6

Understanding and Managing Stakeholder Networks

The current environment for tobacco control consists of many "silos" of organizations and expertise, with connectedness within disciplines but few clear linkages between disciplines and among stakeholder groups. There may be a future for the tobacco control field in which linked, interdependent resources are used collaboratively to build synergy, share expertise, and reduce duplication of effort. The processes of creating, analyzing, and maintaining networks of tobacco control stakeholders are key to functioning in a systems environment.

This chapter provides an overview of network theory and analysis methods and approaches for using knowledge to provide a deeper understanding of strategies to promote collaboration of people and organizations in a public health context. The chapter explores issues involved in applying networks to tobacco control and implications for research in the field. Finally, findings are presented from a case study using network analysis for evaluation of the tobacco control process.

Society must be reconceptualized as a complex network of groups of interacting individuals whose membership and communication patterns are seldom confined to one such group alone.

—Diana Crane, Invisible Colleges (1972)

Introduction

The complexity of tobacco use is such that no one person or organization is likely to "solve" the problem. Effective tobacco control programs are comprehensive and have components that attack the problem at individual, organizational, community, and societal/environmental levels. For example, intervention programs aimed at the individual (e.g., offering advice on smoking cessation) are more likely to reduce smoking in the population if they coincide with interventions at the organizational level (e.g., smoking bans in the workplace and at home) and at the environmental level (e.g., increased price of cigarettes through increases in excise taxes or passage of minimum price laws). Comprehensive tobacco control programming requires collaboration among a mix of individuals and organizations with varied interests, talents and skills, knowledge, and resources.

Similarly, because of the complex and multidimensional determinants of tobacco use, no one scientific discipline is likely to solve the problem either. Instead, a high degree of transdisciplinary collaboration is required, leading to development of new research tools and conceptual models and, finally, to interventions that take into account the full spectrum of biobehavioral and environmental aspects of tobacco use.

This complexity requires collaboration among tobacco control practitioners and scientists. In addition, the work of the scientists must be made accessible to practitioners, and the experiential knowledge of the practitioners must be accessible to scientists. This will ensure that the appropriate research questions relevant to tobacco control are being asked and answered.

This chapter examines the questions of "who works with whom" in a system and how organizations and individuals are brought together. The approach here focuses on the concepts in network analysis theories and the applications of network analysis that can be used to improve collaboration among and between the communities of public health practice and science.

Overview of Network Theory

In their recent book, *Social Networks and Organizations,* Kilduff and Tsai[1] provide a useful introduction to the importance of networks. They cite the example of Paul Revere and his famous "midnight ride" in 1775 to alert local townspeople near Boston, Massachusetts, of the imminent arrival of British soldiers. Most Americans know this story, thanks to Longfellow's poem. It is not so well known that on the same night, another rider, William Dawes, carried the same message and rode the same number of miles to other towns in the Boston area. Thanks to Revere, the message that the British were arriving spread rapidly. For Dawes, however, the message went largely unheeded, so most people, including the local militia leaders, were unprepared. Why was there such a difference? The answer, according to Kilduff and Tsai, is that Revere knew very well the communities he visited that night, and thus, he knew which individuals to contact so his message would spread rapidly. Because Dawes did not know many people in the communities he rode through, he contacted very few of the right people. Those he did contact were not well connected to others who could both spread the word quickly and initiate action to prepare for the coming invasion.

This example, whether apocryphal or not, demonstrates the importance and value of networks. Despite good intentions, similar resources, and high motivation, success in getting things done is often highly dependent on having an effective social

network. Most people by now understand this point, at least regarding the importance of their personal network for such things as obtaining a desired job, achieving a promotion, or accomplishing politically sensitive tasks. The role networks play in society has been popularized through the movie *Six Degrees of Separation* and by the work of Watts,[2] who discusses "small-world" properties of networks. He argues that small-world networks, which exhibit only a few degrees of separation between any two nodes, can be used to explain the operation of both social and physical systems and the connection between seemingly random actions. It is far less well known how the study of networks, through network analysis, can be a valuable tool for organizational administrators and policy officials, in their efforts to address complex health and social problems through multiorganizational collaboration. Networks are critical to organizational life. However, attempts to apply what scholars know about networks to enhance the effectiveness of multiorganizational efforts in complex areas such as tobacco control, obesity, and chronic disease have been extremely limited.

Networks have been defined in a variety of ways, and no single definition is widely accepted. Even the term *network* is not always used. Many who study community and other organizational networks prefer to talk about partnerships, strategic alliances, interorganizational relationships, coalitions, or collaborative agreements.[3] Many also focus only on dyads (relationships between two persons or two organizations). Despite differences, nearly all definitions refer to certain common themes, including social interaction, relationships, collaboration, collective action, trust, and cooperation. Here, a network is defined as a group of three or more individuals, groups, or organizations connected in ways that are believed to facilitate achievement of a common goal. The relationships among network members are primarily nonhierarchical and have partial and often substantial operating autonomy. Network members can be linked by many types of connections and flows, such as information, materials, economic resources, services, and social support. Examination and analysis of a network include relationships, the absence of relationships, and the implications of both for achieving outcomes.

No single, grand "theory of networks" exists. Instead, scholars in a wide range of disciplines, including anthropology, communication, economics, management, psychology, political science, and sociology, have used a number of theories over the years to help explain network structure and processes in interpersonal networks and organizational networks. Because the focus of this chapter is interorganizational networks, the theories, concepts, and measures are discussed, whenever possible, as they apply to organizations. To use the terminology of network analysis, organizations are considered as the "nodes" of the network. The primary caveat is that organizations consist of individuals. Social interaction among organizations ultimately occurs primarily between individuals acting on behalf of organizations.

Network Perspectives from Two Levels of Analysis

Network theory can be thought of as coming from two different but complementary perspectives: the view from the individual (actor) level and the view from the network level of analysis. Wasserman and Galaskiewicz[4] also make this distinction, referring to a microlevel versus a macrolevel network focus.

Individual-level theories have a long tradition in social research and have guided most of the knowledge about networks. Individual-level views, often considered to be egocentric, are concerned with trying to explain how involvement of an individual

or organization in a network affects its actions and outcomes. For example, some individual-centered theories focus on an organization and its "embeddedness"[5] in a network. Prominent examples in the organizational literature include work by Burkhardt and Brass,[6] Burt,[7] and Uzzi.[8] Frequently, the focus of this research is dyadic relationships between organizations.[9] Dyads are the basic building blocks of networks. However, dyad-focused research is limited in that the network is primarily seen as a collection of two-party relationships, rather than as a unique, multiorganizational social structure in its own right.

Individual-level theories and related research can help to answer questions such as (1) which types of links are most or least beneficial to individual network members; (2) which network positions might be most or least influential; and (3) how the position of organizations in a network might shift over time in response to changes within and outside the network.

Structural issues that are typically examined and used to explain networks and network outcomes on an individual level include the following:

- *In-degree and out-degree centrality.* Does an organization occupy a central position or a more peripheral position in the network based on the number of networking ties it sends to or receives from other organizations? Degree centrality is based on the number of *direct* links maintained by an organization. Calculation of in-degree and out-degree centrality is based on the balance of assets such as resources, information, and clients coming *into* an organization from others in the network versus those being sent *out* to other organizations.
- *Closeness centrality.* Is an organization in a structural position to discern or spread information that might reside in any organization in the network, even through indirect ties? Central organizations have short "paths" (connections) to all other organizations in the network. Closeness centrality is thus calculated by considering the shortest path connecting an organization to all other organizations in the network. Direct connections, where A is connected to B, are shorter than indirect ones, where A is connected to B only indirectly through ties to C, which is tied directly to B. Unlike the case with degree centrality, in closeness centrality, *indirect* connections are viewed as valuable conduits of exchange.
- *Betweenness centrality.* Does an organization serve as a gatekeeper within the network? If so, it must maintain intermediary links between organizations that are not directly connected with one another. Hence, the organization's betweenness centrality is calculated by considering the extent to which an individual's position in the network lies "between" the positions of other individuals.
- *Multiplexity.* What is the strength of the relationship an organization maintains with network partners, based on the number of types of links (e.g., joint programs, referrals, and research) connecting them? Multiplex ties are thought to be an indicator of the strength and durability of links, because they enable the connection between two organizations to be sustained even if one type of link dissolves.
- *Broker relationships and structural holes.* To what extent does an organization span gaps (structural holes) in a network, and what are the implications of this for the organization? Organizations that span structural holes are considered to be brokers, often occupying positions of considerable influence.
- *Cliques.* Cliques are clusters of three or more organizations connected to one

another. The level of connectedness in a clique affects organizational outcomes in ways that are different from the effects of dyadic involvement.

Network-level theories draw on and use many of the ideas and measures developed by individual researchers. However, the focus is not on the individual organization but on explaining properties and characteristics of the network as a whole. The key consideration is outcomes on the network level, rather than on the organization level. For instance, instead of examining how organizational centrality might affect the performance or influence of individual member organizations, the network-level perspective would focus on overall network structures and processes. Network-level characteristics would be determined, compared across networks, and then used to answer questions such as how overall sustainability or absorptive capacity of the network could be enhanced or how the multiorganizational services provided to a client group might be strengthened. This perspective presumes that a network involves many organizations working collaboratively toward a common goal and that the success of one network organization may or may not be critical to the success of the entire network and its client group. The preference is for optimization of the network even if it comes at the cost of local maximization for any node or group of nodes in the network.

Work at the network level has blossomed over the past decade, but it has primarily been conceptual, anecdotal, or based on single case studies performed at one point in time. Networks have been used in studies of mental health,[10–13] and comparative empirical work has been done in other settings.[14–17] These and other studies used many of the structural issues discussed previously in this section for individual-level networks. Typically, these structural issues are aggregated across an entire network and then compared with those of other networks providing similar services. Unique network-level properties also are considered in those studies, including the following:

- *Density.* What is the overall level of connectedness among organizations in the network? Are some networks more fully connected than others? How much density is beneficial versus detrimental to the effectiveness of the network?
- *Fragmentation.* Are all or most network members connected, either directly or indirectly (i.e., through another organization), or is the network broken into fragments of unconnected organizations, dyads, and cliques? Fragmented networks have many structural holes.
- *Governance.* What mechanism is used to govern and/or manage the overall network? This mechanism can range from self-governance, with network members collectively running the system, to lead-agency models governed by a single organization that also provides critical core services, to a network administrative organization model. In this model, a separate entity is established for the sole purpose of facilitating network activity.
- *Degree, closeness, and betweenness centralization.* To what extent are a small proportion of the organizations in the network considerably more central in terms of degree, betweenness, or closeness centrality, as opposed to a network in which most organizations have relatively similar levels of centrality? Highly centralized networks may be organized in a manner approximating a hub-and-spoke pattern, popularized recently as "scale free" networks. Decentralized networks are far more dispersed, with links spread more evenly among members.
- *Cliques.* What is the clique structure of the network? How many cliques exist? Which types of organizations are

involved? How large are the cliques? Are they connected to other cliques or fragmented? How much overlap is there across cliques, depending on the type of link involved (e.g., shared information or joint programs)?

