Resilience to Health Shocks:

How do Family Information and Support Networks Respond to Unexpected Negative Health Events?

Lindsay K. Brown and Tiffany C.E. Veinot
University of Michigan, Ann Arbor MI 48109, USA
likathry@umich.edu, tveinot@umich.edu

Abstract. Social networks can respond to outside shocks by "turtling up" (clustering around strong ties) instead of adapting by activating more weak ties to obtain new information, however this has not been shown in smaller, personal information and support networks. Therefore, the goal of this study was to explore whether these networks respond to shocks similarly. To do this, we evaluated the impacts of health shocks, unforeseen and disruptive health events, on the structure (e.g. network size/transitivity and tie strength/type) and function, i.e. ability to provide resources like information and social support, of information and support networks for families managing chronic illness. Using clustered sampling methods, families managing HIV/AIDS or type 2 diabetes were recruited. Longitudinal interview, survey and network data were collected from 28 families over a period of 2.5 years, with up to five contacts per family. We report descriptive statistics and random effects models using family-level data for network change in relation to health shocks. Health shocks were not significantly associated with changes in structure or function of family networks. Some change, however, was observed, with most measures trending down from one time to the next including proportions of weak ties and informational support ties, indicating these networks are not adapting by accessing novel information channels. Although further work is needed, the patterns of change observed did not match network responses to shocks found in prior work implying a possible difference in the ways that these networks respond to shocks and in what is actually driving observed changes.

Keywords: Network Shocks, Health Support Networks, Chronic Illness.

1 Introduction

Social networks are sensitive to the occurrences of disruptive and unforeseen external events. Prior work in organizational contexts has shown that workplace social networks react to shocks by "turtling up", i.e. higher clustering and increased strong-tie interaction, rather than adapting by activating more weak ties to obtain new information [1]. Other work has looked at responder communication networks during emergency response situations [2] and health provider communication networks during times of outbreaks [3], however this work is based on archival reports and does not specifically consider how existing networks react to uncertainty. In the context of managing

chronic illnesses, social networks are a critical source of information and social support for both chronically ill individuals and their family caregivers [4][5]. Past research has shown that major health events such as strokes are associated with reductions in the size of patients' social networks [6], but little work has examined how health-related shocks affect the structure and functionality of networks that support chronically ill patients, such as families. Therefore, the current study explores changes in family information and support network structures and functions, i.e. ability to provide network-associated resources such as information flows and social support, after the experience of a health shock. Hence, this study will investigate the following research questions:

RQ1. Does the structure of family information and support networks change after a patient experiences a health-related shock?
RQ2. Does the function of family information and support networks change after a patient experiences a health-related shock?

2 Research Methods

In a mixed methods study of families dealing with chronic illness, adult people with HIV/AIDS or Type 2 diabetes were recruited from healthcare facilities, nonprofit organizations, and an online research portal. HIV/AIDS and Type 2 diabetes were selected for this study as they represent a variety of chronic illness experiences including varying levels of stigmatization, treatment types, and communicability. Quota sampling methods were utilized to obtain a sample of patients which were roughly balanced across the two disease groups as well as being representative of the race and gender composition of the state in which the study was conducted. Family members were recruited via chain referral sampling where each patient was asked to recruit at least one family member who played a role in their disease management activities to participate in the study group. Over 2.5 years, each recruited family group completed semi-structured individual interviews and surveys at times 1 and 5, and semi-structured family group interviews and individual surveys at times 2-4. Surveys included social network data, and measures of network function. Social network data were collected using the paper-based, name generator procedure developed by Hogan et al. [7], where participants visually arrange post-it notes with identified network members on a large paper with three concentric circles, corresponding to the strength of their relationship to that individual. The survey also included questions about which network members provided participants with support (informational, tangible, and emotional). Network function variables were measured using survey scale measures for collaborative information behaviors (seeking and use), developed based on prior qualitative work [8][9], and perceived social support, using the Multidimensional Scale of Perceived Social Support [10]. Network data were translated into matrices for a) overall support networks and b) networks in which three specific forms of support that are critical to the management of chronic illness were exchanged: informational, emotional and tangible support.

Health shocks were defined as disruptive and unforeseen negative health events that participants believed increased their stress levels. A binary measure for occurrences of any type of health shock was generated via selective coding using transcripts from semi-structured interviews. This coding identified six types of health shocks which occurred in the dataset (hospitalizations, new diagnoses, declines in health, medication issues causing adverse reactions such as blood sugar irregularities, other health issues such as blood sugar crashes or temporary illnesses, and health issues of family members).

In order to assess how these occurrences related to changes in network structure and network function, family-level descriptive statistics were obtained for 6 measures of network structure (size, transitivity, proportion of weak ties, and proportions of ties providing informational, tangible, or emotional support) and 2 measures of network function (perceived social support and collaborative information behavior) according to whether or not a shock had occurred. Additionally, unadjusted random effects models were run to evaluate the impact of shocks on the six network structure and two network function measures, accounting for clustering of data by family groups over time.

