, and transparency across the Federal enterprise is needed
- Best practices, standardization, and community outreach are critical success factors
- The world has not prepared for more frequent outbreaks as global population expands and drivers for disease emergence are intensifying – local events are now global events
- A governance council or other unifying central authority may be needed

- USAID's EPT/PREDICT program has sampled more than 56,000 rats, bats, and NHPs in countries around the world and discovered ~820 completely new viruses. An estimated 1.3M viruses await discovery...

"Diseases are inevitable, pandemics are preventable."

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Backup Slides

Computational Outbreak Modeling

A new, multidisciplinary science is forming around the development of mechanistic and statistical modeling approaches, spurred by scientific advances across a range of areas, as well as near real-time availability of relevant data during outbreaks

Public health scientists are increasingly relying on computational tools to understand epidemiological patterns and implement prevention and control measures

PPFST is focused on the potential of computational outbreak modeling to achieve the vision of anticipatory public health

Modeling Uncertainty

Many descriptive and predictive models have been used to address five uncertainties, across emerging and re-emerging diseases (Zika, Ebola):

- **Outbreak growth rate and future course.** A key parameter describing outbreak dynamics is the reproduction number, or the number of people, on average, infected by each infected person
- **Regional or international spread.** Commercial air travel datasets allow modelers to assess pathogen importation risk for airports globally, to identify areas at high risk for importation and evaluate the utility of screening incoming travelers
- **Possible interventions and clinical trials.** A major contribution of modeling to outbreak preparation and response is enabling assessment and comparison of possible control measures
- **Pathogen evolution and genetic determinants of function.** As genetic sequence data become available on pathogens circulating during an outbreak, models can establish how the outbreak strain is related to any previous strains
- **Pathogen origin and drivers of emergence.** Few models attempt to predict the time and place of an outbreak beforehand; retrospective studies of outbreak precursors have identified possible precipitating factors, for some diseases

Examples: Federal response to Zika

Operational modeling and data- and information-sharing:

- BARDA performed real-time epidemic analysis to estimate demand for diagnostics and treatment resources, and convened the Modeling Coordination Group with federal and non-federal partners
- CDC estimated the risk for severe outcomes such as microcephaly, projected the course of the epidemic, and established a public website for sharing of machine-readable epidemiological data.

Modeling-related R&D:

- NIH supported studies modeling possible Zika control strategies; co-risk and interactions of Zika and other arthropod-borne viruses; genetic determinants of Zika emergence and fitness; competence of *Aedes aegypti* and *Aedes albopictus* to transmit Zika; and possible mosquito vector insecticide resistance
- NSF funded rapid-response grants to develop predictive models and discover principles governing transmission dynamics for Zika
- USGS explored modeling approaches to identify potential disease emergence areas and focus investigations into factors driving disease emergence

Development of diagnostic and testing tools:

- DARPA supported development of a field-portable device for rapid diagnosis of Zika virus and other pathogens
- CDC and NMRC provided reference testing for Zika infection
- NIH developed molecular tools to rapidly assess Zika virus adaptation during the outbreak
- NIST assessed molecular methods for distinguishing Zika virus from related viruses