Theories of Social Networks and Network Behavior

As previously noted, there is no single, unified theory of networks. Some researchers[18,19] even argue that there is no network theory at all. Rather, they claim that the study of networks is, at this point, more of an attempt to study social relationships by using a particular set of analytic methods and concepts (e.g., centrality). Most who study networks, however, do draw on one or more of a number of theories developed to explain networks and network behavior. These theories are discussed in considerable depth in two recent books: one by Monge and Contractor[20] on communication networks and the other by Kilduff and Tsai[1] on organizational networks. A brief overview of the major categories of theories that have been used to explain network behavior is provided here.

- *Self-interest.* Self-interest theories, drawing on economic principles of maximization of individual value, explain network behavior based on the self-interest of those involved in the network. In its simplest form, this explanation contends that organizations seek network links with other organizations if and only if it is in their interest to do so. For instance, one organization might want to create a network link to another organization from which it seeks to draw knowledge, skills, or resources. Network members can build their own social capital and thus enhance their outcomes by acting as social entrepreneurs and brokers, spanning structural holes.[7] Transaction cost economics also has been used to explain networks based on self-interest. Using this approach, network members seek connections that allow them to operate most efficiently by minimizing the cost of transactions (e.g., overhead, distance, and accessibility) and maximizing the gains from transactions (gross value of services or materials being sought). Theories of self-interest are most useful in understanding networks in which the organization with the self-interest has the ability to coerce other organizations to be a part of its network.
- *Exchange and resource dependence.* A more viable network explanation is premised on theories of exchange and resource dependence. According to this perspective, organizations seek and form network ties with other organizations to reduce uncertainty and attract needed resources. The nature of these interorganizational ties is based on implicit consideration of the relative terms of exchange. The primary issue is power or its reciprocal, dependence. One organization may develop strong ties to another based on resource needs (e.g., money and information). However, it also seeks to balance this dependence through mutual dependencies with its linkage partner (i.e., exchange of needed resources) or through the influence and power this relationship provides for dealing with others in the network.[21,22] Decisions to be part of a network thus involve a complicated set of exchange relationships between and among all network members.
- *Collective action.* The two previous approaches are based on individual organizations structuring their network to draw resources from one another. Theories of collective action, on the other hand, explain situations in which organizations create network links with other organizations, not to seek or exchange resources with one another, but to maximize their joint ability to seek resources from or provide them to third

parties. For instance, organizations might choose to share information to mobilize more effectively in a campaign to promote smoking cessation. Theories of collective action explain the viability of network links based on the mutual interest and benefits associated with joint action by the two organizations. These theories build on public goods theory[23] with the idea that individuals and organizations are motivated to join and work in networks to reap the benefits of collective action. The benefits presumably could not be obtained by acting through motives of self-interest or social exchange, even in a network context. Theories of collective action are broadly useful for explaining why organizations might form and sustain a network. Researchers[24] have explored reasons behind the formation of particular network structures and which structures might be most effective under particular conditions.

- *Social contagion.* The perspective of social contagion focuses on the impact of network involvement on subsequent behaviors. Contagion occurs as a result of interacting with network members and being "infected" by their attitudes and behaviors. In general, greater involvement (embeddedness) results in greater contagion, leading to similar attitudes, beliefs, and behaviors among network members. In the organizational literature, network involvement has frequently been used to explain why some organizations mimic the behavior of others, such as adopting total quality management; other "trendy" solutions to management problems;[25] or certain attitudes, innovations, or ideas.
- *Homophily.* The approach of homophily provides relatively simple but compelling reasons for why networks form and to a lesser extent, why they are sustained. Homophily is based on the assumption that individuals and organizations are more likely to create links with one another if they are similar. It is the "birds of a feather flock together" argument.[26] The underlying contention here is that there is a "comfort zone" associated with maintaining links with like-minded individuals or organizations. Although such networks may be attractive, it is reasonable to infer from research on group decision making that homogeneous networks also are likely to be less creative and innovative.
- *Proximity.* Like homophily, proximity provides a simple but powerful explanation for the maintenance of network links. Early research in organizational settings indicates that the frequency of face-to-face dyadic communication drops precipitously after the first 75–100 feet.[27,28] Proximity is based on the concept that physical closeness is likely to result in more opportunities for a social relationship than is separation by longer distances. More recent studies[29] considered the effect of communication technologies (e.g., e-mail and instant messaging) on the impact of physical proximity. Findings suggest that the effects of higher levels of interactions via electronic channels have a bimodal distribution. The impact is highest among those with the closest physical proximity and those who are the greatest distance apart.
- *Change and evolution.* Theories of organizational change and evolution have focused nearly exclusively on internal change or on the evolution of organizational populations.[30] However, some researchers have made efforts to extend what is known about change and evolution to networks by examining the influence of network involvement on organizational survival and on evolution of the network itself. The work on network involvement addressed network life-cycle stages and the importance of building legitimacy if the network is to be sustained.[31] A central assumption is

that organizations create network links to maximize the "fitness" of the entire network and thereby to be "selected" from an ecology of other networks in the community. This perspective might explain why organizations involved in the tobacco control network might strategically create ties that help to preserve the long-term viability of the tobacco control community relative to other networks in health care communities, such as those focusing on obesity control.

Researchers have used all of these theoretical approaches to explain key aspects of network behavior. In some sense, they are competing theories, because all are attempts to explain the same basic phenomenon. However, networks are complex mechanisms, and an explanation of the actions and structures of network members and the network as a whole cannot be boiled down to one simple theory. Individuals and organizations typically join and sustain their involvement in networks for multiple reasons. The theories merely reflect this complexity. Indeed, there is a compelling case for the use of multitheoretical, multilevel models for explaining, simulating, and designing real-world networks.[17,20]

Effective Organizational Networks

Drawing on these theories, researchers have studied many networks in a broad range of settings. On the basis of research at the network level of analysis, a number of tentative conclusions can be drawn about criteria for an effective network. This list is not exhaustive, but it provides a brief overview of much of the existing knowledge about organizational networks. It also forms the basis of the subsequent discussion about application of network analysis to build and strengthen tobacco control efforts.

- *Multiple levels of collaboration.* Collaboration should occur at multiple organizational levels. Having network ties at only one organizational level (e.g., top-level administrators) minimizes commitment to the network by lower-level organizational participants. This reduces the chances of successful implementation of network strategies. Involving multiple people in an organization also increases the likelihood that network links will be maintained when someone leaves the organization.
- *Focused integration.* Extremely dense networks are inefficient, requiring a great deal of time and energy to maintain. Effective networks should have moderate levels of integration among members, with some fragmentation and structural holes.
- *Strong links.* The strength of linkages (multiplexity) among network members should be varied, depending on critical network needs. Some organizations should be connected through multiple ties, but other network members can and should maintain weak ties.
- *Network governance.* Governance of the network should be based on the size and complexity of the network and on its stage of evolution. Generally, small networks can be self-governed, but larger networks are most effective when governed through a lead agency or network administrative organization.
- *Involvement.* Most network relationships should be based on trust and commitment to network goals, even when contractual ties (e.g., funding) are present. Trust and commitment generally need to be built gradually, often first through low-intensity ties.
- *Legitimacy.* Networks must build legitimacy as they grow, both internally (through network members) and externally (e.g., through outside funding and the media). Legitimacy helps to build

commitment to the network and its goals and is critical for sustaining the network.

- *Resources.* Effective networks have sufficient resources to work on network-level goals and activities, rather than focusing solely on internal organizational issues. Resources can come from network members or from outside sources. Minimally, resources are needed for basic business necessities, such as staffing, telephones, and a newsletter.
- *Knowledge repositories.* Organizations that publish materials in digital knowledge repositories (e.g., Web sites) are more likely, not less likely, to be targeted for direct communication from other organizations. Organizations use published information in digital repositories to identify "who knows what" and "who knows whom." Then, rather than being content to download the published information in these repositories, they seek out the "who" directly for further clarification and collaboration. In essence, a knowledge repository serves as an effective signal of the organization's knowledge but not as an effective substitute for disseminating knowledge to other organizations within the network.
- *Dedicated network alliance function.* Nodes in effective networks have developed an in-house dedicated network alliance function as part of human resources activities. The purpose is to help build "learning" about how to grow the network more effectively and to monitor for action cues to dissolve some network links.
- *Exploration, exploitation, and mobilization.* Organizations use "dense" (highly connected) networks to effectively exploit resources. This practice may contribute to incremental innovation. However, organizations use sparse small-world networks to explore novel ideas. This approach is most appropriate for identifying disruptive technologies and might contribute to disjunctive innovations. In addition, organizations use "star" networks to enable mobilization. This strategy is most appropriate for formulating and implementing standards, policies, or procedures.
- *Goals.* Long-term goals such as improved health status are important, but results are frequently not apparent for many years. Thus, networks must have goals that are specific, attainable, and appealing to a broad range of network members. To build commitment and legitimacy, network members must have a sense of accomplishment. Such goals can focus on network structure, processes, and short-range outcomes.
- *Stability.* Although networks are designed for flexibility, major system upheavals are not conducive to the effectiveness of networks, especially after early formation and growth. Major system change can disrupt established, trust-based relationships that have evolved over a long period.

Value of Organizational Networks

Use of cooperative networks of organizations has become a key strategy for addressing the public's most pressing health and human services needs. These networks have become important mechanisms in many states and communities, as well as nationally and internationally. Their functions are as follows:

- Building capacity to recognize complex health and social problems
- Planning strategies systematically to best meet critical public health needs
- Developing and implementing policy related to public health needs

- Mobilizing, leveraging, and obtaining scarce resources
- Facilitating the flow of knowledge and information to address complex problems
- Delivering needed services

By working together as a network, organizations can improve both their efficiency and the effectiveness of the services and programs they offer.[32,33] Potential benefits of network involvement are substantial. They include improved services, better access to services, less duplication of effort, better communication and access to information, improved innovation, and ultimately, more sensitive and reliable indicators of health status. Research has demonstrated that networks are especially valuable for nonprofit and public organizations working to address a broad range of problems in community and regional health and human services.[12,34] Organizational networks offer the following benefits to health care providers:

- *Provide a team approach to complex public health issues.* Networks are especially helpful for addressing problems that are complex and seemingly intractable.[32] The magnitude of many problems in health and human services is simply too great for any one organization to resolve single-handedly. Such problems require a "fishing net" approach—a structure of organizations that is agile, flexible, easily reconfigured, and yet robust, and that can rapidly bring together the set of diverse skills, resources, and expertise required to address these problems effectively.
- *Address multiple needs.* Networks can work with clients who have multiple needs (e.g., education, disease prevention, treatment, and referral), as well as requirements to treat combinations of illnesses (e.g., substance abuse and mental illness or cancer and depression).
- *Counteract fragmentation of multiple-provider organizations.* Despite the multiple needs of clients, health care providers usually offer a limited range of services. Such fragmentation may be cultural or it may be based on differing treatment philosophies and methods, traditions, or funding streams. When services are fragmented, clients generally suffer, receiving only partial treatment or being forced to deal with multiple providers on their own. When organizations establish a network, however, fragmented services can be integrated across providers, enabling clients to enter a *system* for delivery of services that meets a broad range of needs across multiple organizations.
- *Ease problems related to geographic dispersion.* Organizations in large cities, rural areas, or different states, regions, or countries often can benefit immensely by sharing information, ideas, and resources. However, geographical dispersion often keeps them isolated. Networks provide a formal mechanism to encourage and facilitate collaboration, even when face-to-face contact is not possible.
- *Optimize use of resources.* Networks are efficient mechanisms for providing needed services under the constraints of limited resources. When provided through a network, scarce resources can be shared and duplication of services can be minimized through the coordinated efforts.
- *Facilitate transfer of knowledge and enhance learning.* Organizations have considerable knowledge and expertise, but that information frequently stays within the organization or is shared only sparingly. To address complex health care problems, however, the broad sharing of knowledge is critical. By establishing formal mechanisms to facilitate information transfer and by

creating the framework for more informal interactions, networks can enhance the flow of knowledge across organizations. This improves both the amount and speed of learning by participants in the organization. In addition, networks can be used to build "transactive memory systems"[35] in which highly differentiated but easily accessible pockets of specialized knowledge are distributed across the network. Such networks can enhance the efficiency (speed) and effectiveness (quality) of learning across a broad range of areas, including client needs, delivery of services, advocacy, research, policy, and funding.

