

Journal of Urban Health: Bulletin of the New York Academy of Medicine \circledast 2001 The New York Academy of Medicine

Interorganizational Relationships Among HIV/AIDS Service Organizations in Baltimore: A Network Analysis

Jennafer Kwait, Thomas W. Valente, and David D. Celentano

ABSTRACT A wide variety of organizations has become involved in providing medical and social services to people living with human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS). Although there is much interest among policymakers, service providers, and clients in coordination among HIV/AIDS service organizations, few studies have used network analytic tools to examine existing systems of HIV-related care. In an effort to fill this gap, this study used network analysis methods to describe several aspects of the interorganizational relationships among 30 HIV/ AIDS service agencies in Baltimore, Maryland. Client referrals to other organizations, client referrals from other organizations, exchange of information about shared clients, formal written linkage agreements for client referrals, and joint programs were each examined as a distinct type of network tie, with each the basis of a separate network among these 30 organizations. All of the networks except the one based on joint programs were relatively well connected, with most organizations either directly or indirectly linked. Most of the interorganizational collaboration occurred on a rather ad hoc basis for the purposes of meeting the more immediate needs presented by clients. Highly structured coordination involving substantial investment of resources and ongoing interagency activities appeared to be less common. The findings from this study also suggest that the providers in Baltimore tend to work directly with others as client needs arise rather than negotiating through "clearinghouse" types of organizations. Of the 30 HIV/AIDS service organizations, 5 were highly central in at least four of the five different types of networks. These five organizations—each having a critical role in the continuum of care-may be considered the most central core of the HIV/ AIDS service delivery network in Baltimore. These organizations tend to be those that have been created specifically to provide HIV-related services or that specialize in HIV/AIDS care. This research can help policymakers understand how an HIV-related service delivery network may function and delineate key features of a network. In all communities, this type of assessment is critical to designing interventions to promote collaboration that are feasible within the context of existing interorganizational relationships. This type of data also has implications for informing activities to build the capacity of HIV/AIDS service organizations.

Dr. Valente is with the Department of Preventive Medicine, School of Medicine, University of Southern California, Alhambra; Dr. Celentano is with the Department of Epidemiology, Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland.

Correspondence: Jennafer Kwait, PhD, 5510 Cornish Road, Bethesda, MD 20814. (E-mail: jkwait@ qwestonline.com)

INTRODUCTION

People living with human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) often need a variety of medical and social services—including primary medical care, dental care, home health and hospice care, mental health services, housing, transportation, meal delivery, and emergency financial assistance—throughout the course of their illness. In communities across the nation, many types of organizations are now involved in providing these various services to people living with HIV/AIDS. In the early days of the epidemic, however, many health care and social service organizations that traditionally provided care to people in need were slow to respond to the AIDS epidemic. Several reasons, including disdain for certain lifestyles and fear of contagion, have been cited¹ for the initial failure of organizations to meet the needs of people living with AIDS (see Ref. 2 for an in-depth analysis of the failure of organizations and other institutions to respond to the AIDS epidemic).

Grassroots organizations responded to this lack of formal services by creating AIDS-specific programs and agencies to address the diverse medical and social service needs of people with AIDS.^{1,3} These AIDS service organizations first arose in cities with a high prevalence of AIDS cases, such as New York City and San Francisco, California.⁴ AIDS service organizations still have a central role in the delivery of HIV-related care in many communities. As the epidemic continued to grow, existing organizations that were part of the traditional health care system also began to develop AIDS services.

The current HIV/AIDS service delivery systems in communities across the country thus comprise a very diverse group of organizations, including hospital-based clinics, local health departments, and community-based agencies. The mix of services provided by individual organizations varies, with some offering a wide range of different medical and social services and others offering only a single specialized service. For example, a hospital-based clinic may provide primary medical care, mental health counseling, case management, support groups, and direct financial assistance for food or transportation. Alternatively, an AIDS service organization may provide only meal delivery to homebound people with AIDS. In this service delivery environment, HIV-positive clients must often seek care at several organizations to obtain their needed services.

