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Perspective

How to Facilitate Social Contagion?

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Abstract

Achieving the Millennium Development Goals has proven to be a real challenge. Providing evidence on cost-effective interventions did not prove to be sufficient to secure the trust of national authorities, health care providers and patients. Introducing change in a health system requires a good understanding of the relationships between the actors of the system. Social network analysis can provide a new avenue to analyse the diffusion of innovations within a health system or a health organisation and analyse the structure and the properties of a health system. Evidence has been generated on the necessity of not only identifying the actors of a system but also qualifying the relationships between these actors.

Keywords

Social Network Analysis, Health System, Innovations

Background

The role of networks has become crucial in health care during the 21st century with the emergence of informational and technological innovations, and with recognition from health managers that hospitals were no longer the only site of health care delivery (1). Health care providers have acknowledged the role of other actors ranging from medical and non-medical to private and public, as well as the positive impact of multi-scale and multi-disciplinary network-based initiatives (1). The attributes of a person such as gender, age, socio-economic status, educational background influence a person's behaviour such as smoking habit or health seeking behaviour. But these attributes also have an impact on their relationships—their social network. These networks have in their turn an influence on how people behave. Social network analysis (SNA) focuses on the understanding of the relationships between actors and the influence of social network on individuals' decisions and the diffusion of innovations.

The emergence of SNA

Social networks are composed of a set of actors (for example, in the health sector, hospitals, doctors and patients) often called "nodes", represented by spots (2–4) that are interconnected by a set of "ties" or relationships shown by straight lines (5) (Figure 1). In order to model systems, social network researchers applied mathematical and graphical techniques to illustrate and understand the complexity of human and organisational relationships.

SNA is not new. Understanding how social networks function started in the 1930s and, in 1934 following an epidemic in a New York school, Moreno tried to analyse why the pandemic had spread so quickly amongst the pupils (6)—social network theories were used for the first time in public health. Moreno was also a pioneer to graphically represent the relationships between pupils (7). Applications of SNA in various scientific domains rapidly expanded. Between 1980 and 1990, 2196 articles on social networks were published and recorded in the Web of Knowledge℠ platform. In the 1990s, and with the development of computers, there was a real enthusiasm for SNA and between 1990 and 2000, they were 11,380 articles and there was a further four-fold expansion during the decade between 2000 and 2010 (39,466 articles). The tipping point in the history of SNA was in the 2000s when SNA was labelled by the *New York Times* as one of the "new ideas" of 2003 and, in November of the same year, *Business 2.0* described it as the "the Hottest New Technology of the 2003" (8). 'Social network' has become a very common term in the 21st Century with the emergence of vast virtual social networks through the development of the internet, mobile and smart phones. In November 2012, at the Global Symposium on Health Systems Research in Beijing, SNA had become a popular concept and the scientific study of social networks has been recognised as a robust methodology to help health service managers and policy makers make informed decisions on how to introduce changes and innovations in a health system.

The role of social network analysis in social science

In social sciences, SNA has proven to be helpful in understanding the nature of relations between actors within a system and how these relationships influence the structure of a system (9). In ecology, studies using SNA have focused on the relationships between the different species in a food web and how the disappearance of one species could have major impact on other species connected in the same food web (10). Social network theories have also been very useful when studying interactions between ecological systems and communities (6,11). Academics have found that there is a relationship between the type of links between actors (i.e. bonding between actors of the system or bridging links with other systems) and the resilience of social-ecological systems (12,13). In organisational studies,

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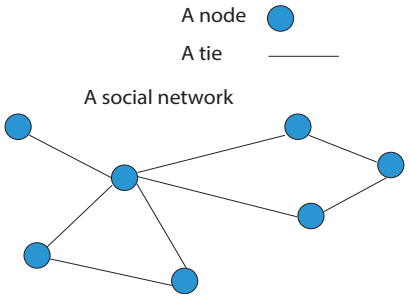

Figure 1. The graphic representation

scholars have shown that social networks determine the level of cooperation between individuals: in other words, individuals tend to collaborate more easily with their direct neighbours (14). SNA researchers have also shown that, while individuals are connected with a limited number of people, all people in the world are indirectly connected by a number of ties that on average does not exceed "six degrees" (15). SNA showed that social connections represent a social capital that provides, for example, the power to find jobs (16) or finalise business contracts (17). Individuals connected through a social network tend to have similar beliefs and values (18). Social networks theory has also helped researchers to understand the management and diffusion of knowledge (19), group behaviour, group dynamics, and organisational structures (20).