Networks also have shortcomings that can seriously undermine their effectiveness, even resulting in dissolution. Challenges to building and maintaining a successful network are numerous, but several factors affecting networks stand out as being most common, based on the research conducted.

- *Undermining of autonomy in decision making.* The downside of collaboration in any setting is that participants can no longer focus solely on their own needs. In organizational networks, members must consider the interests and expectations of other network members, thereby limiting their autonomy in decision making. The problem is most acute for network members who cooperate very closely, because decisions made by one member have a major impact on the other member(s). In addition, most contemporary organizations are confronted with the dilemma of having to cooperate with many of the same organizations they compete with in other contexts. A generic form of this dilemma occurs when organizations cooperate to provide complementary health services in a local community but compete for resources from local, state, and federal agencies to provide these services. This phenomenon of cooperation and competition[36] in the network further undermines autonomy in decision making.

- *Generation of conflicting loyalty and commitment.* Even in organizational networks, the key links are among

Putting Network Analysis to Work on Rural Chronic Disease

A team led by University of Arizona professor Keith Provan[a] explored the impact of community networks on management of chronic disease in a rural county of southern Arizona, using classic network analysis measures and self-assessment by participants.

This project, with support from a Turning Point grant funded by the W.K. Kellogg and Robert Wood Johnson Foundations, involved creation of a participatory coalition led by the Cochise County department of health to address issues of chronic disease. This group included stakeholders such as local politicians, law enforcement groups, faith-based organizations, and service providers. The work of the group was repeatedly evaluated during the two-year study, through data-collection efforts and participation in focus groups.

Results include a higher level of collaboration over an increased number of channels, including a near doubling in the number of nonredundant referrals and a broad perception (>90% of the 22 respondents) that collaboration had enhanced the agency's ability to serve its clients. At the same time, key issues for future network efforts were identified, including the need for strong leadership and continued funding.

[a]Provan, K. G., L. Nakama, M. A. Veazie, N. I. Teufel-Shone, and C. Huddleston. 2003. Building community capacity around chronic disease services through a collaborative interorganizational network. *Health Education and Behavior* 30 (6): 646–62.

individuals. These individuals are employed by, trained by, and socialized in one organization. Network involvement means going beyond the employing organization, in effect, becoming a multiorganizational participant. Often, however, loyalty and commitment to the organization are stronger than those to the network, even though organizational goals may best be accomplished through network collaboration. Some also may have internal conflicts, advocating network goals in their organization but encountering resistance from those who do not share this view. In general, having a narrow, organizational perspective can severely limit the achievements of a network.

- *Requirements for additional time and resources.* One of the main benefits of networks is that they can overcome deficiencies in systemwide resources. Nevertheless, they do require resources to become established and to operate. These resources may come from external sources, such as government agencies or foundations, or they may consist of contributions from network members. In either case, however, network members may feel that these resources could best be spent on their own organization and its clients. This problem is especially true considering the contribution of time required to participate in maintaining the network and its management. Directors of health and human service agencies generally embrace the network concept but not necessarily the time, effort, and money required to build and maintain an effective network. This is one of the reasons some effective organizations have invested in the creation of a "dedicated network alliance function" to nurture the network.
- *Need to manage collaboratively rather than hierarchically.* Traditional bureaucratic forms of control may not be widely accepted in most health and human service settings. However, organizational employees still work in hierarchical settings governed by rules, procedures, and the decisions of supervisors and top management. This mechanism is efficient and well understood. In contrast, networks are mostly not hierarchical. Some organizational members may clearly be more influential than others, and some networks are constructed around funding and/or regulatory relationships. Yet, members can always withdraw from the network, despite consequences. As a result, network decisions can be messy, time consuming, and often frustrating, especially to those accustomed to working in a hierarchy. Some networks are designed to only share information, which limits this problem. However, many others are designed to coordinate delivery of services and programs, requiring significant agreement from participants. Although network decisions need not be consensual, they do need to be based on trust and reciprocity if the network is to be successful over an extended period.

These shortcomings are very real and can limit the accomplishments of networks. Nonetheless, most health and human services professionals recognize the advantages of networks, at least generally, and they believe strongly in the value of the collaborative process. However, many of those involved in networks, especially network leaders, may have difficulty recognizing and demonstrating progress in building the network. In light of the potential problems mentioned here, it may be relatively easy to conclude that the potential of the network is not being fully realized. The apparent lack of progress and tangible outcomes can be frustrating, especially for those who played a leadership role in building the network and are strongly committed to its success.

One problem is that most health leaders do not feel equipped to take steps to examine

the quality and functioning of their network. This can best be accomplished through an objective and systematic process, but most network participants do not have the tools to do this. In addition, most tend to view the network from the perspective of the effect on their organization of network relationships. This view limits an objective understanding of the network as a whole. If collaborative efforts are to be effective, participants must look beyond their own needs, interests, and perspectives and consider how a multiorganizational network might be structured and governed to maximize its capacity to address critical health and human service problems.

In the academic and research literature of the past two decades, a great deal of knowledge about organizational networks has been generated.[3] Unfortunately, very little of this work has reached the world of health practice, except in a very general way.[37,38] Nonetheless, network analysis, as developed in the scholarly literature, can be used in a very applied way to help public and nonprofit organizations build and sustain networks across a broad range of health and human services, including control of tobacco use, chronic diseases such as diabetes and HIV/AIDS, obesity control, child and youth health, mental health, and substance abuse. Network analysis techniques offer four key benefits to these efforts:

1. They offer a global view, which helps participants understand the network and its components and how the network operates.
2. They help stakeholders to see exactly where their organization fits in the structure of the network, based not just on their own impressions but on the actual experiences of the other network participants.
3. They give managers access to data that they can use to shift priorities and resources to become more or less involved either in the network as a whole or with certain key organizations that may be critical to their own effectiveness and the effectiveness of the network as a whole.
4. They provide members of the network with the tools to visually navigate the network and seek out relevant partners to help them solve specific problems. In this way, network analysis techniques help people involved in tobacco control to learn more about "who knows what" and where to go to obtain needed information.

Application of Network Analysis

As described previously, network analysis is a method of collecting and analyzing data from multiple individuals or organizations that may be interacting with one another. Unlike more traditional methods, the unit of analysis is the relationship between organizations, not the organization itself. Network analysis allows for examination and comparison of the relationship between one organization and another (dyads), among clusters or cliques of three or more organizations, and among all the organizations that constitute the network as a whole. Depending on the type of data collected, it is possible to examine a range of issues across these organization groupings. Issues include the following:

- Overall level of involvement among organizations in the network
- Pattern or structure of involvement
- Number of other organizations to which any one organization is linked
- Specific organizations and types of organizations to which any organization is connected

- Types of interactions between organizations (e.g., client referrals, shared resources, and shared information)
- Organizational level of the relationship (e.g., administrative or service level)
- Extent to which network ties are narrow (e.g., relationship between two individuals) or broad (e.g., relationships among multiple individuals in each organization)
- Extent or strength of each relationship (e.g., through referrals only or referrals and shared resources)
- Level of trust each organization has in its dealings with every other organization
- Perceived benefits and drawbacks of network involvement

Because network analysis focuses on relationships across and among all network members, once collected, data generally are displayed and analyzed by using a matrix reflecting each organization's links with every other organization in the network. Typically, data are collected from every network member (e.g., agency head or program director) by using questionnaires or structured interviews. The next section presents details about network data-collection methods focused specifically on tobacco control. Monge and Contractor[20] provide a more comprehensive description of techniques for measurement of communication networks.

Once network data are collected and analyzed, this information can be used in a variety of ways to assist leaders in understanding the structure and condition of the network and to facilitate strategic planning to strengthen the network. A recent publication of Provan and associates[39] offers a series of guidelines for this process. Their work forms the basis of a set of practical research questions that are developed at the end of this chapter to guide the study and use of network analysis in tobacco control.

Even though network analysis can be extremely helpful for building the "capacity" of a stakeholder community[40,41] to address its most critical health needs through enhanced collaboration, it is certainly not a panacea. Network analysis is useful to demonstrate connections and relationships among agencies, reflecting the structure of the network. However, structure alone provides only a partial understanding of the reason(s) a network may or may not be effective. Networks having few and/or weak ties based on low trust are unlikely to be effective. Having many structural ties does not, in itself, guarantee the success of the network. Network goals must still be clearly established and collectively addressed, and effective network leadership is critical to the process.

Use of Network Methods for Tobacco Control

Once the applicability and value of network analysis are established for critical issues in health care, particularly within a tobacco control context, the question becomes one of defining the key issues in conducting a network study. What information should be collected? How should data be collected? What might be the results of data analysis? This section addresses these questions, focusing specifically on networks in tobacco control.

The discussion is guided by knowledge of two emerging but very different networks in tobacco control—the North American Quitline Consortium and the Global Tobacco Research Network (GTRN).

- *North American Quitline Consortium.* On February 3, 2004, the U.S. Secretary of Health and Human Services announced a plan to establish a nationwide toll-free

telephone number (1-800-QUIT NOW) that will serve as a single access point to a national network of "quitlines" (hotlines for obtaining help to stop smoking). At the time of the announcement, 38 states had independent quitlines to deliver information, advice, support, and referrals to smokers or their surrogates. Telephone counselors at the Cancer Information Service, National Cancer Institute (NCI), were charged with providing assistance to individuals in states with no quitlines until those states could develop their own systems. The launch of the nationwide access number triggered a need for closer collaboration among the previously independent state-sponsored quitlines, which used different technologies, offered different services, and received funding and technical support from different sources. Working toward a national capacity to deliver quitline services will require collaboration among state and provincial health departments, quitline vendors, researchers, and national organizations.

- *Global Tobacco Research Network.* GTRN was started with the goal of enhancing research by promoting collaboration and partnerships, providing information, facilitating training, and sharing research tools among investigators around the world. The network is being developed around three core concepts: global network consolidation, global knowledge management, and global knowledge sharing. It aims to consolidate the weakly interlinked multisector community of researchers and institutions involved in the broad spectrum of research addressing the determinants, consequences, and control of tobacco production; promotion and consumption of tobacco products; and exposure to tobacco smoke. The NCI-funded initiative is timely, because of the need to implement the World Health Organization-sponsored Framework Convention on Tobacco Control, a framework for consistent global tobacco control policy and legislation.

