Application of Social Network Analysis to a Public Health Emergency Preparedness-Funded Workforce Program

Christine A. Bevc, PhD, MA,¹
Milissa L. Markiewicz, MPH, MIA,¹ Jennifer Hegle, MPH,¹
Jennifer A. Horney, PhD, MPH,¹ Lana Deyneka,² and Pia D.M. MacDonald, PhD, MPH¹

¹University of North Carolina - Chapel Hill
²North Carolina Division of Public Health

Background

- Social network analysis seeks to understand individual actions in the context of structured relationships (or the structures directly).\(^1,2\)
- Considerable work on disease epidemics and transmission networks \(^3,4\)
  - Examples: HIV/AIDS,\(^5\) STDs (Chlamydia, Gonorrhea, Syphilis),\(^6\) SARS,\(^7\) H1N1,\(^8\) Smoking,\(^9\) and Obesity\(^10\)
- Shift focus towards public health surveillance system
  - Detection, monitoring, and reporting of possible public health outbreaks and emergencies, including bioterrorism

Public Health Epidemiologists

• Introduced in 2003 by North Carolina Division of Public Health (DPH)
  – CDC PHEP-Funded Workforce Program
  – Provide LHDs and NC DPH with a dedicated point of contact within 11 major hospitals

• Primary tasks and responsibilities
  – 46% time spent surveillance, detection, and monitoring
  – 21% time spent assisting LHDs
  – Educating and communicating with clinicians, hospitals, and the public health system
Study Objectives

- Examine the relationship and patterns of interaction among hospital-based public health epidemiologists (PHEs) and their partners related to public health surveillance activities
  - To identify key actors and partnerships in the public health epidemiologist (PHE) network to understand how these relationships impact current and potential flows of information and communication
  - To determine the extent to which the program fulfills its intended liaison role between LHDs and local hospitals
Methodology

Defining the Network\textsuperscript{11,12}

- **Actors** – Public health departments/districts, hospitals, and public health epidemiologists
- **Edges** – Relationship and patterns of reported interaction (e.g. info requests, lab results, disease outbreak) among PHEs and their partners related to CD surveillance activities

Collecting the Data

- **Survey** – Roster checklist, open-ended - LHDs
- **Qualitative interviews** with PHE and hospital staff

Network analysis was conducted in \textit{R} using \textit{statnet} package.\textsuperscript{13}

Interactions within PHE Program

Common Reported Interactions among PHEs-LHDs-Hospitals
Based on Survey, Interview, and Program Data

- Support and Services
  - Case Investigations/Event Information
- Program Catchment Area
  - Referral Hospitals
    - “Preferred Partners”
- Regional Epi-Teams
  - State Preparedness Regions
  - Geographic Contiguity
- Jurisdiction
  - Public Health Reporting

PHEs

LHDs

Hospitals
Interactions within PHE Program
Basic Network Descriptives

Geographic Projection of PHE Interactions with LHDs and Hospitals
Nodes weighted by betweenness centrality

Actors
- 11 PHEs
- 85 LHDs (100 counties)
- 109 Hospitals

Edges
2,264 reported interactions
Interactions within PHE Program
Basic Network Descriptives

Interactions among PHEs-LHDs-Hospitals
Fruchterman-Reingold projection, nodes weighted according to **betweenness**

**Graph-Level**\(^{14,15}\)
Density = 0.047
Reciprocity = 0.923

**Node-Level**\(^{16}\)
Degree, \(\mu = 20.6\)
- \(\mu_{\text{PHE}} = 15.1\)
- \(\mu_{\text{LHD}} = 18.8\)
- \(\mu_{\text{Hospitals}} = 1.9\)
Betweenness, \(\mu = 528.1\)
- \(\mu_{\text{PHE}} = 3086.8\)
- \(\mu_{\text{LHD}} = 814.3\)
- \(\mu_{\text{Hospitals}} = 7.4\)

Measurement and Assessment

- Validate qualitative findings assoc w/ PHEs
  - Providing a communication channel between LHDs and clinicians/other hospital staff
  - Providing a “bridge”\(^\text{17}\) between local/state public health
- Gould-Fernandez brokerage analysis\(^\text{18,19,20}\)
  - Differentiate specific roles in the public health surveillance system
    - Determine whether PHEs fulfill liaison role