3 Results

3.1 Characteristics of Participating Families

Twenty-eight families (14 with diabetes and 14 with HIV/AIDS in the family) provided data at two or more contacts, for 93 unique observations across the families. Twelve out of 28 patients were female, and 16 were male. Family group sizes (the number of family members participating in the study) ranged from two to five, with the majority (71.4%) having 2 family members participating in the study (including the patient). Family network sizes (the number of people identified as part of the family information and support networks by participants, which included people not in the study) ranged from 3 to 27 individuals with an average size of approximately 13 individuals.

3.2 Health Shocks and Network Structure

There were 21 instances in which families had experienced any health shock between the current time (*t)* and the previous time (*t-1)*. These events occurred for 12 out of 28 families (42.9%) at least once, with 7 families (25%) experiencing shocks at multiple time-points throughout the study. Shocks included hospitalizations (1 family), new diagnoses (1 family), declines in health (3 families), medication issues which caused adverse reactions such as blood sugar irregularities (4 families), other health issues such as blood sugar crashes or temporary illnesses (4 families), and health issues of family members (5 families). The following analyses look at both families that experienced these shocks and families that did not, in order to evaluate the impact of shocks on family networks.

The network structure measures analyzed included:

- Network size: a measure of the number of people in a particular family's information and support networks (number of nodes).
- Network transitivity: a measure of the overall connectivity of a network, calculated as the number of completed triads over the total number of possible triads.
- Proportion of weak ties: the proportion of connections in each network which participants reported as weak connections.
- Proportion of support ties: the proportion of connections in the network through which informational, emotional, or tangible support was received by study participants.

All network structure measures, except network size, ranged from 0 to 1, which means that the change in these measures (value of network measure at time *t* minus value at time *t-1*) could range from -1 to 1. Possible values for change in network size had a greater possible range given that network size ranged from 3 to 27 individuals, although observed change remained relatively small as network size was fairly stable.

Descriptive statistics and results of random effects models for changes in network structure variables are shown in *Table 1*. Although some changes in network structure were observed including; a) decreases in network transitivity b) decreases in proportions of support ties, with informational support ties having the largest decrease c) decreases in proportion of weak ties and d) increases in network size; random effects models did not show significant impacts of health shocks on observed changes in network structure. These data serve as an indicator that although changes occurred in the family support networks throughout the study, these changes may not be significantly explained by the occurrence of health shocks.

Perceived social support values were based on a 4-item measure including questions based on the MSPSS such as "my family really tries to help me" and "I get the emotional help and support I need from my family." These items were rated for agreement on a scale of 1 (strongly disagree) to 5 (strongly agree) and had high inter-item reliability at all time-points (Cronbach's $\alpha = 0.890$ to 0.922).

Descriptive statistics and results of random effects models for network function variables are shown in *Table 2*. Although some changes in network function after shocks were observed including; a) decreases in collaborative information behavior and b) increases in perceived social support; random effects models did not show significant impacts of health shocks on observed changes in network function.

Table 1. Change in network structure measures by occurrence of health shock (N = 93)

Change in value from previous (*t-1*) to current (*t*) time	**Had health shock between *t-1* and *t*** (n = 21) Mean (SD)	**No health shock between *t-1* and *t*** (n = 72) Mean (SD)	**Effect of Health Shocks** [a]
Network Size	0.857 (2.330)	-0.264 (3.692)	-1.1210; p = 0.189
Network Transitivity	-0.091 (0.172)	-0.058 (0.215)	0.0490; p = 0.396
Proportion of Weak Ties	-0.042 (0.142)	-0.073 (0.164)	0.0304; p = 0.441
Proportion of Informational Support Ties	-0.072 (0.206)	-0.009 (0.199)	-0.0650; p = 0.214
Proportion of Emotional Support Ties	-0.050 (0.192)	-0.003 (0.269)	-0.0526; p = 0.405
Proportion of Tangible Support Ties	-0.064 (0.201)	0.010 (0.209)	-0.0740; p = 0.149

[a] Model coefficients of separate unadjusted random effects models, clustered by family id, evaluating health shocks as a potential predictor of changes in each network structure measure.

3.3 Health Shocks and Network Function

Analyzed measures of network function included collaborative information behavior, based upon a novel scale developed by one of the study authors, and perceived social support, using questions from the Multidimensional Scale of Perceived Social Support (MSPSS).

Collaborative information behavior values were based on a 13-item measure including questions such as “A family member gave me information about [HIV or Diabetes] without me asking for it” and “I asked a family member questions about [HIV or Diabetes].” These items were rated for frequency on a scale of 1 (never) to 5 (a great deal) and had high inter-item reliability at all time-points (Cronbach’s $\alpha = 0.895$ to 0.935).