Information Needed for Network Analyses

Network studies must address certain fundamental questions about the type of information to be collected—Who? What? How? Where? When? The question of "who?" is probably the most basic. It refers to which organizations, groups, or individuals are involved or should be involved in the network for provision of tobacco control services. These are the *nodes* of the network. The nodes may vary from network to network (e.g., from one state to another). Therefore, a key first step is to determine who is and who should be involved in the network being studied. For example, in the Quitline network, relevant organizations might include the following:

- Tobacco control advocacy groups
- Research groups (e.g., government agencies, universities, nonprofit organizations, and drug firms)
- Sources of funding (e.g., governments and foundations)
- Agencies and groups disseminating information
- Providers of technical services (e.g., state and provincial health departments)
- Providers of treatment services
- Health insurers and health maintenance organizations
- Mental health agencies and institutions treating substance abuse

The list may seem daunting at first. A critical problem in network analysis research has been to determine who qualifies to be included in the network (i.e., the problem of "network bounding"). Most network researchers prefer to cast a

Global Network for Tobacco Control

Far too often, "silos" of information and knowledge in tobacco control exist within the borders of countries and organizations. To address this problem, the Global Tobacco Research Network (GTRN)[a] has evolved as a Web-based portal for linkage and knowledge sharing in the international tobacco control community. Current features include the following:

- Contact directories, opportunities, and event calendars related to global tobacco control
- Access to country profiles and industry documents
- Research resources ranging from youth programs to epidemiology, including both source materials and presentations
- A searchable database of tobacco control literature
- Employment and learning opportunities
- An ambitious Tobacco Atlas of statistics and information
- A Research Assistance Matching project linking researchers in developing countries with appropriate experts in the network

GTRN is administered by the Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland, with a technology infrastructure provided by GLOBALink. GTRN itself operates in a network environment, through the governance of a steering committee. Members include NCI, the American Cancer Society, and tobacco control research and advocacy organizations.

[a]Global Tobacco Research Network. 2006. Web site. http://www.tobaccoresearch.net.

relatively wide net initially—for example, including all organizations that might be involved in tobacco control in a particular state or region in a state quitline network. Once data collection begins, many of these organizations may "self-select" out of the process, informing researchers that they have little or no involvement in tobacco control efforts. In addition, the actual analysis of the network data ultimately collected determines which organizations are central, which are peripheral, and which are not involved at all.

On the other hand, researchers conducting a network study must be adequately informed *before* data are collected so that all relevant organizations are included. Decisions on which organizations to include and which to exclude from the study often are based on a procedure known as reputational "snowball" sampling. In this procedure, people who are known to be centrally involved in the network are asked to identify organizations and individuals active in tobacco control in a particular community, state, or region or in a certain domain of policy or research. This process is continued with other key informants until no new names are generated.

The second question for network data collection is "what?" This question involves more deeply examining the services offered by each of the types of organizations identified here as relevant to quitlines. These services are in a broad range of areas including but not limited to education, language (e.g., translation), referral, clinical treatment, funding, counseling, research, pharmacy, policy and advocacy, training and technical assistance, and outreach. These areas also may include categories that focus on target communities to which these services are offered—for example, low-income children in minority groups and older single women.

In their work in mental health, Provan and Milward[12] identify the concept of a

"service implementation network," which is highly relevant here. This concept refers to involvement of parts of an organization, rather than the entire organization, in a program effort. In tobacco control, the organizations identified by answering the question "who?" may be only partially involved in tobacco control, through a single service, or they may provide multiple tobacco control services. In either case, to understand fully how the network is structured and operates, it is essential to collect data on services, not just data on organizations.

This concept helps to provide a better understanding of the importance of the "what?" question. In most states or cities, for example, a public health department manages many programs, including but certainly not limited to tobacco control. Thus, the connection of a public health department to 10 other agencies has relevance to tobacco control only if the connection is based on tobacco control services and activities. Furthermore, it is critical to know whether the department is involved in only one aspect of tobacco control efforts or in multiple aspects. Thus, to know that a public health department is a node in a state quitline network may be interesting, but only a more thorough understanding of the network reveals its value to tobacco control efforts. Some examples are presented here.

- The public health department in one state may be linked to other organizations in the quitline network through funding, treatment, referrals, and technical support. In contrast, in another state, the department may be linked to the same number of other quitline network organizations, but solely through the technical support it provides. This difference in level of involvement may be critical for explaining why the first network is effective and the second is struggling.
- By obtaining a full range of specific types of tobacco control services, it is possible to tell, for example, how certain types of services and activities are clustered in the network, if certain types of services and activities are underrepresented or are being duplicated, and which other organizations' network members might seek to acquire needed advice, expertise, and treatment for clients.
- In the case of GTRN, knowledge of which organizations are involved in the network and the types of information that are differentially exchanged would help to reveal the pattern of knowledge transfer among different types of members (e.g., health agencies and research centers) and whether such patterns differ across geographic regions.

The third question for network data collection is "how?" This question refers to the type and frequency of network relationships. These may be either formal or informal and ongoing or intermittent. Formal relationships are specifically constructed with a strategic purpose in mind. Examples are joint programs, funding contracts, and memoranda of agreement. Most of these relationships are established by organizational directors and administrators, and they tend to be governed by enforceable contracts and/or operating guidelines.

Such relationships may be highly cooperative and may be used to solidify the ties between two or more organizations. On the other hand, the relationship may be somewhat distant (at arm's length) and may involve considerable monitoring. The formal relationships described here are mostly ongoing, because they typically establish the framework for a relationship that occurs regularly over an extended period. More intermittent formal relationships might include meetings among network members. Such meetings would be formalized to ensure that network

members have a specific opportunity to share ideas, concerns, or issues with each other. However, such meetings generally would occur only occasionally, particularly when difficulties are involved in bringing all members together at one time or place.

Informal relationships also are common. They represent the real "glue" that holds any network together. Ring and Van de Ven[42] discuss the relationship between formal and informal aspects of interorganizational relationships. If network members are bound together only through formal mechanisms, they frequently do not develop the trust that enables a network to operate effectively as a network, as opposed to a loose collection of organizations with a more or less common goal. Informal relationships also can be ongoing or intermittent. However, like any social relationship, the less frequently the tie is used, the more likely the relationship is to dissolve.

The most common type of informal relationship is likely to be shared information. Information can be shared through channels such as e-mail, telephone calls, and personal meetings. Many of these activities may initially be based on friendship. Yet, when people try to construct a viable network to improve health outcomes, the evolution of informal ties can be encouraged through use of more formal mechanisms such as electronic mailing lists and conferences. GTRN provides a good example of how ties based on informal information sharing can be encouraged and formalized to establish a mechanism for building global understanding of research on tobacco control. The mechanism itself has been formalized. However, the flow of information on research and policy is informal, based on the needs, interests, and expertise of the network members operating in many different countries throughout the world.

In the area of services delivery, an important additional source of informal relationships is client referrals. Referrals typically are based on an informal understanding among organizations that clients/patients can be served most effectively through the efforts of multiple, interconnected providers. In tobacco control, this might mean that a patient enters the system through a quitline but is referred to several other agencies for services such as treatment, counseling, or education. Each agency involved is part of a knowledge network and therefore has a more or less accurate understanding of the expertise and capacities of the other organizations in the network. Each agency refers patients accordingly, on a trust-based assumption that other agencies in the knowledge network will do their part to help the patients.

The fourth question is "where?" This question refers to the location of the levels of involvement that constitute a network. Essentially, networks can form either vertically or horizontally, and often both forms are involved. Vertical networks might include relationships between organizations operating at the community level and those operating at the state or provincial level. They could also include the interactions between state and national organizations or between community and national organizations. Vertical networks are frequently formal, involving ties between funding sources and recipients, technical service ties, and connections between policy formulation and implementation.

Horizontal relationships are network ties that occur within a community, state, province, or nation, or internationally, as is the case with GTRN. Horizontal relationships can be formal or informal. Informal, trust-based ties usually make up a large part of most successful horizontal networks. At the same time, however, the network could have a formalized governance structure, designed to facilitate network collaboration and interactions, attract funding, and act to resolve conflicts. Horizontal relationships are most common

when organizations recognize the need to cooperate to achieve common goals and interests. However, the services and activities they perform are complementary, rather than competitive.

The fifth and final question is "when?" The vast majority of research on networks is cross-sectional, focusing only on data collected at one point in time. However, networks are constantly evolving as new organizations enter and old ones leave and as network members change their partners and mode of interaction. The theorizing[42,43] and limited longitudinal research on network evolution clearly point to differences in the ways in which relationships develop.[44] Identifiable stages of evolution are even suggested, from initial formation and early growth, through maturity, to sustainability or ultimate demise.[31] When data are collected from multiple networks, caution must be exercised so comparisons are made only across networks at relatively similar stages of development. In addition, network data collected at one point in time should be interpreted with the knowledge that conclusions drawn may be unique to that particular stage of network evolution.

To summarize, in studies of networks in tobacco control, five types of data are needed for full understanding of network structure and processes.

- "Who?"—Which organizations are and should be involved in the network?
- "What?"—What specific services and activities are exchanged by each network member?
- "How?"—How are relationships among network members constructed (i.e., what types of ties)? How frequently do these relationships occur?
- "Where?"—Where do the relationships among network members occur? Do these relationships involve vertical and/or horizontal ties?
- "When?"—When do different kinds of network relationships develop? How do they change over time?

Conducting Research on Tobacco Control Networks

Despite the lack of previous research on tobacco control networks, the case made thus far is that networks offer valuable mechanisms for building the strength of the tobacco control system at multiple levels (i.e., community, regional, national, and international). However, to maximize the impact and benefit of networks, one must fully understand them both conceptually and analytically. Thus, network analysis can be a powerful and important tool for strengthening tobacco control efforts. The previous section discusses types of information needed to conduct such an analysis. Details of data collection are presented here. Again, discussion of methods focuses on the quitline networks and GTRN.

The quantitative analysis of organizational networks is not more common in health care in general and in tobacco control in particular for two reasons. First, most social scientists are trained in traditional data-collection methods, especially random sampling and data analysis with use of inferential statistics. These methods generally are not appropriate for network analysis, although more and more researchers have become familiar with network methods in recent years. Second, network analysis is not more common because the research can be costly and time consuming. This is true especially if data are collected over multiple periods, across multiple networks, and using both quantitative and qualitative methods. This sort of research is critical for advancing knowledge about the operation and

evolution of networks, and it can contribute to the solution of complex health problems. Typically, little or no data are available from secondary sources on relationships between and among organizations involved in a network, except perhaps through formal ties such as contracts. As a result, most network data must be collected from primary sources. Longitudinal data collection performed across multiple networks requires large-scale grant funding from federal agencies or private foundations.

In view of the importance and prevalence of networks in most areas of health, the time has come to apply what is known about both the theory and methods of networks to help strengthen tobacco control efforts. To that end, a number of sequential steps can be followed to collect the data described in the previous section. The approach used by Provan and colleagues[14,31,45,46] in multiple network studies is outlined here, but it can be adapted for use in a variety of settings. Presentation of this comprehensive approach is followed by several more streamlined alternatives that can be used if time and cost considerations are paramount.