Organizations thus must work collaboratively to ensure that clients receive the full range of services and do not "fall through the cracks" in the system. However, clients and providers are frequently frustrated by fragmentation and duplication of services that have arisen as a consequence of the rapid emergence of many separate and autonomous HIV/AIDS-related agencies and programs in a community. As a result, coordination of care and development of interorganizational relationships have become particularly important topics in the HIV/AIDS services arena. Although there is considerable interest among policymakers, service providers, and clients in the potential for interorganizational networks of HIV/AIDS-related agencies to promote greater accessibility and efficiency of services, few studies have used network analytic tools to examine existing systems of HIV/AIDS care.

In an effort to fill this gap, the study presented in this article used network methods to describe several aspects of the interorganizational relationships among 30 HIV/AIDS service agencies in Baltimore, Maryland. Client referrals to other organizations, client referrals from other organizations, exchange of information about shared clients, formal written linkage agreements for client referrals, and joint programs are each examined as a distinct type of network tie, with each the basis of a separate network among these 30 organizations. These types of linkages were selected because each represents an element that health and human service organizations must often share to meet the needs of their clients better. Client referrals and exchange of information reflect direct service delivery ties, while formal linkage agreements and joint programs suggest administrative linkages (Gans and Horton, 1975, as cited in Ref. 5). Client referrals and exchange of information do not necessarily require provider agencies to make long-term or administrative interorganizational commitments, while formal linkage agreements and joint programs most often do necessitate such obligations.

This article describes the overall interorganizational network structures that emerged in this city, the positions of specific organizations within the different networks, and correlations between the networks. By comparing network structure across the different types of ties, this study offers insight into how the HIV/AIDS service delivery system in Baltimore functions after more than a decade and a half into the epidemic and 5 years of Ryan White CARE Act funding. An important component of this structural analysis is determining whether direct service delivery or administrative interorganizational linkages occurred more frequently among these agencies. By comparing the position of specific organizations—in terms of their relative centrality—across the networks, this study also provides information about the varying roles that these agencies have developed during this period of time. In addition, this organizational-level analysis is used to determine whether there is a difference in the network prominence of organizations created specifically in response to the AIDS epidemic and those that existed prior to the crisis.

METHODS

HIV/AIDS Organizations and Boundary Specification

The network of HIV/AIDS service organizations analyzed in this study was bound prior to data collection. Using this bounded network, the interorganizational network survey questions followed a fixed list format⁶; informants were presented with a complete list of network organizations and asked to provide information about specific types of linkages between their program or agency and each of the others in the network.

Thirty HIV/AIDS service organizations within Baltimore comprise the bounded service delivery network explored in this study. This network excludes organizations that provide only pediatric services because it is possible that these agencies may function in a manner very different from organizations that provide services primarily to adult HIV-positive clients. Also excluded from the study were the many organizations that, by virtue of the types of services they provide (such as substance abuse treatment or shelter care), have clients who are HIV positive but do not specifically address HIV/AIDS as part of their programmatic goals. Exclusion of these organizations served to focus the research on agencies and programs for which an essential component of service delivery was to address client needs related to HIV/AIDS. The 30 network organizations of the study included both freestanding agencies and programs within larger institutions, such as hospitals or departments of public health. The term *organization* as used throughout this article to refer to the actors in the HIV/AIDS service delivery network thus includes both freestanding agencies and programs within larger entities.

