Planned Actors Matter in an Emergency Response Network?  
2015 MERS-CoV Response in South Korea

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Background

- Middle East Respiratory Syndrome Coronavirus (MERS-CoV) is a global pandemic threat that first attacked Saudi Arabia in September 2012.
- South Korea remains the country with the second largest number of confirmed MERS-CoV cases after Saudi Arabia (WHO, n.d.).

Data Sources:
- News article between May 20, 2015 and December 31, 2015
- 2015 MERS Whitepaper by the Korean Government (2016)

Network Data:
- Actors: Group of organizations (e.g., hospitals, local polices, local fires)
- Edges: Response operations (e.g., reporting, patient management, epidemic investigation, lab testing, and other supporting activities)
- Dataset:
  - 38 actors (16 planned actors + 22 unplanned actors)
  - 4,716 edges among the 38 actors

Network Statistics

- Information flow efficiency (Latora and Marchiori, 2001)
  \[ E_{\text{global}}(G) = \frac{1}{N(N-1)} \sum_{i<j} d_{ij} \]
- Hiarchy (Krackhardt, 1994)
  \[ H = 1 - \frac{V}{H_{\text{max}}} \]

Exponential Random Graph Models (ERGM)

\[ Pr(X = x | \theta) = \frac{1}{k(\theta)} \exp(\theta_1 x_1(x) + \theta_2 x_2(x) + \ldots + \theta_4 x_4(x)) \]

Data

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Finding 1.

The MERS response network was not dense, but efficiently structured and less hierarchical at this actor level.

- The actor who consists of central government health authorities (NHD) was at the center of the response network.
- A significant number of unplanned actors directly interacted with NHD.

Finding 2.

NHD was the most influential planned actor in the MERS response network.

- NHD decreases information flow efficiency, but increases hierarchy in all epidemic stages.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Impact</th>
<th>Efficiency</th>
<th>Hierarchy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>Positive</td>
<td>LHC (0.01)</td>
<td>NHD (0.02)</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>NHD (-0.02)</td>
<td>NSD (-0.01)</td>
</tr>
<tr>
<td>Peak</td>
<td>Positive</td>
<td>LFS (0.01)</td>
<td>NHD (0.01)</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>LHC (0.01)</td>
<td>NHD (-0.08)</td>
</tr>
<tr>
<td>Waning</td>
<td>Positive</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>

Finding 3.

Planned actors were more likely to build a tie with other actors in the response network.

- Full model did a better job in capturing the data characteristics compared to the null model.
- Governmental actors were more likely to build a tie with other actors than non-governmental actors.
- Health actors were more likely to build a tie with other actors than non-health actors.
- Provincial actors were more likely to build a tie with other actors than local actors.

Research Questions

1. What are the characteristics of the MERS response network?
2. What is the effect of planned actors on the structure of the response network?
3. Will planned actors predict tie formation in the response network?

Results

**Density**: 3.35  
**Transitivity**: 0.29  
**Efficiency**: 0.95  
**Hierarchy**: 0.06

Note:
- yellow nodes – planned actors, blue nodes – unplanned actors

Conclusion

- Planned actors play a significant role in the response network by two ways:
  1. The central health authority actor influenced information flow efficiency as well as hierarchical structure of the network.
  2. Planned actors predict tie formation in the response network.
- This study contributes to the emergency response literature by empirically analyzing the role of planned actors in the actual response network.

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