- Select the network(s) that will be the focus of investigation (e.g., quitline networks, GTRN, or national networks for tobacco control policy).
- Ascertain whether the study focus will be a single network (i.e., the quitline network or GTRN) or comparison of multiple networks with similar focus—that is, a study examining and comparing networks of researchers in each of the Transdisciplinary Tobacco Use Research Centers, based at eight major universities across the United States.
- Talk with key network leaders to build an initial understanding of what the network is doing, which organizations are involved, and at which levels (e.g., community, regional, or national; see "where?" question in previous section).
- Try to determine the types of involvement critical to the network (see "what?" question)—for example, patterns of information sharing or research capacity in GTRN or referrals, contracts, shared information, or technical support for quitline networks. The "how?" question also may be addressed at this point, especially to limit the types of involvement to be studied—for example, deciding not to consider intermittent referrals.
- Develop an inclusive list of network organizations that use "reputational" sampling techniques (see "who?" question). Reputational sampling[19,47] is an iterative process relying on cumulative knowledge of network participants about who is involved in the network. The procedure starts with questioning those who are presumed to be the most central network members and then moving outward, depending on who is named.
- Determine (e.g., through telephone calls) the key individuals at each organization who are most likely to be knowledgeable about the network activities and involvement of their organization. Decide whether only one or several of these "key informants" should provide data on the network involvement of their organization. Because individuals in the same organization, especially a large organization with diverse services, often interact with outside organizations, responses of multiple informants about network involvement should be aggregated to form a single organizational response. Some of these key informants may have helped to define the network initially (i.e., the "who?" question). However, in the absence of objective data on which organizations are included in the network (e.g., an official membership list) or on specific network activities and ties, some cross-contamination is likely to be unavoidable.

- Develop broad cooperation and support from network participants for conducting the network analysis. If possible, make one or more presentations to the members of each network studied, demonstrating the type of data to be collected; how data will be collected; what is expected of them as respondents; how results will be reported to them;[39] and how the findings might be used to strengthen tobacco control efforts for their organization, their network, and other tobacco control networks.
- To achieve the best response rate, obtain one or more letters of support/endorsement of the study from the most important and/or influential network members, especially from key funding agencies such as NCI or the Centers for Disease Control and Prevention (CDC).
- Create a survey instrument that addresses who, what, how, and where and that provides sufficient information to develop a comprehensive understanding of the network (see list in previous section on "Application of Network Analysis"). One member of the Initiative on the Study and Implementation of Systems (ISIS) team[14] recently used this questionnaire in a study of a broad-based community coalition addressing chronic disease prevention and treatment. The organizations in the network are listed on the survey, so that every organization responds to an identical and complete list of network participants. Additional questions can and should be added to obtain specific data on individual organizations and respondents. Such data might include organizational funding, involvement with tobacco control relative to other health issues, types of services offered, and perceptual indicators of network effectiveness.
- Send the survey by mail or e-mail, along with letters of support and a cover letter explaining the project, to all network organizations and potential respondents. The survey can be Web based or handwritten. If it is mailed, include a postage-paid return envelope.
- One week after mailing, follow up with a telephone call to each respondent and discuss receipt of the survey and any questions about completion. Continue follow-up by telephone call and/or e-mail weekly or every other week, until further efforts seem fruitless. Aim for approximately 80%–90% response. Dillman[48] reviews effective general survey methods using both mail and telephone.
- Depending on the number of networks studied, the size of each network, and budget constraints, visit each site shortly after the survey is mailed and interview as many network members as possible, especially those who are most heavily involved. If the survey form has not been completed, go through the questionnaire during the interview to maximize the response rate and discuss in-depth perceptions and attitudes about network involvement to help provide a rich contextual understanding of the operation and evolution of the network and its goals.
- Obtain all key available secondary data relevant to the study, including contextual data such as differences in tobacco use and tobacco control funding across networks, if multiple networks are being compared. Ideally, multiple outcome indicators also would be available for comparison with network-level measures over time.
- Code, analyze, and interpret all network data. Decide whether to use symmetrical and confirmed network data, symmetrical and unconfirmed network data, or both for the analysis. Unconfirmed data are the raw survey results for network involvement, based on the reports from each organization in the network. Confirmed data, validated against parties listed in the survey

responses, are considered to be far more reliable if the goal of the research is to establish the existence of links in the absence of objective data. In the absence of symmetry and confirmation, unconfirmed data can be used. These data can provide potentially valuable information on "weak tie" relationships.[49] In addition, asymmetrical ties may be desired to reflect certain types of links, such as when trying to determine reputation or network influence (i.e., who lists whom as most influential).

- Report baseline network findings within each network studied and across multiple networks to network participants and key officials involved in tobacco control policy.
- Repeat the data-collection process after about 12–18 months and/or after a significant event that might alter network activities and structure in major ways (see "when?" question). Data should be collected at least twice and preferably three times to enable thorough understanding and explanation of network evolution and progress. Code, analyze, and interpret the results from all data-collection efforts, and compare findings within and across networks over time. Compare network data with tobacco control outcomes.

As noted previously, this data-collection method is extremely thorough and will provide an in-depth understanding of network structures and processes in tobacco control. Conducting this sort of data collection is highly recommended, but budget and time constraints may limit what is possible. To accommodate these constraints, the approach can be streamlined in several ways. Several alternatives to the full-blown data-collection effort are listed below.

- Use a limited procedure for reputational sampling. Identification of most network organizations can usually be obtained from a subgroup of the members of the full network, especially those who are most heavily involved in and most knowledgeable about the network. Caution should be exercised here, however, because this approach tends to underidentify network members who are not well connected.
- Conduct a partial network analysis by focusing only on a limited set of organizations that most informants believe to be the key network members. This approach might involve collecting data from 20–25 organizations versus 50–75 or more in the full network. Connections among the subsets of network agencies can be confirmed because they would report their links to one another. Connections to the larger network could still be reported, but these links would not be confirmed, providing a somewhat less reliable picture of the full network.
- Collect data from a small number of networks. This approach limits generalizability but can still produce valuable information on network "best practices" if the networks studied are carefully selected. For example, two or three quitline networks in states with well-established programs could be compared with two or three quitline networks in other states in which the program is just getting started. Another option is to study GTRN in two or three regions, comparing network structures and patterns of involvement.
- Limit the number of types of network involvement to only the two or three most important ones (e.g., resource sharing, information sharing, and referrals).
- Collect data on network involvement only from a single key informant at each organization, rather than using multiple informants. Single informants can be asked to check with other organizational members to ensure that survey

responses reflect the *organization's* network and not just the respondent's network.

- Do not conduct interviews with network members. Limit network visits to one or two before data collection and one visit later to present and discuss findings. Substitute on-site interviews of most network members with telephone interviews as part of the survey follow-up process. Use of limited interviews is especially appropriate when multiple networks are compared or when network members are scattered geographically across a wide area, as with GTRN.
- Examine network evolution across two time periods only (instead of three or more), and conduct data collection at two-year intervals.

The information collected from either of these approaches can be used to develop an exercise for mapping network assets for the development, deployment, analysis, redesign, and simulation of networks.

Case Study of Network Analysis in Tobacco Control Evaluation

As a case study of network analysis in tobacco control, a project headed by Doug Luke of Saint Louis University, Missouri, is examined here. The project, performed in 2004, shows how the technique can be used as part of the process evaluation of tobacco control programs. Evaluation of the tobacco control process typically focuses on "counting" activities. Program evaluation includes determination of factors such as the amount of funding, numbers and types of prevention activities, and the number of countermarketing advertisement spots aired. This type of evaluation of local and state tobacco control programs ignores the complexity of the systems of agencies, organizations, and people who coordinate activities to achieve a common goal of reducing the health burden of smoking and tobacco use.

A state comprehensive tobacco control program typically consists of a lead agency directing tobacco control funds to a series of state and local contractees. The lead agency also coordinates activities with voluntary agencies such as the American Cancer Society (ACS) and the American Lung Association (ALA). State and local coalitions provide guidance and outreach. Finally, a state program may include other types of partners, including public relations firms, local law enforcement agencies, or state attorney general offices. Network analysis is an analytic tool that is particularly appropriate for evaluating state tobacco control programs by using this type of systems perspective. The purpose of this case study is to show how network analysis is being used in an ongoing multistate project to evaluate tobacco control programs.

Collection of Network Data from State Tobacco Control Programs

The network analysis data reported here came from two large-scale multistate projects to evaluate tobacco control programs. These projects were conducted by the Center for Tobacco Policy Research, Saint Louis University School of Public Health,[50] and were funded by the American Legacy Foundation and the Chronic Disease Directors Association. The primary goals of these process evaluation studies were to assess (1) the implementation of CDC guidelines for *Best Practices for Comprehensive Tobacco Control Programs*[51] by state tobacco control programs, and (2) changes in state programs in response to massive cuts in funding.

The network analysis data were collected to facilitate understanding of the

ISIS Examines Its Own Network

To bring home the concepts of network analysis for ISIS members, a short proof-of-concept exercise was performed before a summit meeting in the Washington, DC, area in January 2004.

A questionnaire was designed and distributed to the meeting participants, who represented government agencies such as NCI and CDC, tobacco control research and advocacy organizations, and academic institutions. Each stakeholder was asked eight questions. The questions included requests for identification of their greatest needs and desired future interactions and other organizations with which they had financial, professional, or networking interactions.

Network involvement was analyzed based on these responses by using the Inquiring Knowledge Networks On the Web system from the University of Illinois at Urbana-Champaign. This system is a Web-based environment for conducting network analyses. Network results were illustrated graphically by using a series of network plots reflecting which organizations were linked and the ways in which they were linked. (See network on facing page.)

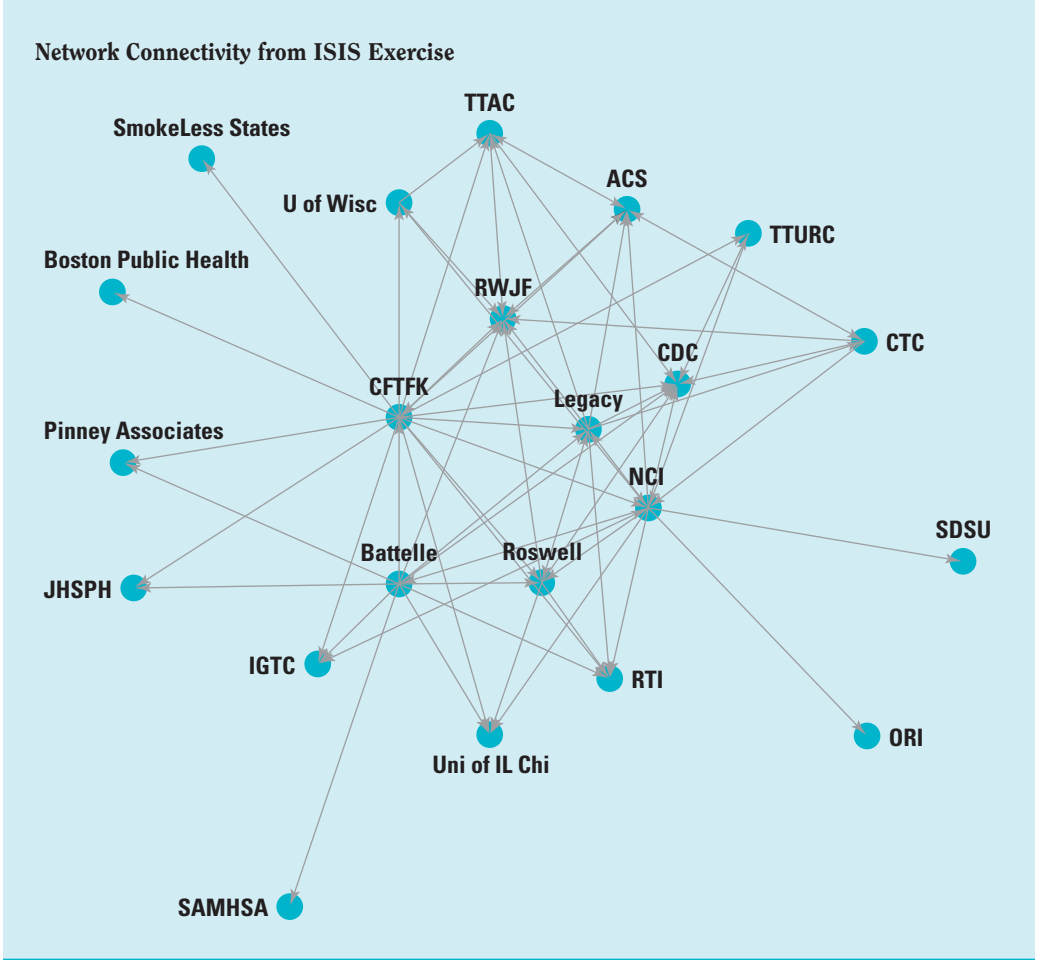
Within a very small nonrepresentative sample, this exercise nonetheless provided the ISIS stakeholders with a good overview of many of the network concepts discussed in this chapter, including centrality, cliques, and referral networks. More important, it served as a catalyst for productive dialogue between experts in networks and other disciplines, with an eye toward integrating network methods as part of a broader systems approach to tobacco control.

