Refining and Improving the Methodology for the National Health Security Preparedness Index

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Model Design and Methodology Work Group Meetings for the National Health Security Preparedness Index

March 10, 2015

NHSPPI Program Management Office
University of Kentucky
Meeting Objectives

• Orient members of the Model Design and Analytic Methodology Workgroups to the current status of the Index and processes for refinement.

• Reach agreement on directions for Index refinement in 2015
Agenda

- Welcome, Introductions, and Charge to the Workgroups
- Overview of the Index and Developmental Processes
- Areas for Refinement:
  1. Item Consolidation and Grouping
  2. Item Scaling
  3. Item Weighting
  4. Imputations
  5. Trend Analysis
  6. New Domains/Subdomains and Items
- Next Steps and Conclusions
Introductions
## Workgroup Members 2015

### Model Design
- Chris Nelson, RAND (CHAIR)
- Tim Sellnow, UKY
- Susan Cutter, Univ SC
- James Kendra, U Delaware
- Pat Sweeney, LHD director
- Jennifer Horney, TAMU
- John J. Grefenste, UPitt
- Robert Burhans, NY
- Jim Blumenstock, ASTHO*
- Daniel Hanfling, M.D. (chair of the healthcare task force)*
- Jim Craig (past chair of directors of public health preparedness)*
- Jackie Scott, Sstate of Michigan)*
- Erin Sutton, Virginia Beach Emergency Management*

### Analytic Methodology
- Chris Bollinger, UKY (CHAIR)
- Cristine Bevc, UCF
- Nathan Hubert, Cornell
- Ann Marie Mieir, UNC
- Bridget Booske Catlin, UWI
- Julie Ivy, NCSU
- David Eisenman, UCLA
- Robyn Gershon, UCSF
- Erica Martin, SUNY
- Jackie Merrill, Columbia U
- James Rajotte RI*
- Eric Carbone, CDC*

### Stakeholder
- Cathy Slemp (CHAIR)
- Kathleen Kimball-Baker (CHAIR)
- Gerrit Bakker, ASTHO
- Nicole Dunifon, NACCHO
- Andrew Jahier, FEMA
- Doug Farquhar, National Conference of State Legislatures
- Claire Reiss, National League of Cities
- Kelly DeGraff, Corporation for National and Community Service
- Jayne Lux, National Business Group on Health
- Liam O'Fallon, NIEHS/NIH
- Sarah, NYC OEPR
- CDC Representative (TBD)
- SAMHSA Representative (TBD)
Index Overview and Developmental Processes
Overarching Goals for the Index

- Increase awareness & understanding
- Stimulate dialogue, debate & discussion
- Encourage coordination & collaboration
- Facilitate planning & policy development
- Support benchmarking & quality improvement
- Drive research & development
Guiding Principles for the Index

http://www.nhsipi.org/tools-resources/guiding-principles/

- Health security is multifactorial
- Health security is a shared responsibility – all sectors
- Broad definition of preparedness from PPD-8
- Disaster risk reduction and primary prevention as core concepts
- Must be practical and value-added
- Build on existing data sources: low-burden
- Align with existing capabilities and frameworks
- Accurately and completely reflect state and national preparedness
- Use transparent development process that is stakeholder driven, continuously improving, based on real-world experience
- Value of composite information exceeds sum of the parts
- Advance the science of preparedness measurement
National Advisory Committee Members | 2015

1. Tom Inglesby, (Chair) UPMC Center for Health Security
2. Robert Burhans, Emergency Management Consultant
3. Anita Chandra, RAND
4. Ana-Marie Jones, Collaborating Agencies Responding to Disasters
5. Eric Klinenberg, New York University
6. Jeff Levi, Trust for America’s Health
7. Nicole Lurie, Assistant Secretary for Preparedness and Response
8. Stephanie Lynch, Caddo Parish (LA) Commissioner
9. Suzet McKinney, Chicago Department of Public Health
10. Stephen Redd, CDC Office of Public Health Preparedness & Response
11. Richard Reed, American Red Cross
12. Martin Jose Sepulveda, IBM Corporation
13. Claudia Thompson, NIH National Institute of Environmental Health Sci.
14. John Wiesman, Washington State Secretary of Health
Charge for the Workgroups