Applications in public health

Health care providers have recognised the role of other actors, medical and non-medical, private and public, as well as the positive impact of multi-scale and multi-disciplinary network-based initiatives (21). In health systems research, networks have implicitly been at the heart of health systems (22). In their own definition of a health system, Kohn *et al.* (23) made even more explicit how social networks play a crucial role. They saw a health system as a network of actors who aimed to provide health care: *"In health care, a system can be an integrated delivery system, a centrally owned multihospital system, or a virtual system comprised of many different partners over a wide geographical area"* (23).

SNA has already been applied in public health to analyse transmission mode of HIV/AIDS (24), the sharing of needles amongst a network of drug users (25), information seeking by patients on health facilities and treatments (26), health service management (27), health systems research (28), and knowledge transfer and exchange (29). The application of SNA has been very productive to understand disease transmission (30). In the case of HIV/AIDS or sexually transmitted diseases, SNA helps predict how a disease outbreak is based on the nature of relationships between the members of a community (31). Several studies focused on the link between the number and quality of social relationships and morbidity (32,33). A study showed that child mortality decreased with increased social network of the mother (34). However, much more can be done to understand individual or collective behaviour through the study of social networks as explained in the following sections.

In terms of social contagion, SNA tells us that an innovation is usually adopted by a small number of people in the network, the early adopters (35), and is then promoted by opinion leaders, people who are at the centre of the network and have the capacity to reach people located at different levels of the network (36). Opinion leaders will contaminate their own peers and by homophily, contagion will spread amongst peers (37,38).

The optimal structure of a social network

Mathematicians and software developers have elaborated a series of algorithms and software packages that can be used by researchers to identify the characteristics of networks' members and, characterise the structure of the social networks (39–41). Three types of networks have been identified by social scientists: ego-centric, socio-centric and open-system networks (42). Ego-centric networks are networks where connections relate to a single individual (e.g. list of my best friends). Socio-centric networks are networks within a well defined social environment such the relationships between health professionals within the hospital. Open system networks have no clear limits and could be extended as long as we find more connections (e.g. relationships between public health universities in the world). The analysis of social networks could be conducted at the level of every node or member of the network or the whole network level.

At the individual level, scientists were interested to understand why two individuals were connected to each other. They discovered that people who were geographically close to each other or visited the same place at the same time were more likely to establish a relationship (43), which is described in literature as propinquity or geographical proximity (44). Homophily is another characteristic of individuals studied by SNA: people tend to have relationships with people who have similar characteristics as themselves (45). This means that the composition of a personal social network reflects the characteristics of that person and those ideas that are communicated within a network are consensual rather than innovative (46). The implication of homophily is that the introduction of a new management system or a new drug for example into a health system needs to come from an actor who stands outside the network.

At the whole network level, studies focused on measuring the various properties of the network: density and structural holes to analyse the number of ties between nodes, centrality to identify the nodes that have more ties than others, and distance that measures the number of ties separating two different nodes. For example, it was shown that dense networks facilitate circulation of information (38) although too dense networks can become less innovative (47). A centralised network present the advantage of being an efficient model when introducing an innovation: only a low number of individuals need to be contacted for promoting an innovation. It may also result in bottlenecks if the individuals at the centre of the network block the diffusion (37). In terms of distance, the diffusion of innovations can be accelerated when the distance between actors within the network is short (42). Understanding the properties of the network can help predict the pace of diffusion of an innovation within a network and shape the most efficient strategy to introduce a new idea or technology. For example, the structure of a network can be described in terms of centrality. Freeman showed that the network structure with the highest centralisation degree is the star network (Figure 2) (48).