Two methods were used to identify organizations that were involved in provid-

ing HIV/AIDS-specific services in Baltimore. The first method was to include all nonpediatric organizations in the city that received Ryan White CARE Act Title I funds in federal fiscal years 1995 and 1996.* The Baltimore metropolitan area first became eligible to receive these Title I funds in fiscal year 1992. Since that time, local agencies and programs have received grants from the city under specific service priorities identified by the Greater Baltimore HIV Health Services Planning Council. These funded organizations use their Title I grants to support services specifically for people living with HIV/AIDS. Receipt of Title I funds was thus a good indicator of whether an organization was involved in HIV/AIDS-specific care. Agencies receiving these funds thus became the foundation of the bounded network for this research.†

Because it was possible that organizations involved in HIV/AIDS-specific care did not receive Title I funds in 1995 and 1996, a second process was used to identify additional organizations for inclusion in the network. This process was based on data collected during an earlier project to assess the availability of HIV/AIDS services in the Baltimore metropolitan area after initial implementation of the CARE Act Title I program in this community. As part of the survey conducted for this project among organizations involved in HIV/AIDS-specific care, respondents were asked to list the five agencies to which clients with or affected by HIV were most often referred. Organizations that received at least two nominations as a place to which clients were most often referred were included in the network for this current study of interorganizational relationships. Using these two criteria, 30 organizations were identified—25 based on Title I funding and 5 based on previous research findings—for inclusion in the HIV/AIDS service delivery network.

The 30 organizations that compose the HIV/AIDS service delivery network analyzed in this research include a variety of different types of agencies. As reported by the organizational informants, the majority (70.0%) of the organizations in the network were private and not for profit. In terms of organizational type, the largest percentage (33.3%) of organizations was social service agencies, followed by federal- or state-qualified community health centers (20%) and local/state health department programs (16.7%). The services provided by these network organizations include primary medical care, dental care, mental health services, support groups, skilled home health care, home-based hospice care, substance abuse treatment, case management, in-home attendant care, home-delivered meals, housing, legal services, nutritional counseling, and vouchers/reimbursement for needed products or services.

Survey Design

Two survey instruments were used in this research: one to assess interorganizational relationships at the direct service delivery level and one to assess relationships at

^{*}The Ryan White CARE Act of 1990 and subsequent amendments to this legislation were authorized and funded by Congress to support communities in developing and improving their capacity to meet the many needs of people living with HIV/AIDS better. Under the original federal legislation, Title I of the CARE Act provided grants directly to metropolitan areas that had at least 2,000 cumulative AIDS cases or a 0.0025 cumulative incidence rate.

[†]Organizations funded only under the service priorities of inpatient hospice care and outreach were not included as part of the network. Inpatient hospices were excluded because they provide a service aimed at end-of-life care and thus are not routinely involved in client-based interorganizational activities such as client referrals. The outreach category was excluded because this priority does not necessarily encompass a direct medical or social service aimed at providing care to HIV-positive individuals. Separately funded programs that were part of a larger institution were considered as distinct entities only if they did not function together as a unit.

the administrative level. Instruments used in interorganizational network studies completed by other researchers were used as tools to guide the development and design of the surveys used in this project.⁷⁻¹² The final version of the survey was completed after extensive pretesting with local providers.

The survey for the direct service delivery level included questions about three of the different types of interorganizational linkages presented in this analysis: client referrals to other organizations, client referrals from other organizations, and exchange of care-related information with other organizations. The specific network questions were as follows:

- 1. How many adult HIV-positive clients on average does your organization *refer for direct services* to the following programs and agencies in 1 month?
- 2. How many adult HIV-positive clients on average does your organization *receive for direct services* from the following programs and agencies in 1 month?
- 3. When adult HIV-positive clients are receiving care at both your organization and the following programs and agencies, how often on average does your organization *exchange care-related information* about these clients with the other program or agency (when confidentiality standards are met)?

A list of the 30 network organizations followed each of these questions. In this format, informants were presented with the first question, given directions for responding, and asked to answer in reference to each listed program or agency. The same process was followed for the other two network questions. In reporting the number of adult HIV-positive clients referred or received in the first two direct service network questions, nearly all informants indicated that the figures given were estimates. These informants did confirm, however, that their responses reflected a sense of relativeness among organizations in terms of the extent of client referrals.* For the question about information exchange, informants first were asked whether they had shared clients with an organization. If the informant reported that there were no shared clients with the listed program or agency, then "not applicable" was indicated. If shared clients were reported, informants were asked to rate on a scale of 0 to 4 how often care-related information about these shared clients was exchanged with the other program or agency (0 = not at all, 4 = very often).