Provide scientific and operational guidance on ways of improving the Index as a tool for advancing health security, preparedness and community resiliency.
Model Design Work Group

- Subject matter experts in health security, preparedness and resiliency theory, policy and practice.
- Refine and update the conceptual model of health security and preparedness that provides a theoretical and structural foundation for the Index.
- Ensure that key constructs related to health security, preparedness and resiliency are reflected in the Index’s domains, subdomains and individual measures.
Analytic Methodology Workgroup

- Comprised of subject matter experts in measurement, analytic methods and modeling.
- Refine the validation studies performed on the Index, and to identify strategies for enhancing the scaling, grouping, weighting, and risk-adjusting of individual measures in the Index and its sub-components.
- Identify opportunities for using the Index and its underlying data and measures for predictive and scenario modeling and simulation applications that enhance the utility of the Index as a decision-support tool in policy and practice.
Current Index Structure and Methodology

- 194 individual measures
  - Unweighted average
- 18 subdomains
  - Unweighted average
- 6 domains
  - Unweighted average
- State overall values
  - Unweighted average
- National overall values

Scaling

- Dichotomous: value of 0 or 10
- Continuous: % of maximum state value x10, remove outliers >+2SD
- Missing values imputed as average of nonmissing measures within subdomain
2014 Index Results

- National average: 7.5
- State overall results range from 6.5 to 8.4
Directions for Development & Refinement
Need for Refinement

To become a credible and useful tool for decision-making, the Index needs to:

- Discriminate between different dimensions of preparedness
- Discriminate between high and low levels of preparedness
- Show sensitivity and specificity to changes in preparedness levels over time
Common problems in Index construction

- Combining unrelated measures
- Items do not reflect constructs/domains
- Distortions in scaling and weighting
Directions for Expansion and Refinement

- **Consolidation**: reduce correlated, redundant & noisy measures

- **Composition**: expand social, environmental economic indicators of preparedness & resiliency

- **Alignment**: with established national frameworks

- **Grouping & weighting**: use empirical methods for internal consistency, discriminant power

- **Scaling**: reflect distributional properties

- **Comparisons**: address accuracy and uncertainty

- **Trending**: track changes via backward compatibility
Validation studies with 2014 Index

- **Internal Consistency Reliability (ICR):** testing at domain and subdomain levels
- **Multi-Trait Scaling Analysis (MTS):** item to scale comparisons for convergence and discrimination
- **Sensitivity analyses:** testing alternative scaling, weighting, imputation algorithms
Validation studies with 2014 Index

Internal Consistency Reliability Estimates

<table>
<thead>
<tr>
<th>Domain</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health security surveillance</td>
<td>0.377</td>
</tr>
<tr>
<td>Community planning &amp; engagement</td>
<td>0.382</td>
</tr>
<tr>
<td>Incident &amp; information management</td>
<td>0.455</td>
</tr>
<tr>
<td>Healthcare delivery</td>
<td>0.354</td>
</tr>
<tr>
<td>Countermeasure management</td>
<td>0.231</td>
</tr>
<tr>
<td>Environmental/occupational health</td>
<td>0.546</td>
</tr>
<tr>
<td>Overall</td>
<td>0.311</td>
</tr>
</tbody>
</table>
Recommendation (1): Consolidate and Regroup Items