Brokerage Analysis

The **liaison** role identifies the frequency in which PHEs (or others) may serve as a “go-between” for hospitals and LHDs.\[^{22,23}\]

## Brokerage Results

### Brokerage Properties – Frequency Distribution

<table>
<thead>
<tr>
<th></th>
<th>Coordinator</th>
<th>Itinerant</th>
<th>Gatekeeper</th>
<th>Representative</th>
<th>Liaison</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHEs (n=11)</td>
<td>12</td>
<td>766</td>
<td>226</td>
<td>179</td>
<td>873</td>
</tr>
<tr>
<td>LHDs (n=85)</td>
<td>2,884</td>
<td>242</td>
<td>3,557</td>
<td>2,589</td>
<td>340</td>
</tr>
<tr>
<td>Hospitals (n=109)</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,896</td>
<td>1,024</td>
<td>3,783</td>
<td>2,768</td>
<td>1,245</td>
</tr>
</tbody>
</table>

Source: Lind et al. 2008.

Brokerage Results

Brokerage Properties (within Groups)

<table>
<thead>
<tr>
<th></th>
<th>Coordinator</th>
<th>Itinerant</th>
<th>Gatekeeper</th>
<th>Representative</th>
<th>Liaison</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHEs (n=11)</td>
<td>0.6%</td>
<td>37.3%</td>
<td>11.0%</td>
<td>8.7%</td>
<td>42.5%</td>
</tr>
<tr>
<td>LHDs (n=85)</td>
<td>30.0%</td>
<td>2.5%</td>
<td>37.0%</td>
<td>26.9%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Hospitals (n=109)</td>
<td>---</td>
<td>33.3%</td>
<td>---</td>
<td>---</td>
<td>66.7%</td>
</tr>
</tbody>
</table>

Source: Lind et al. 2008.

### Brokerage Results

#### Brokerage Properties (across Groups)

<table>
<thead>
<tr>
<th></th>
<th>Coordinator</th>
<th>Itinerant</th>
<th>Gatekeeper</th>
<th>Representative</th>
<th>Liaison</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHEs (n=11)</strong></td>
<td>0.4%</td>
<td>74.8%</td>
<td>6.0%</td>
<td>6.5%</td>
<td>70.1%</td>
</tr>
<tr>
<td><strong>LHDs (n=85)</strong></td>
<td>99.6%</td>
<td>23.6%</td>
<td>94.0%</td>
<td>93.5%</td>
<td>27.3%</td>
</tr>
<tr>
<td><strong>Hospitals (n=109)</strong></td>
<td>---</td>
<td>1.6%</td>
<td>---</td>
<td>---</td>
<td>2.6%</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>24.7%</td>
<td>8.7%</td>
<td>32.3%</td>
<td>23.6%</td>
<td>10.6%</td>
</tr>
</tbody>
</table>

Source: Lind et al. 2008.

Brokerage by PHEs

Geographic Projection of PHE Interactions with LHDs and Hospitals

Nodes weighted according to brokerage score, liaison role
Conclusions

- Brokerage analysis provides one approach to help assess and validate a PHEP-funded program

- Limitations
  - Does not explore factors/attributes influencing roles
  - Limited only to public health and program-related activities
  - Snapshot w/in past year (May-Sept 2010)

- PHEs improves information and communication in routine/non-routine public health events
  - Greatly enhanced completeness (58.9%) and timeliness (66.1%) of H1N1 reporting in the community
  - Greatly enhanced (62.7%) communication between hospitals and local health departments, i.e. CD reporting/investigation
Implications and Directions

- Informing stakeholder decision-making
  - Reports and follow-up discussions within 60 days
- Evaluating the hospital catchment area
  - State-wide system coverage
- Assessing the time-lag reduction
  - Timeliness of info requests*
    - PHE Hospitals (39.8%)
    - Non-PHE (15.7%)
- Building a robust model
  - Identifying program factors
  - Incorporation of actor attributes

* Response time of “immediately” - when LHDs asked about time to receive requested information
North Carolina Preparedness & Emergency Response Research Center (NCPERRC)

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University of North Carolina - Chapel Hill

Phone: (919) 966-0341
Email: bevc@unc.edu

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For additional information: http://nccphp.sph.unc.edu/ncperrc/