The first section of the administrative-level survey gathered descriptive information about the organizations. The next section of the administrative-level survey included questions about the remaining types of interorganizational linkages: written formal linkage agreements to refer clients to other organizations, agreements to receive clients from other organizations, and joint programs with other organizations. The specific network questions were as follows:

1. With which of the following programs and agencies does your organization have a *written formal linkage agreement to refer adult HIV-positive clients* for direct services?

^{*}In one case, the informant was unable to quantify the number of clients referred or received. In an effort to accommodate these circumstances yet still gather some data about this organization, the informant was asked to rate on a scale of 0 to 4 the extent that clients were referred to or received from the other programs or agencies.

- 2. With which of the following programs and agencies does your organization have a *written formal linkage agreement to receive adult HIV-positive clients referred* for direct services?
- 3. With which of the following programs and agencies does your organization *jointly operate an ongoing direct service delivery program* for HIV-positive adults?

As in the survey at the direct service delivery level, a list of the 30 network organizations followed each of these questions. Informants were presented with the first question, given directions for responding, and asked to indicate the listed programs and agencies with which their organization had this type of tie. The same process was followed for the other two network questions.

Organizational Informants

The key informant approach was used to collect the data analyzed in this study.^{13,14} In-person interviews were arranged with individuals identified as key informants at each of the network organizations. In organizations for which the two surveys were completed by different individuals, the informant for the survey at the direct service delivery level was often a staff member involved in case management, while the administrative-level informant was the executive director or program administrator.

Data Preparation and Analysis

The original matrices for client referrals sent, client referrals received, and information exchange were comprised of valued data as described above. Both valued and dichotomous data were used to analyze these three types of network linkages; dichotomous data were used to measure density and degree centrality, while valued data were used to create a more sensitive measure of centrality.

The valued data for both of the client referral matrices and the information exchange matrix were dichotomized using 0 as a cutoff point. The resulting matrices indicated the presence or absence of a relationship between each pair of organizations for each of these types of tie. Density and degree centrality were then calculated. Centrality in each of the valued client referral matrices ("referrals to" and "referrals from") was calculated using a slightly lengthy, but not complicated, method. In an effort to present this method most clearly, the following description includes only the referrals to network. The analysis of valued data assessed the frequency with which each organization was identified as a place to which a relatively large number of HIV-positive clients were referred. This analysis was completed by (1) calculating the mean number of clients referred by each responding organization (excluding those to which no referrals were made), (2) identifying the organizations to which each responding organization sent more than its mean number of client referrals, (3) counting—down each column of the matrix—the number of times that each organization was identified as place to which more than the mean number of clients were referred by the other organizations in the network, and (4) dividing this figure by 28, the total number of organizations that provided client referral data. Additional methods for handling missing data from the two organizations that did not respond to the direct service delivery level survey are discussed below.

As indicated above, data about the frequency of information exchange were collected only if there were shared clients between the responding organization and each of the others. For the purposes of this analysis, a response of "not applicable" (indicating that there were no shared clients) was coded as 0 (indicating that there was no exchange of information about shared clients) in the matrix of care-related information exchange. This data coding had the effect of collapsing into the same category responses that indicated no shared clients and those that indicated two agencies had shared clients but did not exchange care-related information at all. The lack of shared clients as a reason for no exchange of information was thus disregarded in this analysis. The valued data that indicated the frequency of information exchange were analyzed by calculating for each organization in the network the proportion (using 28 organizations as the denominator) of the others that identified it as a place with which they exchanged information about clients above their average level of frequency of exchange.

