FY2016 Extended White Paper

Using Risk Analysis to Assess the Value of Improved Biosurveillance

This study will extend and begin transitioning a tool that can be used to assess strategies for enhancing biosurveillance and improving decisions about whether and how to act after detection of a biosurveillance signal during a bioterrorism event.

1. **Theme Area**: Risk Management/Operations Research
2. **Principal Investigator (PI)**: Henry H. Willis
3. **Institution**: RAND Corporation
4. **Co-Investigators**: Adam Rose and Heather Rosoff (through collaboration of parallel work)
5. **Research Transition Lead**: Single Henry H. Willis
6. **Keywords**: Value-of-information, biosurveillance, bioterrorism, decision analysis

**Figure 1: Screen shot of the prototype Value-of-Information Analysis Tool**

**Brief Description**: (1-2 paragraph description)

The Department of Homeland Security, Office of Health Affairs manages the National Biosurveillance Integration Center (NBIC). The mission of NBIC is to enable early warning and shared situational awareness of bioterrorism events and disseminate warning and recommended actions to the appropriate interagency partners in a timely fashion to improve the public response to these incidents (DHS 2012). To improve the nation’s biosurveillance capabilities, NBIC is evaluating new ways to complete these processes and seeks tools to help policymakers weigh response options. In prior work, CREATE applied two standard decision analysis tools to biosurveillance – decision trees and value-of-information analysis – to develop tools for evaluating the value of strategies to enhance biosurveillance and to improve decisions about whether and how to act after detection of a biosurveillance signal. The prototype tool was developed around the context of protecting DHS workforce and personnel during an infectious disease outbreak. This study will extend these tools to other decision contexts for DHS and begin the process of transitioning the results of that prior work into broadly used tools by DHS and DHHS.

8. **Research Objectives**:

This research will extend the value-of-information tools developed to additional public health emergency response contexts. By doing so, the research will evaluate the generalizability of the approach to other diseases and countermeasure sets beyond those developed in the initial prototype for DHS workforce protection. Extending the tool to more complex decision contexts will require integration of more sophisticated disease models, thus we will collaborate with the DHHS-funded MIDAS center at the University of Pittsburgh. The Director of this center, Dr. Mark Roberts has expressed interest in this collaboration. Finally, the extended applications will also extend the value-of-information analysis to include assessment of public reactions to false positive and false negative decisions in the context of repeated review and use of biosurveillance information.
9. **Research Transition Objectives:**
Previous work in this effort was initiated at the motivation of Dr. Julie Waters (DHS Office of Health Affairs, National Biosurveillance Integration Center). Through the proposed work, the investigator will work with Dr. Waters to enable use of the research methods developed and decision support tool within the Office of Health Affairs through generalization of the decision support tools and training sessions for Office of Health Affairs personnel. In addition, the investigator will identify opportunities to extend use of the tool to other DHS components who adapt operational plans to biosurveillance information (like CBP Office of Field Operations) and to other public health emergency response organizations (like the office of the DHHS Assistant Secretary for Preparedness and Response).

10. **Interfaces to Current CREATE Projects:**
This work will benefit from interaction with CREATE’s economic analysis studies to understand the consequences of different bioterrorism incidents and with CREATE’s work on risk perception to understand the consequences of false alerts about such incidents.

11. **Previous or current work relevant to the proposed project, why is DHS interested, identify expected DHS users.**
Prior work has developed and extended a decision analysis tool that uses value-of-information analysis. Year 1 of the study developed the prototype decision support tool based on a Decision Analysis paper that describes how value of information analysis could be used to guide investments in improving biosurveillance (Willis and Moore, 2012). Year 2 (currently funded in 2015) extends that work to additional decisions in the realm of NBIC and to other biosurveillance preparedness planning in support of FEMA, DHS S&T, and the Department of Health and Human Services, Assistant Secretary for Preparedness and Response (DHHS-ASPR). The completed work suggests opportunities to transition this tool and approach to broader application across both DHS and DHHS. The current proposal will advance this research transition opportunity, beginning with collaboration with Dr. Julie Waters at DHS OHA NBIC.