Table 2. Change in network function measures by occurrence of health shocks (N = 93)

Change in value from previous (*t-1*) to current (*t*) time	**Had health shock between *t-1* and *t*** (n = 21) Mean (SD)	**No health shock between *t-1* and *t*** (n = 72) Mean (SD)	**Effect of Health Shocks** [a]
Collaborative Information Behavior	-1.523 (6.715)	-1.670 (5.845)	0.1468; p = 0.922
Perceived Social Support	0.098 (1.756)	-0.142 (2.242)	0.2366; p = 0.692

[a] Model coefficients of separate unadjusted random effects models, clustered by family id, evaluating health shocks as a potential predictor of changes in each network function measure.

4 Discussion and Conclusions

We found that, although changes in network structure and function were observed when a health shock occurred, there were no significant associations between the occurrence of health shocks and these changes. This is contrary to previous findings suggesting that social network structures and communicative functions are impacted by stressful events [1] and that structures are particularly impacted by health shocks [6]. However, these previous works explored either larger networks with more weak ties [1] or personal social networks before and after a major initiating health shock (stroke) [6]. Unlike the present study, they did not explore the impact of subsequent shocks on family information and support networks which were already activated for the purpose of managing a chronic health condition. The initiating shock, the diagnosis of a chronic health condition, may have caused an initial adaptation process which led to family networks which were more resilient to subsequent health shocks than networks formed under more stable conditions. Additionally, findings suggest that the observed changes in these networks may be driven by factors other than health shocks. This insight about the drivers of change may be particularly important as, given the critical role of these networks in the management of chronic illness [4][5], ensuring network stability or expansion in the face of changing and declining conditions over the trajectory of illness is vitally important to extending and improving quality of life for patients and their caregivers. In our future work, we will explore the drivers of observed network changes by performing qualitative analysis of the interview data associated with this study to ascertain what, if any, unique occurrences happened within these families at the times of those changes. There may be other types of issues, such as interpersonal conflicts, or relocations of family members. which can better explain the occurrence of changes in these networks. Additionally, the lack of adaptive behaviors in response to health shocks, i.e. activating novel information channels via weak and informational support ties, may indicate that the burden on existing family caregivers increases as they need to respond to increased information and support needs in the face of health shocks. However, this study had some limitations, including a relatively small sample size and

therefore, more work is needed with larger sample sizes in order to confirm these findings. Our future work will also include an exploration of motifs, local interaction patterns within complex networks [11], to determine if there were changes associated with health shocks at a more localized level even if they were not evidenced in the overall network structures.

References

1. Romero, D., Uzzi, B., Kleinberg, J.: Social Networks under Stress: Specialized Team Roles and Their Communication Structure. ACM Transactions on the Web 13(1), 1-24 (2019).
2. Butts, C., Petrescu-Prahova, M, Cross, B.: Responder Communication Networks in the World Trade Center Disaster: Implications for Modeling of Communication for Emergency Settings. Math Sociology 31(2), 121-147 (2007).
3. Dutta, S., Rao, H. Infectious Diseases, Contamination Rumors, and Ethnic Violence: Regimental Mutinies in the Bengal Naval Army in 1857 India. Organizational Behavior and Human Decision Processes 129, 36-47 (2015).
4. Yap, S., Kim, J., Lee, C., Xu, Y., Kim, J.: Social Capital and Health Risk: An Integrative Review. Australasian Marketing Journal, (2018).
5. Maass, R., Kloekner, C., Lindstrom, B., Lillefjell, M.: The Impact of Neighborhood Social Capital on Life Satisfaction and Self-Related Health: A Possible Pathway for Health Promotion? Health & Place 42, 120-128 (2016).
6. Northcott, S., Hirani, S. Hilari, K.: A Typology to Explain Changing Social Networks Post Stroke. The Gerontologist 58(3), 500-511 (2017).
7. Hogan, B., Carrasco, J.A., Wellman, B.: Visualizing Personal Networks: Working with Participant-aided Sociograms. Field Methods 19(2), 116-144 (2007).
8. Veinot, T.: Interactive Acquisition and Sharing: Understanding the Dynamics of HIV/AIDS Information Networks. Journal of the American Society for Information Science and Technology 60(11), 2313-2332 (2009).
9. Veinot, T.: A Multilevel Model of HIV/AIDS Information/Help Network Development. Journal of Documentation 66(6), 875-905 (2010).
10. Zimet, G., Dahlem, N., Zimet, S., Farley, G.: The Multidimensional Scale of Perceived Social Support. Journal of Personality Assessment 52, 30-41 (1988).
11. Arnold, T., Daxenberger, J., Gurevych, I., Weihe, K.: Is Interaction More Important than Individual Performance?: A Study of Motifs in Wikia. In *Proceedings of the 26th International Conference on World Wide Web Companion* (pp. 1609-1617). International World Wide Web Conferences Steering Committee. (2017).