The original matrix of written formal linkage agreements for client referrals was comprised of dichotomous data indicating the presence or absence of this type of tie between organizations. As described above, the interorganizational survey included two separate network questions pertaining to written formal linkage agreements for client referrals. The first question addressed linkage agreements to refer clients to other organizations, and the second addressed agreements to receive clients from other organizations. However, respondents indicated during the data collection process that most of the linkage agreements between their organization and the others addressed both referral and receipt of clients. For the purposes of this analysis, the two linkage agreement questions thus were combined to create a single matrix indicating whether each responding agency reported any formal linkage agreement with each of the others.

The original matrix of jointly operated direct service delivery programs was comprised of dichotomous data indicating whether two organizations shared a program. The number of ties in the row or column of each organization reflects how many others with which it shared a program, rather than how many joint programs it had.

On a final note, exchange of information about shared clients, written formal linkage agreements, and joint programs each theoretically exist mutually between organizations, with matrices of the presence or absence of these types of ties consequently symmetric. However, the data collection and analysis methods used in this project allowed for the possibility of asymmetrical data, in which two organizations did not agree in their reporting of the presence or absence of information exchange, linkage agreements, or joint programs with the other.

Missing Data

Missing data about interorganizational relationships were an issue only for the survey at the direct service delivery level for two organizations. Data indicating the presence or absence of direct service delivery ties were imputed from responses given by each of the other organizations in the network.* To explore whether im-

^{*}The following example describes this method for imputing missing interorganizational data for a case in which data from organization M are missing: If the informant from organization A reports that client referrals are received from organization M, then the researcher indicates in the survey for organization M that clients are referred to organization A. The same process was followed using data from each of the organizations in the network. This method of handling missing data has implications for interpretation of outgoing nominations for the two organizations that did not complete the survey at the direct service delivery level because information for the entire row was imputed rather than for a single cell in a column. Results based on outgoing ties for these two organizations must thus be considered with caution.

puting these data made any substantial differences in the results of the network analysis, several analyses were completed in which the two organizations that did not complete the survey were dropped. Excluding these organizations had minimal impact on the position of organizations in the network and the overall structure of the network when compared to the findings based on imputed data. Given these findings, and because data were available about administrative linkages from these two organizations that otherwise would have been unused, the decision was made to include these agencies in the analyses based on dichotomous data.

For analyses based on valued data, such as the frequency as a place to which a large number of clients were referred, data from these two organizations were considered missing and thus were not included in the calculations. The values given by the responding organizations were estimates that reflected a sense of relativeness of the extent or depth of interorganizational ties with the other programs and agencies. If data from each of these programs or agencies were used to fill in missing information for the two organizations that did not complete the survey, this sense of relativeness would not have been reflected in the imputed data.

RESULTS

Density measures provided information about overall network structure and cohesion. In-degree and out-degree centrality scores, along with the centrality measure based on valued data, were used to measure the relative prominence of the organizations in each of the networks.^{15,16} To identify the most and least central organizations in each type of network, the top and bottom 20th percentile values of degree scores (dichotomous data) and proportions (valued data) were used as cutoff points. Organizations with scores/proportions above the 80th percentile value were considered most central in a given network, and those with scores/proportions below the 20th percentile value were considered least central. Internetwork correlations were computed using the quadratic assignment procedure (QAP).¹⁷

Each organization was given a number to which it is referred throughout the network analysis results section. Use of a number rather than an organizational name is intended to preserve confidentiality. Numbers also ensure that organizations are distinguishable from one another, which is not the case when only basic descriptors such as legal designation and service type are used. The Appendix describes each numbered organization and indicates the primary service offered.

