National Biodefense Preparedness Decision Support Tools

Institute of Medicine
Prepositioned Medical Countermeasures for the Public Workshop

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Decision Support Tools

Preparedness and response activities for disaster management are challenging due to the uncertainties of events and the requirement to act on the basis of absent or partial information. Decision Support Tools compile and visually present complex issues to decision makers in a way that best communicates risks/benefits of various courses of action, to facilitate the identification and solution of problems.

- Decision Support Tools (e.g. visualizations, models, checklists) enhance common understanding of the situation space and decision space for critical national preparedness requirements by enabling:
  - Level-setting among stakeholders on nature of specific catastrophic events and preparedness requirements
  - Enhanced understanding of ‘as-is’ plans and capabilities
  - Identification of capability, planning, preparedness, and response challenges and gaps for additional focus.
Time Sensitive Decision Making

Impact of Decision on the Outcome

Availability & Accuracy of Information

Value of Information for Decision Making

Not enough info to decide

Not enough time to act
Critical Decisions and Actions (Examples)

Zero – 96 Hours

Confirmation of Attack
- Coordination/Execution of MCM Distribution
- Identification of Area/Population Exposed
- Interdiction/Apprehension of Perpetrators
- Emergency Communications to Public

Identification of CIKR Impacts

Maintenance of Critical Essential Functions
- Medical Care for Mass Casualties
- Distribution/Dispensing of MCM

Decontamination & Restoration

Indication of Attack
- 12 Hrs
- 24 Hrs
- 36 Hrs
- 48 Hrs
- 60 Hrs
- 72 Hrs
- 84 Hrs
- 96 Hrs
Anthrax Attack Timeline
Preparedness Planning Tool

Overview and Assumptions
Anthrax Attack Preparedness Planning Tool

Objectives

- Enables decision makers and planners to explore the timeline implications of decision making on and execution of actions related to the deployment of medical countermeasures in response to a wide area aerosolized anthrax attack.

- **It is:**
  - A model of a generic attack, focusing on timing and scale
  - Intended to highlight implications of the time necessary to make and execute decisions
  - Capable of incorporating variety of different disease models
  - Focused illustratively on the National Capital Region (NCR), but is adaptable to any location.

- **It is not:**
  - A high fidelity scenario model or operational decision making tool
  - A prediction tool
Startup Interface

Anthrax Attack Timeline Dashboard

Detection Via:
- BioWatch Sensor
- Syndromic Surveillance
- Clinical Detection

Time of Attack:
- Working Hours
- non-Working Hours

Anthrax Model:
- Wilkening Model B
- Wilkening Model C
- Wein, et. al. (2003)

Exposed Population: 210,080

Click Map to center radius
(For planning purposes and not intended to depict notional plume coverage)
Timeline Interface

Anthrax Attack Timeline Dashboard

Wein. et al. Disease Model

<table>
<thead>
<tr>
<th>Step</th>
<th>Time from Release</th>
<th>Time since Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector Filter Collection</td>
<td>24 Hours</td>
<td>24 Hours</td>
</tr>
<tr>
<td>Lab Confirmation</td>
<td>36 Hours</td>
<td>52 Hours</td>
</tr>
<tr>
<td>SNS Deploy Decision</td>
<td>44 Hours</td>
<td>72 Hours</td>
</tr>
<tr>
<td>SNS Arrival</td>
<td>52 Hours</td>
<td>96 Hours</td>
</tr>
<tr>
<td>SNS Configured</td>
<td>60 Hours</td>
<td>120 Hours</td>
</tr>
<tr>
<td>SNS Deployed</td>
<td>1,060 Hours</td>
<td>144 Hours</td>
</tr>
</tbody>
</table>

Hrs since release: 500
Symptomatic: 95,460
Fatalities: 761,660
Fatality Rate: 73%