Note. TTAC = Tobacco Technical Assistance Consortium; U of Wisc = University of Wisconsin; ACS = American Cancer Society; TTURC = Transdisciplinary Tobacco Use Research Center; RWJF = Robert Wood Johnson Foundation; CTC = Center for Tobacco Cessation; CDC = Centers for Disease Control and Prevention; CFTFK = Campaign for Tobacco-Free Kids; Legacy = American Legacy Foundation; NCI = National Cancer Institute; SDSU = San Diego State University; JHSPH = Johns Hopkins School of Public Health; IGTC = Institute for Global Tobacco Control; RTI = Research Triangle Institute International; Uni of IL Chi = University of Illinois at Chicago; ORI = Oregon Research Institute; SAMHSA = Substance Abuse and Mental Health Services Administration.

structure of these complex state tobacco control programs, to identify other state characteristics related to program structure, and to determine whether changes in program funding and political support are associated with changes in program structure. The network analysis had three phases: network delineation, network data collection, and network analysis.

As discussed here, network delineation is the process of defining and identifying the network. In this case, the manager of the state tobacco control program was asked to identify every agency partner that played a critical role in planning and implementing the state tobacco control program. A modified snowball sampling approach was used to complete the list of program partners by contacting members on the initial list and asking whether any important partners had been omitted from the list. For the states evaluated in 2002, the tobacco control networks typically ranged from 14 to 17 partners. In addition to the lead agency (usually the state health department), the other commonly observed types of program partners included regional coalitions (in all 10 states), statewide coalitions (9 of 10 states), contractees (10 states), ACS (10 states), ALA (7 states), and the American Heart Association (6 states).

Once the network for each state was defined, an expert informant from each network partner agency was asked to participate in the study. In the network analysis, four primary pieces of relational network information were collected: (1) funding relationships among partners, (2) frequency



of contact, (3) degree of cooperation, and (4) perceived importance of network partners in achieving state tobacco control goals. The next section presents results from the question on frequency of contact.

Information Learned about Tobacco Control Program Networks

A primary purpose of the evaluation of state tobacco control programs was to explore the influence of state financial and political climates on the structure and processes of tobacco control programs. Financial and political climate ratings were produced for each state according to a number of criteria. States were seen as having a positive financial climate for tobacco control if they (1) were meeting CDC recommendations for the amount of money budgeted for tobacco control, (2) had relatively high levels of per capita spending on tobacco control, (3) had set a high excise tax on cigarettes, and (4) had not securitized funding from the Master Settlement Agreement. States were rated as having a positive political climate if they had (1) multiple tobacco control "champions" in positions of authority and influence, (2) support for tobacco control from the governor, (3) support for tobacco control from the legislature, and (4) a low tobacco industry presence in the state. The

ratings for political and financial climates were combined in a summary scale that could range from –9 to +9. Table 6.1 shows the ratings for the states evaluated in 2002. During this time, Indiana, Mississippi, and Hawaii had relatively positive climates for tobacco control. However, Wyoming, Michigan, Oklahoma, and Missouri had more challenging environments.

To determine whether political or financial climate was related to network structure, the contact networks for each state were examined. The contact networks for Indiana and Mississippi, two states with relatively positive climates, are shown in figure 6.1. A link connects two partners if they have contact with each other at least once per month. Contact is defined broadly and includes face-to-face meetings, telephone conversations, and e-mail. Examination of this network reveals which partners are more centrally located in the contact network and which are more peripheral. For example, the Indiana Tobacco Prevention and Cessation Agency (ITPC) is the lead agency for Indiana, and it has frequent contact with all 14 other network members. Boys and Girls Clubs (B&G Clubs), on the other hand, meets only monthly with three of the network members. Thus, ITPC plays a more central role in the communication network in the Indiana tobacco control program. This result can be measured more formally by calculating Freeman's betweenness centrality—the measure of how often a particular network member lies "in between" any two other network members, linking members who are not directly connected.[52]

A high score for betweenness centrality indicates a node that is central in a network and can be considered to be a gatekeeper or controller of information. In the network figures here, nodes with the highest scores for betweenness are colored purple and nodes with the lowest scores are colored yellow. For both Indiana and Mississippi, the agency with the greatest centrality is the lead agency for the state tobacco program.

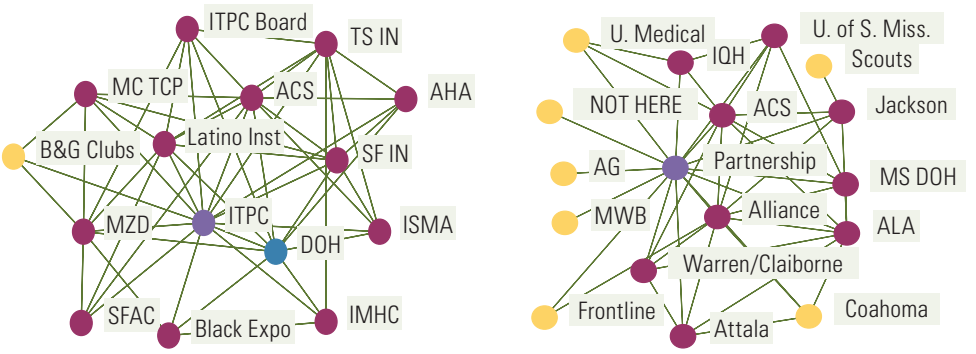
Finally, the centrality for an entire network can be assessed with the centralization index. This index is calculated by summing the differences between all centrality scores and the maximum centrality score. The scores for Indiana and Mississippi are both higher than 20%. This finding indicates a moderate amount of communication hierarchy—that is, both networks have a few highly central nodes and many peripheral nodes.

The contact networks for Michigan and Oklahoma, two states with much poorer

Table 6.1 Ratings of Political and Financial Climates for 10 States in 2002

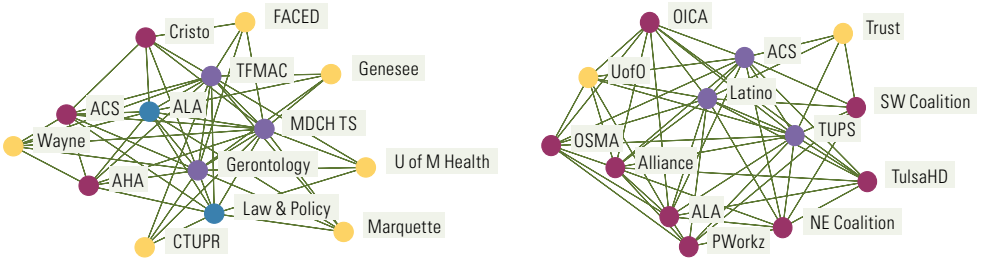
State	Political support	Financial support	Total score
Indiana	Very strong	Strong	+5
Mississippi	Very strong	Strong	+4
Hawaii	Strong	Very Strong	+4
Pennsylvania	Moderate	Strong	+2
Washington	Strong	Moderate	0
New York	Moderate	Moderate	–1
Wyoming	Challenging	Strong	–3
Michigan	Challenging	Moderate	–3
Oklahoma	Challenging	Challenging	–5
Missouri	Challenging	Challenging	–9

Figure 6.1 Contact Networks for Two States with Strong Financial and Political Climates (Indiana, left; Mississippi, right)



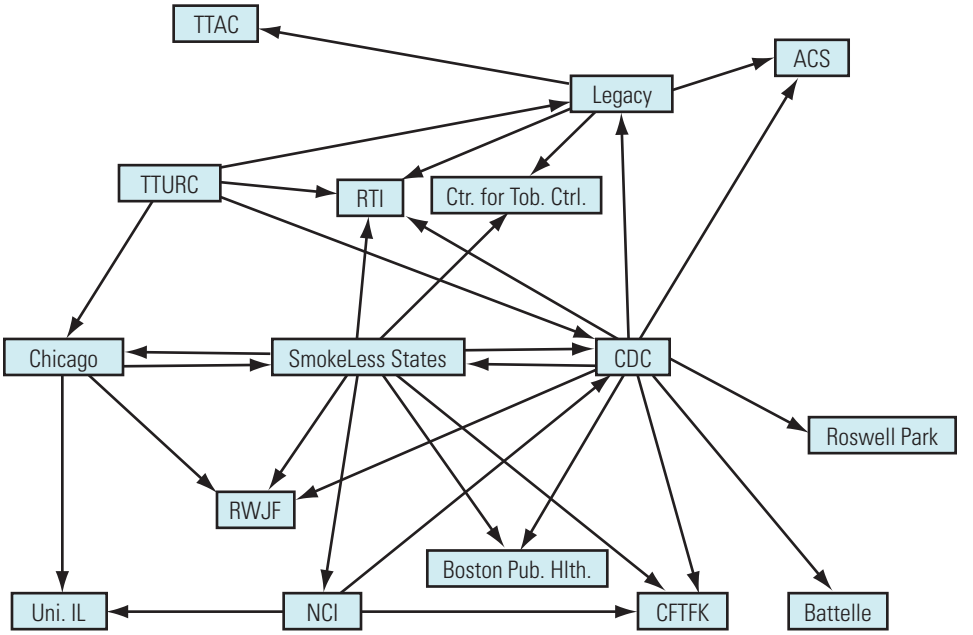
Notes. Indiana (left) had a centralization index of 22.7%, and Mississippi (right) had a centralization index of 20.5%. ITPC = Indiana Tobacco Prevention and Cessation Agency; TS IN = Tobacco Smart Indiana; MC TCP = Marion County Tobacco Control Program; ACS = American Cancer Society; AHA = American Heart Association; B&G Clubs = Indiana Alliance of Boys and Girls Clubs; Latino Inst = Indiana Latino Institute; SF IN = Smokefree Indiana; MZD = MZD Advertising; ISMA = Indiana State Medical Association; DOH = Indiana State Department of Health; SFAC = Smokefree Allen County; Black Expo = Indiana Black Expo; IMHC = Indiana Minority Health Coalition; U. Medical = University Medical Center; U. of S. Miss. = University of Southern Mississippi; IQH = Information and Quality Healthcare; Scouts = Girl Scouts of Gulf Pines; Jackson = Partnership for a Healthy Jackson County; AG = Attorney General's Office; Partnership = Partnership for a Healthy Mississippi; MS DOH = Mississippi State Department of Health; MWB = Maris, West & Baker; Alliance = Mississippi SmokeLess States Alliance; ALA = American Lung Association; Warren/Claiborne = Partnership for a Healthy Warren/Claiborne Counties; Frontline = Frontline State Board; Coahoma = Partnership for a Healthy Coahoma; Attala = Partnership for a Healthy Attala.