- Consider **dropping** items that are not minimally correlated with domain or subdomain \((r<0.2)\)
- Consider **regrouping** items that are correlated with multiple domains \((r>0.6)\)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Drop</th>
<th>Keep</th>
<th>Regroup</th>
<th>Constant</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveillance</td>
<td>11</td>
<td>7</td>
<td>11</td>
<td>5</td>
<td>34</td>
</tr>
<tr>
<td>Comm planning/engagement</td>
<td>5</td>
<td>19</td>
<td>20</td>
<td>1</td>
<td>45</td>
</tr>
<tr>
<td>Incident/information mgt</td>
<td>3</td>
<td>8</td>
<td>15</td>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>Health care delivery</td>
<td>7</td>
<td>18</td>
<td>34</td>
<td>0</td>
<td>59</td>
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<tr>
<td>Countermeasures mgt</td>
<td>2</td>
<td>6</td>
<td>9</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Environmental/occupational</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>31</td>
<td>65</td>
<td>90</td>
<td>11</td>
<td>197</td>
</tr>
</tbody>
</table>
Recommendation (1): Consolidate and Regroup Items

Relationship Between Current and Revised Index
(31 Measures Dropped from Index)

\[ y = 1.1556x - 0.116 \]
\[ R^2 = 0.9476 \]
Recommendation (1):
Consolidate and Regroup Items

Comparison of State Ranks
(31 Measures Dropped from Index)
### Recommendation (1): Consolidate and Regroup Items

**Items to Consider for Drop**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>M18</td>
<td>M286</td>
<td>M331</td>
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<tr>
<td>M256</td>
<td>M49</td>
<td>M168</td>
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<tr>
<td>M23</td>
<td>M53</td>
<td>M303</td>
</tr>
<tr>
<td>M13</td>
<td>M266</td>
<td>M304</td>
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<tr>
<td>M14</td>
<td>M268</td>
<td>M45</td>
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<tr>
<td>M15</td>
<td>M189</td>
<td>M293</td>
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<tr>
<td>M8</td>
<td>M10</td>
<td>M61</td>
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<tr>
<td>M211</td>
<td>M227</td>
<td>M271</td>
</tr>
<tr>
<td>M219</td>
<td>M336</td>
<td>M276</td>
</tr>
<tr>
<td>M6</td>
<td>M104</td>
<td>M195</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M196</td>
</tr>
</tbody>
</table>
Recommendation (1):
Consolidate and Regroup Items

Items with No Variation – Consider Drop

<table>
<thead>
<tr>
<th>M17</th>
</tr>
</thead>
<tbody>
<tr>
<td>M19</td>
</tr>
<tr>
<td>M20</td>
</tr>
<tr>
<td>M289</td>
</tr>
<tr>
<td>M150</td>
</tr>
<tr>
<td>M341</td>
</tr>
<tr>
<td>M342</td>
</tr>
<tr>
<td>M345</td>
</tr>
<tr>
<td>M274</td>
</tr>
</tbody>
</table>
Recommendation (2): Scaling

Scaling Items
- Old = actual/max ; trimming at +2 S.D
- New = (actual – min)/(max-min)

Aggregating Items
- Old = linear averaging  -> perfect substitution
- New = geometric mean  -> higher importance to items with lower performance
Recommendation (3): Weighting

Old = equal weighting of items within subdomains gives rise to large differences in implicit weighting in the overall Index

New = weights based on expert panel Delphi ratings
Validation studies with 2014 Index

% Impact on Final Index Score

Index Measures
The Relative Impact of 10 Measures

- Risk-adjusted 30-day mortality among Medicare beneficiaries hospitalized for heart attack, heart failure, or pneumonia (M299)
- Percent of long-stay residents assessed and appropriately given the seasonal influenza vaccine (M307)
- State average activities of daily living (ADL) dependence (M302)
- In case of an emergency, does your {state public health} laboratory have a 24/7/365 contact system in place? (M229)
- Percentage of residents eating dinner with their family at least a few times a week (M173)
- State participates in Emergency System for Advance Registration of Volunteer Health Professionals (ESARVHP) Program {and has a state volunteer registry} (M36)
- For which of the following organisms or their toxins does your {state public health} laboratory provide or assure testing for food and or water samples to assist with foodborne disease outbreak investigations: (several listed, e.g., Salmonella) (M276)
- State operate{s} its own meat and/or poultry inspection program (M277)
- Which of the following {organizations} provide certification or accreditation of your state public health laboratory? (FDA and/or USDA) (M258)
- Does your {state public health} laboratory test for {number of following types of} water: drinking, private well-water, recreational, surface, underground storage tanks, or waste? (M275)
Measures with the Most and Least Leverage