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Tool Assumptions

■ Exposed area is circular and uniform
■ Applied probit slopes indicating infective dose for humans derived from Sverdlovsk
■ 100% recovery for pre-symptomatic patients fully compliant with antibiotic regime
■ 60% recovery rate for symptomatic (prodromal) patients administered MCMs
■ 100% fatality rate for patients in fulminant state, notwithstanding treatment
■ Disease progression not dependent on age or other health factors (e.g., smoking)
■ Re-aerosolization not modeled
■ ‘MCM Deployed’ represents the time antibiotics arrive at PODs; model factors between 0-24 hours before all potentially exposed victims receive first dose.
  – Time to receive first dosage can be modified to model specific distribution schemes under consideration
■ Does not factor issues such as constrained resources; variations of sociological response of the public and responders; or functionality of MCM distribution plans and execution.
■ Constant population density assumed in NCR
  – Future work may include linking directly tract-based to Census data
■ Population of DC increases during day by 71%
■ ‘Rush Hour’ time of attack with 60% of subject population outdoors/in vehicles.
  – Assumptions such as % of people outdoors during attack, as well as protection factor for buildings, can be modified by user
### Disease Models Applied

<table>
<thead>
<tr>
<th></th>
<th>Wilkening A1 Model</th>
<th>Wilkening B Model</th>
<th>Wilkening C Model</th>
<th>Wein et al Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incubation Time</strong></td>
<td>Lognormal distribution with $\mu = 5.4$ and $\sigma = .73$</td>
<td>Lognormal distribution with $\mu = 5.0$ and $\sigma = .17$</td>
<td>Lognormal distribution with $\mu = 5.0$ and $\sigma = .17$</td>
<td>Lognormal distribution with $\mu = 5.57$ and $\sigma = .72$</td>
</tr>
<tr>
<td><strong>Prodromal Time</strong></td>
<td>Lognormal distribution with $\mu = 3.9$ and $\sigma = .35$</td>
<td>Lognormal distribution with $\mu = 3.9$ and $\sigma = .35$</td>
<td>Lognormal distribution with $\mu = 3.9$ and $\sigma = .35$</td>
<td>Lognormal distribution with $\mu = 4.03$ and $\sigma = .35$</td>
</tr>
<tr>
<td><strong>Fulminant Time</strong></td>
<td>Uniform Distribution with $a = 72$ hours and $b = 24$ hours</td>
<td>Uniform Distribution with $a = 72$ hours and $b = 24$ hours</td>
<td>Uniform Distribution with $a = 72$ hours and $b = 24$ hours</td>
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</table>

### Source

### Notes
- This is a much more aggressive model of the disease, similar to what was observed in the 2001 US attacks.
- This model closely agrees with the model generated by Wein, et. al, 2003.
- This model closely agrees with the model generated by Wilkening’s C model.
Demo Run Results – Wein et al

Anthrax Attack Timeline Dashboard

- Release
- Detector Filter Collection
- Lab Confirmation
- SNS Deploy Decision
- SNS Arrival
- SNS Configured
- SNS Deployed
- Last Medicated

- Hours since release
- First symptomatic
- First fatality
- First Medicated
- Last Medicated

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<td>SNS Deployed</td>
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</table>

- Hrs since release: 500
- Symptomatic: 0
- Fatalities: 191,500
- Fatality Rate: 18%

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Demo Run Results – Wilkening C

Anthrax Attack Timeline Dashboard

**Wilkening C Disease Model**

- **Hrs since release:** 500
- **Symptomatic:** 0
- **Fatalities:** 187,430
- **Fatality Rate:** 18%

**Steps and Times**

- **Detector Filter Collection:** 24 hours
- **Lab Confirmation:** 12 hours
- **SNS Deploy Decision:** 8 hours
- **SNS Arrival:** 8 hours
- **SNS Configured:** 8 hours
- **SNS Deployed:** 96 hours

**Timeline**

- Release
- Detector Filter Collection
- Lab Confirmation
- SNS Deploy Decision
- SNS Arrival
- SNS Configured
- SNS Deployed
- First symptom: 24 hours
- First fatality: 72 hours
- 96 hours: First medicated
- 144 hours: Last medicated
- 156 hours: SNS deployed
- 168 hours: Last medicated
- 192 hours: End of timeline

**Number Exposed**

- 1,200,000
- 1,000,000
- 800,000
- 600,000
- 400,000
- 200,000
- 0

**Symptomatic**

- 1,200,000

**Fatalities**

- 0
## Demo Run Results – Wilkening A1

### Anthrax Attack Timeline Dashboard

**Wilkening A1 Disease Model**

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</tbody>
</table>

- **Hrs since release:** 500
- **Symptomatic:** 0
- **Fatalities:** 277,770
- **Fatality Rate:** 26%

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Demo Run Results – Wilkening B