In terms of the general structure of a network, two properties were particularly used in SNA: cohesion and shape (49). Cohesion defines the number of connections within the network and includes sub-properties such as density and fragmentation. Shape relates to the overall distribution of ties and distinguishes the core actors from the peripheral ones (50). In terms of actors, their position provides indications of how actors get access to information. For example, Padgett and Ansell (51) showed that

Table 1. Definition of key network measures

Characteristic	Measure
Betweenness	Betweenness is a measure that indicates how much a node is located in the path between other actors or how much a node connects with other nodes (52).
Degree Centrality	The degree of centrality represents the number of ties a node has (53). If a node has many ties compared to its actors, this indicates that the node has a central position in the network. Centrality can also characterise the shape of a whole network.
Density	Density is defined as the number of existing ties divided by the number of possible ties.
Distance	Distance measures the number of ties that separate two actors. If two nodes are directly connected, the distance is one. If these two nodes are separated by one node, the distance is two.
Reachability	Reachability defines the degree by which a node can be reached by other nodes. If a certain number is unreachable by some actors, it means that the network is fragmented. Reachability corresponds to the number of steps maximally needed to reach from one node to any other nodes in the network (48).

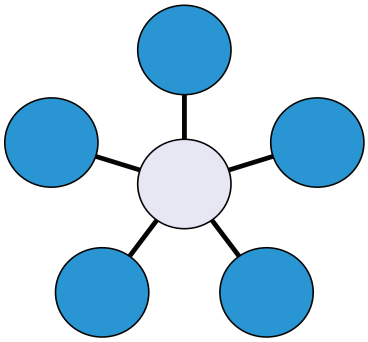

Figure 2. The star network

the power of the Medici family in the 15th century could be attributed to the control of information flows gained as a result of their central position in the Italian business community. Centrality, reachability and betweenness are the most well-known properties of node-related properties. The definitions of these quantitative measures are presented in Table 1.

Rogers and Kincaid (54) discovered that, in Korea, the village that had the highest compliance of contraceptives amongst women was the village that had the highest degree of centrality and where opinion leaders were imitated by women at the periphery of the network. There is also some evidence that the level of density of a network influences the circulation of information between its members: the denser the network, the quicker information spreads (28,38,55). However, it has also been shown that a dense network may be an obstacle to introduce new ideas into a network (56). Identifying the optimal network structure for system performance and diffusion of innovations is probably the next task for social network researchers.

Limitations

SNA has mainly focused on the relationship between actors but only a limited number of studies have focused on the characteristics of the relationship, for example the strength of the link between actors or the type of information circulated between actors. There is also limited research on the link between the structure of the network and the performance of the network (e.g. the impact of social network on the resilience of health systems). A third limitation of SNA is to define the borders of the network. Researchers have difficulty to justify the borders of the network under study as additional sub-networks can often be identified.

How to get started

There are numerous books and papers describing the various methods that can be used in SNA (20,41,46,57–59). These texts explain the various methods used to collect and analyse data and elaborate the measures used to calculate the properties of social networks. Network studies draw extensively on survey and questionnaire data. Researchers can decide on the type of relationship to be studied (e.g. circulation of information, friendship, collaboration) and the persons who will be interviewed. Data can be collected at every level focusing on the direct environment of the researcher: who is collaborating with whom, who is friend with whom? The results can be recorded in an Excel file. Network measures can be calculated and networks drawn using software packages such as UCINET (60). A free online course is also available on Coursera (www.coursera.org) and regular workshops are organised by the International Network for Social Network Analysis (www.insna.org).

Ethical issues

Not applicable.

Competing interests

The author declares no competing interests.

Author's contribution

KB is the single author of the manuscript.

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