12. **Major Deliverables, Research Transition Products and Customers:**
The ultimate goal of this study is to develop a set of simple decision-support tools to help DHS and its partners evaluate how to reduce the risks of bioterrorism. The original tools were designed to address two needs identified through discussions with Steve Bennett and Julie Waters of NBIC:

1) **Evaluating analytic methods to improve biosurveillance:** A decision tree based tool to evaluate the value-of-information from new analytic methods developed to complement the National Biosurveillance Information System in terms of the benefits they bring through reduced risk of bioterrorism.

2) **Evaluating course of action for disaster response:** A decision tree based tool that integrates results of disease progression models to evaluate the risk reduction achieved through alternative interventions to provide complementary analysis to support existing NBIC products.

The current proposal will seek to extend and transition these applications and identify other potential applications across relevant DHS offices in components and with partners at DHHS.
13. **Technical Approach:**

Biosurveillance answers three questions: What is happening? Is action required? and What type of intervention should be initiated? The answer to the first of these questions provides a signal of a potential unusual disease event recognized by collecting, processing and analyzing data. Answering the second two requires interpretation of biosurveillance data.

Figure 2 highlights these two decisions that are fundamental to integrating and acting upon biosurveillance information. The first decision to be made is whether or not to act based on a signal. If the signal is interpreted as being too ambiguous or of too little concern, then no action may be warranted and normal biosurveillance activities would carry on or additional information would be collected to verify the initial analyses and try to reduce the ambiguity. However, if the signal of an event warrants action, the second decision required is about what type of intervention should be implemented.

![Figure 2: A decision perspective on biosurveillance (Willis and Moore, 2012)](image)

To make the decisions presented in Figure 2, NBIC principally relies on information from existing biosurveillance collection processes; the Biosurveillance Common Operating Network and the Federal Biosurveillance Common Operating Picture. Opportunities also exist to integrate information from other national and international biosurveillance efforts. Examples of a few other efforts include (Hitchcock et al. 2007; DHS 2012):

- the DoD Global Emerging Infection Surveillance and Response System (GEIS),
- the World Health Organization’s Global Alert and Response System (GOARN),
- the DTRA Electronic Integrated Disease Surveillance System (EIDSS),
- Project Argus

In addition, NBIC can rely on a large number of existing tools to support biosurveillance analysis and interpretation (see Table 1 for examples).
### Table 1: Examples of existing tools to support biosurveillance analysis and interpretation

<table>
<thead>
<tr>
<th>Information Need</th>
<th>Examples of Analytic Approaches</th>
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<tbody>
<tr>
<td>Event detection</td>
<td>• Syndromic surveillance</td>
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<td></td>
<td>• Social media analysis</td>
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<tr>
<td></td>
<td>• Passive or active disease surveillance</td>
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<tr>
<td>Disease severity and progression</td>
<td>• Dynamic epidemic progression models</td>
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<td></td>
<td>• Disease transmission models</td>
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<td></td>
<td>• Exposure and behavior modeling</td>
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<td>Intervention effectiveness</td>
<td>• Agent-based modeling</td>
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<td>• Probabilistic risk analysis</td>
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<td></td>
<td>• Systems dynamics models</td>
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<td></td>
<td>• Operations research and analysis</td>
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<tr>
<td>Costs and consequences</td>
<td>• Economic analysis models (IO and CGE)</td>
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<tr>
<td></td>
<td>• Stated and revealed preference studies</td>
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</tbody>
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This study will apply standard tools of decision analysis, such as decision trees and value of information analysis (Raiffa 1997; Howard and Matheson 1984; Howard et al. 1972), to help DHS assess the benefits of both new analytic tools to support biosurveillance and recommend courses of action during bioterrorism incidents. Developing these tools will require integration of the results from a variety of other analytic methods including:

- Disease severity and progression models, to understand the expected risks from bioterrorism incidents.
- Models and simulations of incident interventions, to understand how different course of action reduce these risks
- Cost and economic analysis, to understand the costs and consequences of different courses of action during bioterrorism incidents.