Figure 6.2 Contact Networks for Two States with Weak Financial and Political Climates (Michigan, left; Oklahoma, right)



Notes. Michigan (left) had a centralization index of 10.4%, and Oklahoma (right) had a centralization index of 6.6%. FACED = Faith Access to Community Economic Development Corporation; Cristo = Cristo Rey Community Center; TFMAC = Tobacco Free Michigan Action Coalition; Genesee = Genesee County Smokefree Multi-Agency Resource Team; ACS = American Cancer Society; ALA = American Lung Association; MDCH TS = Michigan Department of Community Health, Tobacco Section; Wayne = Wayne County Smoking and Tobacco Intervention Coalition; Gerontology = Center for Social Gerontology; U of M Health = University of Michigan Health System; AHA = American Heart Association; Law & Policy = Tobacco Control Law & Policy Consulting; Marquette = Marquette County Tobacco-Free Coalition; CTUPR = Center for Tobacco Use Prevention and Research; OICA = Oklahoma Institute for Child Advocacy; Trust = Tobacco Settlement Endowment Trust; UofO = University of Oklahoma Health Sciences Center; Latino = Latino Agency; SW Coalition = Southwest Tobacco Free Oklahoma Coalition; TUPS = Oklahoma State Department of Health Tobacco Use Prevention Service; OSMA = Oklahoma State Medical Association; Alliance = Oklahoma Alliance on Health or Tobacco; TulsaHD = Tulsa City-County Health Department; NE Coalition = Northeast Tobacco Free Oklahoma Coalition; PWorkz = PreventionWorkz.

Figure 6.3 Role of Informal Interactions in Referral Patterns



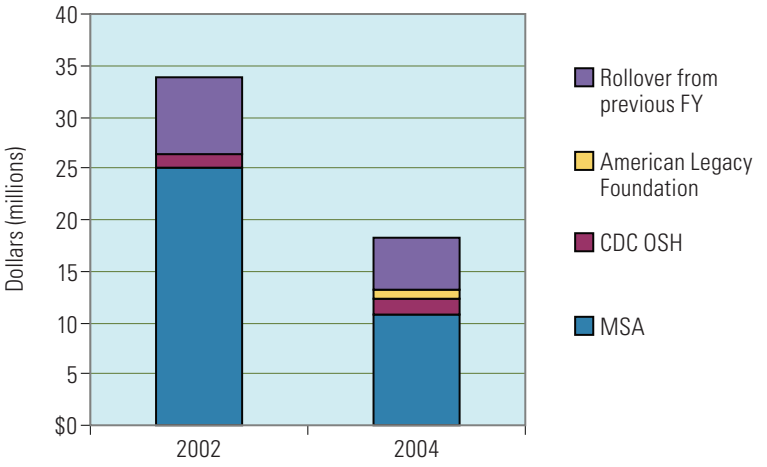
Notes. TTAC = Tobacco Technical Assistance Consortium; ACS = American Cancer Society; Legacy = American Legacy Foundation; TTURC = Transdisciplinary Tobacco Use Research Center; RTI = Research Triangle Institute International; Ctr. for Tob. Ctrl. = Center for Tobacco Control; CDC = Centers for Disease Control and Prevention; RWJF = Robert Wood Johnson Foundation; Boston Pub. Hlth. = Boston Public Health; Uni. IL = University of Illinois; NCI = National Cancer Institute; CFTFK = Campaign for Tobacco-Free Kids.

climates for tobacco control, are shown in figure 6.2. One difference between these two networks is that instead of having only one highly central agency, each state has three central agencies, again indicated by purple nodes. For example, in Oklahoma, the Latino Agencies (Latino) and ACS join the lead agency, the Tobacco Use Prevention Service (TUPS), and are collectively the most central nodes in the state network. The low network centralization indices (10.4% for Michigan and 6.6% for Oklahoma) also show that these networks have a much more active communication structure than was seen for Indiana and Mississippi.

The preliminary interpretation of these patterns is the presence of a relationship between financial and political climates and structures for communication about tobacco control. The hypothesis is that lead agencies in states with positive financial and political climates have the financial and political resources that allow them to take a strong leadership role in the tobacco control program. Conversely, in states that have poor climates, lead agencies no longer have these resources, and thus no longer are the most central agencies in the programs. In fact, a process of network adaptation may be in effect. When funds and support are scarce, tobacco control agencies may reconfigure their relationships to ensure sustainability of the program. In a sense, they may be "sharing the load" when times are tough.

This relationship is apparent for all 10 states, as evidenced by a fitted linear regression line and a smoothed local regression curve (locally weighted scatterplot smoother) (figure 6.3).[53] In addition, the relationship between the financial and political climates

Figure 6.4 Change in Tobacco Control Program Funding for Indiana from 2002 to 2004



Notes. FY = fiscal year; CDC OSH = Centers for Disease Control and Prevention, Office on Smoking and Health; MSA = Master Settlement Agreement.

for tobacco control and the communication structure is moderately positive. The more positive the climate, the more hierarchical is the communication network (r = .32).

Because of the small number of states considered in the calculations, these interpretations must necessarily be tentative. However, a second phase of the state evaluation project allowed longitudinal examination of this hypothesis. In 2004, eight state tobacco control programs were evaluated, including a return visit to Indiana. Between the two evaluation periods, there was major upheaval in the Indiana program. The tobacco control program lost approximately one-half of its funding (figure 6.4). In addition, the state had a new governor who was perceived as being much less supportive of tobacco control (figure 6.5). Consequently, Indiana had a much more challenging financial and political climate for tobacco control in 2004 than it had in previous years. The communication networks for both 2002 and 2004 are shown in figure 6.6. The tobacco control network is the same size in 2004, but it has a very different structure. The centralization index is much lower (decrease from 23% to 13%). This finding indicates a communication structure that is more active. At the same time, the density has increased from 49% to 59%. Density is the proportion of observed ties to possible ties. The higher density indicates that more of the agency partners talked to each other directly in 2004. Thus, there has been a shift in Indiana—as the climate worsened, the network apparently adapted by "flattening" the communication structure and increasing the amount of direct contact. This change over time is consistent with the hypothesis that state climates influence structures of the state tobacco control program.

Network Research Questions for Tobacco Control, Discovery, Diagnosis, and Design

The research described above provides an example of how network analysis can be conducted in a tobacco control context, but it is highly descriptive. Based on research like this, however, network leaders can use findings to help build and strengthen

Figure 6.5 Change in Perceived Political Support for Tobacco Control from Two Indiana Governors, Governor Frank O'Bannon (2002, left) and Governor Joseph Kernan (2004, right)

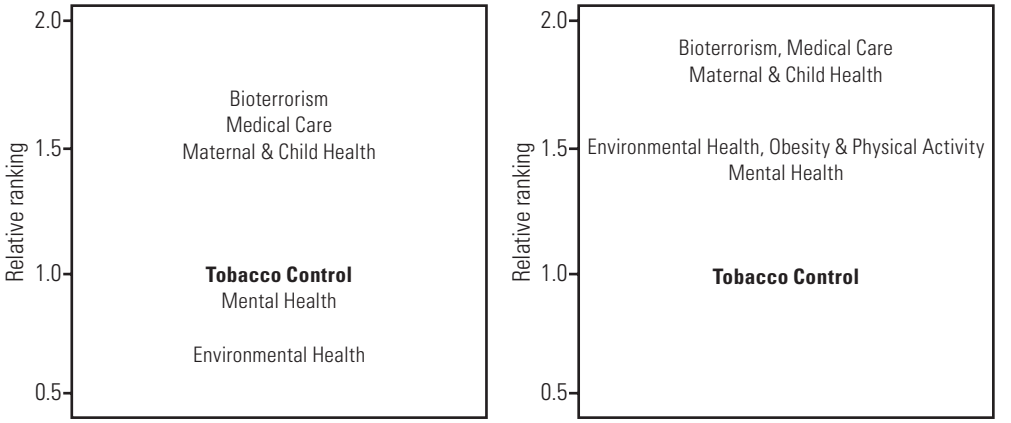
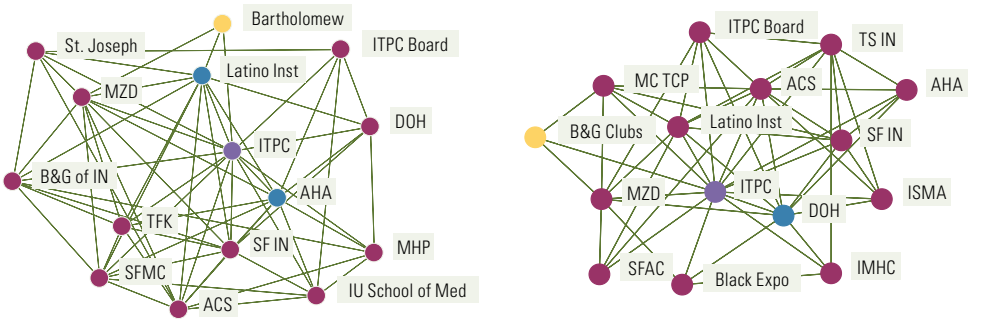


Figure 6.6 Change in Indiana's Tobacco Control Contact Network Structure from 2002 (left) to 2004 (right)



Size	15	Size	15
Density	.49	Density	.59
Centrality	.23	Centrality	.13

Notes. Bartholomew = Bartholomew County; St. Joseph = St. Joseph County; ITPC = Indiana Tobacco Prevention and Cessation; Latino Inst = Indiana Latino Institute; MZD = MZD Advertising; DOH = Indiana State Department of Health; B&G of IN = Indiana Alliance of Boys and Girls Clubs; AHA = American Heart Association; TFK = Tobacco Free Kids; SF IN = Smokefree Indiana; MHP = Madison Health Partners; SFMC = Smokefree Marion County; IU School of Med = Indiana University School of Medicine; ACS = American Cancer Society; TS IN = Tobacco Smart Indiana; MC TCP = Marion County Tobacco Control Program; ISMA = Indiana State Medical Association; SFAC = Smokefree Allen County; IMHC = Indiana Minority Health Coalition; Black Expo = Indiana Black Expo.

their network. Recent work by Provan and colleagues[39] was discussed earlier in this chapter. These researchers proposed a series of questions that might be asked by network leaders and participants to guide their efforts in translating network data into practice. In addition, Contractor and colleagues[54] at the "collaboratory" of Science of Networks in Communities at the University of Illinois at Urbana-Champaign have proposed an innovative, high-risk, high-payoff strategy for basic

network research and its transfer to the practice of enabling networks within various communities. They refer to it as the "3D"—discovery, diagnosis, and design—model.