Percentage Impact on Final Index Value

- M275: 2.23%
- M258: 2.23%
- M277: 2.23%
- M276: 2.09%
- M36: 1.86%
- M173: 0.08%
- M229: 0.08%
- M302: 0.05%
- M307: 0.02%
- M299: 0.01%
The Relative Impact of 10 Measures

- (0.01%) Risk-adjusted 30-day mortality among Medicare beneficiaries hospitalized for heart attack, heart failure, or pneumonia (M299)
- (0.02%) Percent of long-stay residents assessed and appropriately given the seasonal influenza vaccine (M307)
- (0.05%) State average activities of daily living (ADL) dependence (M302)
- (0.08%) In case of an emergency, does your {state public health} laboratory have a 24/7/365 contact system in place? (M229)
- (0.08%) Percentage of residents eating dinner with their family at least a few times a week (M173)
- (1.86%) State participates in Emergency System for Advance Registration of Volunteer Health Professionals (ESARVHP) Program {and has a state volunteer registry} (M36)
- (2.09%) For which of the following organisms or their toxins does your {state public health} laboratory provide or assure testing for food and or water samples to assist with foodborne disease outbreak investigations: (several listed, e.g., Salmonella) (M276)
- (2.23%) State operate{s} its own meat and/or poultry inspection program (M277)
- (2.23%) Which of the following {organizations} provide certification or accreditation of your state public health laboratory? (FDA and/or USDA) (M258)
- (2.23%) Does your {state public health} laboratory test for {number of following types of} water: drinking, private well-water, recreational, surface, underground storage tanks, or waste? (M275)
Recommendation (4): Imputation

- **Old** = substitute average value of nonmissing items
- **New** = use multiple imputation estimates OR impute from prior-year values
Recommendation (5): Trend Analysis

- Use current model structure to calculate Index values for current year and for all previous years:
  - 2015
  - 2014
  - 2013

- Implement updates to the model structure retrospectively for all years of the Index

- Updated Index values fully replace previously calculated values
Recommendation (6): New Measures

- Expand social, environmental economic indicators of preparedness & resilience

Prior workgroup recommendations:
- Pre-event community status
- Federal contributions to preparedness
- Congregate care
- Fatality management
- Outpatient care
- Non-pharmaceutical interventions
- Responder safety and health
Recommendation (6): New Measures

- JCAHO compliance rates with emergency management standards: hospitals, nursing homes, home health, behavioral health
- Infrastructure reliability: power, water, transportation, communication, housing, public facilities
- Geofeedia data on social network communication signals: community concerns, resources
- Workplace policies: PTO, telecommuting
- Cybersecurity measures
- Inter-sectoral & inter-jurisdictional collaboration measures
- Preparedness funding levels & distribution
Future Methodological Issues

- Incorporating sampling variability and uncertainty into the Index
- Confidence intervals for comparisons across domains, states, years
2015 Timeline

2014 Release
- Call for new measures
- Validation studies
  - Refine framework, constructs
  - Secure data sources
  - Refine measure set & specifications
    - Test new scaling, weighting, imputation
      - Test comparisons & trending
        - Sensitivity analysis/simulation
    - Finalize index calcs
      - Update website
        - Messaging

Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

PREPARED
NATIONAL HEALTH SECURITY PREPAREDNESS INDEX
Next Steps

- Meeting summaries
- Virtual meetings