Clients Referred to Other Network Organizations

As indicated in Table 1, the overall density of the referrals to network was 43.10%. The in-degree scores (an in-degree score of an organization is the number of organizations in the network that reported referring adult HIV-positive clients to it for direct services) ranged from 3 to 25 (possible range of 0 to 29), with a mean of 12.50, standard deviation of 6.26, and median of 11.50. The six organizations with the highest (above 19.80, the 80th percentile value) in-degree scores were organizations 13, 1, 15, 18, 24, and 29 with in-degrees of 25, 22, 21, 21, 20, and 20, respectively (Table 2). Four of these organizations provide a variety of social services, but with a focus on a specific service. The primary service of organization 13 is case management, organization 1 is research/patient advocacy and vouchers/reimbursement, organization 15 is housing-related services, and organization 24 is vouchers/reimbursement. The other two organizations with high in-degree scores

Network	Density %
Referrals to	43.10
Referrals from	33.33
Information exchange	48.97
Formal linkage agreement	28.85
Joint program	5.00

TABLE 1. Density of interorganizationalnetwork of HIV/AIDS sevice organizations,Baltimore, MD, 1997

each focus on a single type of service related to health care: financial assistance for AIDS medications (organization 18) and dental care (organization 29).

The five organizations with the lowest (below 7.00, the 20th percentile value) in-degree scores were organizations 6, 11, 27, 4, and 25 with in-degrees of 3, 3, 4, 5, and 6, respectively. The main service of three of these organizations is primary medical care; two of these agencies are community health centers (organizations 11 and 25), and one is a health maintenance organization (organization 27). The two other organizations with low in-degree scores are health department programs; one focuses on case management (organization 6) and the other on substance abuse treatment (organization 4).

The out-degree scores (the out-degree score of an organization is the number of organizations in the network to which it reported referring adult HIV-positive clients for direct services) ranged from 1 to 29 (possible range 0 to 29), with a mean of 12.50, standard deviation of 7.25, and median of 12.00. The six organizations with the highest (above 18.60, the 80th percentile value) out-degree scores were organizations 1, 13, 15, 22, 24, and 16 with out-degrees of 29, 25, 23, 22, 20, and 19, respectively. Five of these organizations provide a range of social services; two (organizations 15 and 22) of these focus their efforts on housing services. The primary services of the three other social service organizations with the highest out-degree scores are research/patient advocacy and vouchers/reimbursement (organization 1), case management (organization 13), and vouchers/reimbursement (or-

	In-degree		Out-degree		
Network	Most central	Least central Most centr		Least central	
Referrals to	1, 13, 15, 18, 24, 29	4, 6, 11, 25, 27	1, 13, 15, 16, 22, 24	2, 5, 19, 20, 25, 29	
Referrals from	9, 13, 14, 24	2, 5, 18, 19, 25, 29	1, 10, 15, 22, 29	4, 7, 11, 14, 21	
Information exchange	3, 9, 13, 15, 16, 24	6, 8, 10	1, 3, 13, 22, 24, 30	7, 10, 11, 16, 20, 25	
Formal linkage agreement	9, 13, 15, 16, 22, 29	6, 7, 11, 18, 25, 27	9, 13, 15, 22	6, 7, 10, 18, 25, 27	
Joint program	9, 13, 14, 15, 19	*	9, 13, 14, 16, 22, 30	ŧ	

TABLE 2. In-degree and out-degree: most and least central organizations in interorganizational network of HIV/AIDS service organizations, Baltimore, MD, 1997

*There were 14 organizations with in-degree scores of 0.

†There were 19 organizations with out-degree scores of 0.

ganization 24). The sixth organization (organization 16) is a hospital-based clinic that focuses its services on primary medical care.

The six organizations with the lowest (below 5.60, the 20th percentile value) out-degree scores were organizations 5, 29, 2, 20, 25,* and 19 with out-degrees of 1, 1, 2, 2, 4, and 5, respectively. Three of these organizations focus on services related to health care; two organizations provide only dental care (organizations 5 and 29), and the other provides mainly primary medical care (organization 25). The other three organizations are social support service providers, including a community-based housing program (organization 2), a transportation assistance agency (organization 20), and a home-delivered meal program (organization 19).