Drawing on ideas from both groups of researchers, this chapter proposes a series of questions that can guide the development of research on tobacco control networks. In addition, the questions proposed have a very practical orientation, demonstrating how network leaders and policy officials might use network analysis in tobacco control. The questions are organized around the concepts of discovery, or learning about who is connected to whom; diagnosis, or analyzing network relationships; and design, which involves application of findings to build, maintain, and strengthen the network.

Discovery

The questions listed here are designed to help a community discover existing communication and knowledge networks. (If only the tobacco control network knew what the tobacco control network knows.) These questions focus on some ways in which network data collection can contribute to a deeper understanding of the structure of a tobacco control network. An important aspect of identification is to determine the capacity of network stakeholders to know "who knows what."

1. What specific organizations and/or individuals constitute a particular tobacco control network?
2. Are individual tobacco control stakeholders able to identify which organizations are included in the network and which are not?
3. Are there large differences between self-identification of network ties and the reports of others in the tobacco control network (i.e., unconfirmed versus confirmed ties)? Does everyone really know who is connected to whom and in what ways?
4. Are individual tobacco control stakeholders able to identify others in the tobacco control community who share specific interests and areas of expertise so they might coalesce into a "community of practice"?
5. Are tobacco control stakeholders able to identify other key organizations and groups outside the tobacco control community that may have expertise and resources needed by those within the network?
6. Can tobacco control stakeholders identify organizations within the network that may have working relationships with these critical outside groups?

Diagnosis

Once the network has been discovered and identified, detailed network analysis methods, both qualitative and quantitative, are used to diagnose network structure and processes. They help the community to diagnose the "health" of the network. These questions focus on what specific attributes are normally assessed in the process of network diagnosis.

1. Which organizations are most central in the network in that they use both direct and indirect measures of centrality? Are these the organizations most essential for addressing client and program needs?
2. Are some network relationships especially strong and others weak? Is the relative strength of ties consistent with network needs for essentials such as information and resources?
3. Who are the connectors, information brokers, and boundary spanners in the network who can meet network needs in areas such as research, funding, and services? Do these important roles even exist in the network? Do the appropriate

organizations and individuals occupy these roles?

4. Is the network broadly connected, highly fragmented, or divided into subgroups and cliques? Which specific subgroups of network organizations have strong working relationships?
5. Is the flow of essentials such as information, knowledge, clients, and funding needed for tobacco control efforts being efficiently and effectively distributed throughout the network? Where are the gaps? Where are the redundancies?
6. Are critical network ties based solely on personal relationships, or have they become institutionalized so they are sustainable over time, as key individuals come and go?
7. Do network members have links to other groups and organizations outside the network that may be helpful to the full network for vital actions such as attracting needed resources and information and influencing policy?
8. How are these external ties structured? Are they primarily through core or peripheral network members? Are network members able to draw on these external ties to "explore" and/or "exploit" the outside environment in ways that might benefit tobacco control efforts?
9. How is the network governed? Are mechanisms and structures in place to facilitate and guide the coordinated actions of network members so tobacco control efforts are appropriately integrated and coordinated?
10. How has the network evolved over time, as evidenced in several waves of data collection? Specifically, has reasonable progress been made in establishing critical network ties and building effective network governance mechanisms?
11. What level of trust and cooperation exists among tobacco control agencies trying to work together? Have trust and cooperation increased or decreased over time?
12. What have been the benefits, drawbacks, and expectations of network involvement? Have these changed over time?
13. Within a particular service domain such as tobacco control, how do networks in some communities, states, or regions compare, along the dimensions described here, with other networks trying to perform similar services?
14. What is the network's *capacity for scanning*—that is, the extent to which it has human and automated "probes" that can bring new information into the network?
15. What is the network's *capability for absorption*—that is, the extent to which it can absorb relevant information scanned from outside the network?
16. What is the network's *efficiency for distribution*—that is, the extent to which it can selectively and strategically distribute the information it absorbs to the appropriate nodes that need it?
17. What is the level of *congestion* within the network due to bottlenecks—that is, the extent to which certain organizations or individuals are holding up the flow of knowledge or resources, because their "circuits are too busy with unnecessary networking"?
18. What is the network's *robustness against disruption*—that is, the extent to which built-in redundancies in the links within the network help to prevent unraveling of the network when one individual or organization departs?
19. What is the network's *vulnerability to external sources*—that is, the extent to which links among members of the network are being brokered by nodes outside the network?

Design

Discovery (identification) and diagnosis contribute to building a deep understanding of one or more tobacco control networks by using the tools and techniques of network analysis. However, once this understanding has been established, it is up to network leaders and members to work with network researchers to put the findings to use. The design phase involves efforts to modify network structures and relationships to enhance the effectiveness of the network. The focus of this phase is on helping the community collectively identify strategies to design (tune) a network to accomplish its goals more effectively. This strategy could apply to an existing network or to a latent or nascent network that needs a jump-start.

Designing a network includes identifying links or nodes that must be restructured, as well as identifying social incentives and technical infrastructures necessary for the network design to be successfully implemented. This "rewiring" of the network is frequently difficult, because it may require changes in the structure and patterns of behavior that have evolved over the life of the network.

The recommendations made here relate to changes network leaders and members may want to consider, not changes that must be addressed. Such changes would be implemented slowly and would be guided by such considerations as a thorough understanding of network context, the individuals involved, and what is politically possible. Networks can be changed to operate more efficiently and effectively, and network analysis provides a rationale for making the necessary changes on the basis of data, rather than assumptions and general observations.

The design questions presented build on the identification and diagnosis questions already discussed. Design is simply the application and use of this knowledge. The design questions are more general than the questions about identification (discovery) and diagnosis, focusing on the types of issues

Linking Systems and Networks: Agent-Based Models

One area that may hold promise for network methods is use of agent-based simulations of networks, a concept from system dynamics. In such simulations, autonomous agents operating under specific rules create evolutionary outcomes.[a] In a tobacco control context, for example, one might simulate the long-term consequences of including specific organizations in a network, adding links (e.g., by creating cross-functional teams), dropping links (e.g., by creating firewalls), or offering incentives for specific types of resource flows among certain members within the network. "What if" scenarios could then be based on these assumptions.

Interest in development of agent-based computational models and multiagent simulation environments has been substantial.[b] Blanche, a computer application developed by Contractor and Monge,[c] is one such computational network modeling environment especially well suited to simulate and visualize changes in a network based on multitheoretical, multilevel mechanisms. Another more distant but promising area is the potential "docking" of the aggregate system dynamics models and agent-based computational network models. Such approaches may help to improve the collective validity and usefulness of these models for practitioners interested in designing networks.

[a]Sterman J. D. 2000. *Business dynamics: Systems thinking and modeling for a complex world.* New York: McGraw-Hill/Irwin.

[b]Gilbert, N., and K. G. Troitzsch. 1999. *Simulation for the social scientist.* Berkshire, UK: Open Univ. Press.

[c]Monge, P. R., and N. Contractor. 2003. *Theories of communication networks.* New York: Oxford Univ. Press.

that might be addressed by an organizational network focused on tobacco control.

1. How can understanding of factors such as who is involved in the network, who knows what, and the location of key information and resources be enhanced? Members of the tobacco control network must have access to all network identification data so they can develop relationships with other network members as needed.
2. How can the network be redesigned to operate more efficiently? How can redundant ties be limited and weak or nonexistent ties in key areas be strengthened? Which relationships should be direct and which should be indirect, brokered by other organizations and individuals? Tobacco control organizations should collaborate to enhance effectiveness, but networks with ties that are too dense are inefficient because everyone is too busy networking to get anything else done.
3. How can the network be redesigned to operate more effectively? Which types of relationships seem to work best? How can these be expanded to other areas of the network? Networks should be redesigned so organizations with assets and skills critical for particular aspects of tobacco control (e.g., information and certain client services) have a high degree of centrality and are not peripheral in the network's structure.
4. Consistent with question 3, what overall types of network design and structure are most appropriate for accomplishing different types of network outcomes? For example, dense networks may work best for achieving collective action, and small-world networks with ties to outside groups may be best for exploring and importing new ideas. In general, however, as noted earlier in this chapter, effective networks typically display "focused integration," with an appropriate mix of weak and strong ties and some fragmentation.
5. In light of existing levels of trust, how can trust be enhanced among network members, especially if the network is to be highly collaborative and not based on hierarchy or contracts? Should trust building focus on key subgroups or cliques of organizations first and then be expanded to others? Have certain low-trust relationships been identified and thus circumvented in the building of network ties?
6. How can the benefits of network collaboration that have been identified be maintained and reinforced? How can the drawbacks be minimized?
7. How can the appropriate network governance structure be established and sustained so network activities and interactions can be encouraged, coordinated, and facilitated on an ongoing basis? What should such a governance structure look like? Who should lead it?
8. How can critical network ties be institutionalized? Tobacco control organizations should work to ensure that key network ties, especially broker ties, are not dependent on a single individual.
9. Based on comparative network analysis across multiple networks, what "best practices" can be established? How can these practices be effectively implemented?

Summary

Network analysis represents an important and currently underused approach for assisting leaders in health care services, public health practice, and development and implementation of health policy, especially in the area of tobacco control. Network analysis can be a powerful tool

for strengthening tobacco control efforts at local, state and regional, national, and international levels. Network analysis can be done (1) by identifying existing networks and who is involved, (2) by diagnosing how these networks are structured and governed and how they operate, and (3) by using this knowledge to help network leaders design networks that work together more effectively to enhance a broad range of tobacco control efforts. This chapter provides an overview of how network analysis might be accomplished and why it would be beneficial for tobacco control programs. The structural data provided by network analysis must be combined with an in-depth knowledge of the nature of the problem being addressed, the services and capacities of the organizations involved, and the social and political contexts in which the network is embedded.

Conclusions

1. Solving complex future issues in tobacco control will require replacing silos of information and activity with greater linkage of tobacco stakeholders through networks.
2. Networks of tobacco control stakeholders form a foundation of the systems environment envisioned for the future of tobacco control. Many components of a systems approach are built around the presumption of stakeholder networks that span multiple levels of tobacco control activity and transcend geography and discipline. These components include building organizational capacity; participatory approaches to planning, implementation, and evaluation; optimization of resources and effort; and dissemination of knowledge and best practices.
3. Network analysis holds the potential for facilitating understanding and strategic management of linkages between stakeholder groups.
4. Numerous theories of network behavior currently coexist, and core concepts that describe networks now have broad acceptance, particularly those related to network attributes and behavior.
5. Network applications in public health are at an early stage. However, they have shown promise in recent studies, particularly in areas where disparate organizations have a common goal. Recent tobacco control applications of networks include the North American Quitline Consortium and Global Tobacco Research Network.
6. Network attributes potentially serve as a measure of the health of tobacco control efforts, as evidenced by a case study correlating network centrality with the strength of political and financial support for tobacco control.
7. In the future, tobacco control programs could consist of multiple networks with specific functional objectives, linked in turn as part of a "network of stakeholders."

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