This work was originally organized into four completed phases as described below that were completed over the first two years. This proposal adds a new fifth phase – research transition.

**Phase 1 – Establishing the biosurveillance decision context**

In the initial phase identified decisions inherent in the biosurveillance processes managed by the DHS NBIC. This included identifying questions asked of biosurveillance and the types of costs and consequences considered when answering these questions. This phase involved review of literature and discussions with experts at NBIC, FEMA, and DHHS-ASPR.

**Phase 2 – Develop a value-of-information analysis tool for biosurveillance**

The second phase developed and evaluated a simple, decision-tree based tool to support value-of-information analysis of new proposals to improve NBIC’s analytic capabilities. The tool allows NBIC to understand which approaches to improving surveillance reduce risk enough to justify the investment required to develop and implement the methods.

**Phase 3 – Establishing the bioterrorism response context**

In the third phase, we identified decisions are inherent in the response to a bioterrorism event, the range of courses of action to be evaluated, and the data that can be used to evaluate them. The decisions and range of courses of action were identified through review of literature and discussions with experts at NBIC, FEMA, and DHHS-ASPR. The data for evaluation was generated through review of literature, discussions with experts in modeling and simulation of bioterrorism events, and analyses of the costs and consequences of bioterrorism.
**Phase 4 – Develop a bioterrorism response risk analysis tool**
The fourth phase built on the results of the initial three phases to develop a decision-tree based tool that evaluates alternative course of action. The tool allows NBIC and its partners at DHS and other agencies to compare how alternative responses to a bioterrorism incident will reduce risks to the nation.

**Phase 5 – Research transition**
The final phase will build seek to identify opportunities to extend and broaden the use of this tool and approach across DHS – either for other public health emergency response applications or other DHS applications where value-of-information analysis would be useful. Activities will include demonstrating the approach, holding tutorials, and delivering briefings to demonstrate opportunities to transition completed CREATE research.

**14. Major Milestones and Dates:**
1. Briefing of potential transition applications and opportunities across DHS and DHHS (March 2016)
2. Memo prioritizing transition opportunities and recommending further transition steps (June 2016)

**15. References:**
Willis HH, Moore M (2012). Improving the value of analysis for biosurveillance. submitted to *Decision Analysis*. 

Willis, Using Risk Analysis to Assess the Value of Improved Biosurveillance
16. Budget: One page maximum, summary-level

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<th>Year 12 – CREATE</th>
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|                 | Henry H. Willis  
|                 | Project Leader  
|                 | Period of Performance: July 1, 2015 through June 30, 2016  |
| Personnel Costs | $64,346  |
| Henry Willis    | 20 days  |
| PRGS Fellow     | 59 days  |
| Travel Costs    | $7,462  |
| Travel and conference costs to cover trips to meet with DHS OHA-NBIC in DC, LA to meet with CREATE leadership.  |
| Computing Costs | $3,192  |
| Total           | $75,000 |
HENRY H. WILLIS

RELEVANT PROFESSIONAL EXPERIENCE
2002 to Present  RAND Corporation, Pittsburgh, PA
Professor, Pardee RAND Graduate School
Director, Homeland Security and Defense Center

1998 to 2002  Carnegie Mellon University, Pittsburgh, PA
Graduate Research Assistant

EDUCATION
2002  PhD, Engineering and Public Policy, Carnegie Mellon University
1995  MS, Environmental Engineering and Science, University of Cincinnati
1993  BA, Chemistry, University of Pennsylvania

SELECTED RECENT PUBLICATIONS


SELECTED AWARDS AND ASSOCIATIONS
National Acad. of Sciences Committee on Chem-Bio Defense Core S&T Capabilities (2012)
Institute for Operations Research and Management Sciences (2001 to Present)
National Acad. of Science Committee on Advanced Spectroscopic Portals (2008–2010)
Editorial Board for Risk Analysis (2008 – Present)