Anthrax Attack Timeline Dashboard

- Release: 24 hrs
- Detector Filter Collection: 24 hrs
- Lab Confirmation: 36 hrs
- SNS Deploy Decision: 44 hrs
- SNS Arrival: 52 hrs
- SNS Configured: 60 hrs
- SNS Deployed: 96 hrs
- First symptomatic: 72 hrs
- First fatality: 120 hrs
- First Medicated: 144 hrs
- Last Medicated: 168 hrs
- Last Deployed: 192 hrs

Hrs since release: 500
Symptomatic: 0
Fatalities: 432,230
Fatality Rate: 41%
Disease Models Comparison

% Fatalities vs. Time until MCM Deployed

Hours between Release and MCM Receipt

Fatalities as % of total

Wilkening Model A1
Wilkening Model B
Wilkening Model C
Wein, et al
Timeline Tool - Graph View

- Fatality Rate vs Hrs since release
- Symptomatic Cases and Fatalities vs Hrs since release

Hrs since release: 500

Fatalities
Symptomatic
Will Recover

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Geospatial Population Mapping Preparedness Tool
Objective: Visualize the location of exposed populations over time

- Provide preparedness planners enhanced understanding of implications of disease spread/population movement on actions and decisions
- Example Questions:
  - How many people over how large of an area exposed?
  - Where do exposed live and work?
  - Where have exposed traveled to?
  - Where is exposed population likely to be at time of detection? When countermeasures are available?
  - Where could MCM be deployed to maximum effect?
Visualizing the exposed population

Notional population distribution 12 hours after attack (t = 12)

- The location of the exposed population allows:
  - Better positioning of PODs/distribution areas
  - Improved distribution of resources for maximum effectiveness
  - Tailored communication planning

- Exposed population may move across jurisdictions, states, and nations within days

IAD: 3590 departures
DCA: 2890 departures
BWI: 1275 departures
Amtrak: 1100 departures
Interstate: 45,380 departures

\[ = 100 \text{ people} \]
Regional View

Notional population distribution 12 hours after attack ($t = 12$)
National and International Views

Notional population distribution 24 hours after attack

- >1000 people
- > 100 people
- > 10 people
Decision Support Tools Applications

Confirmation of Attack

Coordination & Execution of MCM distribution

Identification of Area/Population Exposed

CIKR Impacts

Interdiction & Apprehension of Perpetrators

Emergency Communications to Public

Maintenance of Critical Essential Functions

Rapid Distribution & Dispensing of MCM

Mass Medical Care

Decontamination & Restoration

12 hrs 24 36 48 60 72 84 96 hrs

Indication of Attack

Key

1. Attack Timeline Decisions/Actions Tool
2. GIS/Population Mapping Tool
Acknowledgements

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Backup
Disease Models Used

Generic Disease Model for an individual

- 100% w/ application of countermeasures
- 60% w/ application of countermeasures
Disease Models Comparison

Fatality Rate without Medical countermeasures

Hours after Exposure

0% 5% 10% 15% 20% 25% 30%

Fatality Rate (Fatalities per Day)

Wilkening A1
Wilkening B
Wilkening C
Wein et al
Display Prototypes

- **Mouse-over functionality will allow decision makers to obtain detailed information at the Census Tract level**
  - Census demographic information can be displayed for a tract in addition to anthrax patient status

- **Frame consideration of decision options for reducing potential fatalities:**
  - Distribute MCM earlier?
  - Distribute MCM more in different locations?
  - Better minimize exposure?
  - Isolate population earlier?
  - Better maintain orderly transit patterns?

All data displayed is notional
Geospatial Data

- Data to support the visualization of populations has been obtained from:
  - 2010 Census, 2006 Census daytime population estimates
  - 2009 American Community Survey/FactFinder (Census)
  - 2000 County Worker Flow (Census)
  - Commuting patterns from local county/city governments
  - Census Tract, Zip Code, County, State boundaries from Census/Geography
  - Relevant transit authorities (e.g., airports, Dept. of Transportation

- Candidate Census demographic data to be leveraged:
  - Income, ethnicity, age, education, language, origin, house price, commute times, commute distance, population density, housing type

- Other Geospatial Data:
  - Location of hospitals, fire stations, police stations, critical infrastructure, etc.
Demo Run Results – Wein et al

Anthrax Attack Timeline Dashboard

**Wein. et. al. Disease Model**

**Hrs since release:** 500

**Symptomatic:** 0

**Fatalities:** 192,720

**Fatality Rate:** 18%