Incorporating Geographical Contacts into Social Network Analysis for Contact Tracing in Epidemiology: A Study on Taiwan SARS Data

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OBJECTIVE

In this research, we aim to investigate the necessity of incorporating geographical contacts into Social Network Analysis (SNA) for contact tracing in epidemiology and explore the strengths of multi-mode networks with patients and geographical locations in network visualization for disease spread investigation.

BACKGROUND

In epidemiology, contact tracing is a process to control the spread of an infectious disease and identify individuals who were previously exposed to patients with the disease. After the emergence of AIDS, SNA was demonstrated to be a good supplementary tool for contact tracing [1]. Traditionally, social networks for disease investigation are constructed only with personal contacts since personal contacts are the most identifiable paths for disease transmission. However, for diseases which transmit not only through personal contacts, incorporating geographical contacts into SNA has been demonstrated to reveal potential contacts among patients [2][3].

METHODS

In this research, we use Taiwan SARS data which was collected by the Graduate Institute of Epidemiology at National Taiwan University to investigate the differences in connectivity between personal and geographical contacts in the construction of social networks for these diseases. We first apply personal and geographical contacts to construct contact networks and perform connectivity analysis to measure the degree to which a type of contact can connect individual patients to form a network with two commonly used measures in SNA, the degree of a node and number of components. We also discuss whether including geographical locations as nodes in contact networks provide additional insights in disease investigate through network topology evaluation.

RESULTS

According to our results, geographical contacts, which increase the average degree of nodes from 0 to 108.62 and decrease the number of components from 961 to 82, provide much higher connectivity than personal contacts, which merely increase the average degree of nodes from 0 to 0.31 and decrease the number of component from 961 to 847. Therefore, including geographical contacts is important to understand the underlying context of the transmission of these diseases. We further explore the differences in network topology between one-mode networks with only patients and multi-mode networks with patients and geographical locations for disease investigation. We find that including geographical locations as nodes in a social network provides a good way to see the role that those locations play in the disease transmission and reveal bridges among those geographical locations and households. For a hospital outbreak, including geographical contacts in the network is also useful to see the possible disease transmission scenario

CONCLUSIONS

From our research results, we can see that geographical contacts provide much higher connectivity in network construction than personal contacts. Therefore, for modeling the transmission of these diseases, incorporating contacts into SNA is necessary to construct a well-connected contact network for investigation.

For the strengths of including geographical locations as nodes in the network visualization, our results show that introducing geographical locations in SNA provides a good way not only to see the role that those locations play in the disease transmission but also to identify potential bridges between those locations. If we apply some context data, such as the onset dates of symptoms, we can further understand the development of some outbreaks.

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KEYWORDS

Epidemiology--Transmission models
Epidemiology--Disease outbreaks