Based on the original valued data, each of the organizations in the network may be identified by a proportion of the others as a place to which they send more than their mean number of adult HIV-positive client referrals. These proportions ranged from 0.00 to 0.70, with a mean of 0.17, standard deviation of 0.17, and median of 0.15. The six organizations that were identified by the largest proportions (above 0.32, the 80th percentile value) of organizations as a place to which a relatively large number of client referrals were sent were organizations 13, 3, 9, 18, 1, and 29 with proportions of 0.70, 0.44, 0.41, 0.37, 0.33, and 0.33, respectively. Three of these organizations (organizations 1, 3, and 13) are social support service providers. The other three each focus on providing a different type of medical service, including primary medical care (organization 9), financial assistance with AIDS medications (organization 18), and dental care (organization 29).

Five organizations—organizations 4, 6, 11, 12, and 23—were not identified as places to which any of the organizations sent more than its mean number of HIV-positive client referrals. The main service provided by three of these organizations (organizations 11, 12, and 23) is primary medical care. The other two organizations are both health department programs; one focuses on substance abuse treatment (organization 4) and one on case management (organization 6).

Clients Received From Other Network Organizations

The overall density of the referrals from network was 33.33% (Table 1). The indegree scores (the in-degree score of an organization is the number of organizations in the network that reported receiving adult HIV-positive clients from it for direct services) ranged from 1 to 23 (possible range 0 to 29), with a mean of 9.67, standard deviation of 5.62, and median of 9.50. The four organizations with the highest (above 15.00, the 80th percentile value) in-degree scores were organizations 13, 9, 24, and 14, with in-degrees of 23, 19, 17, and 16, respectively (Table 2). Two of these organizations provide a range of social services; one focuses on case management (organization 13) and the other on vouchers/reimbursement (organization 24). Two provide primary medical care along with a variety of other services (organizations 9 and 14); both of these primary care providers are community health centers.

The six organizations with the lowest (below 4.20, the 20th percentile value) in-degree scores were organizations 18, 19, 5, 29, 2, and 25 with in-degrees of 1, 1, 2, 2, 4, and 4, respectively. Four of these organizations focus their efforts on a specific type of medical service: financial assistance for AIDS medications (organiza-

^{*}Data from organization 25 about outgoing ties were imputed from information reported by the other network organizations.

tion 18), dental care (organizations 5 and 29), and primary medical care (organization 25). The other two provide social services; the primary service of one is homedelivered meals (organization 19) and of the other is housing (organization 2).

The out-degree scores (the out-degree score of an organization is the number of other organizations in the network from which it reported receiving adult HIVpositive clients for direct services) ranged from 0 to 29 (possible range 0 to 29), with a mean of 9.67, standard deviation of 6.63, and median of 8.00. The five organizations with the highest (above 16.00, the 80th percentile value) out-degree scores were organizations 1, 15, 22, 10, and 29, with out-degrees of 29, 18, 18, 17, and 17, respectively. Four of these organizations are social service agencies; two focus on housing services (organizations 15 and 22), one focuses on research/patient advocacy and vouchers/reimbursement (organization 1), and one focuses on assistance with basic sustenance and emergency needs (organization 10). The remaining organization with a high out-degree score is a dental care program (organization 29).

The five organizations with the lowest (below 4.00, the 20th percentile value) out-degree scores were organizations 21, 7, 4, 11, and 14 with out-degrees of 0, 1, 3, 3, and 3, respectively. The main service of four of these organizations is primary medical care; three of these are community health centers (organizations 11, 14, and 21), and one is a local health department (organization 7). The remaining organization with a low out-degree score is a local health department program that focuses on substance abuse treatment (organization 4).

Based on the original valued data, each of the organizations in the network may be identified by a proportion of the others as a place from which they receive more than their mean number of adult HIV-positive client referrals. These proportions ranged from 0.00 to 0.74, with a mean of 0.12, standard deviation of 0.16, and median of 0.07. The three organizations that were identified by the largest proportions (above 0.22, the 80th percentile value) of organizations as a place from which a relatively large number of referrals were received were organizations 13, 9, and 16 with proportions of 0.74, 0.44, and 0.37, respectively. Two of these organizations are primary medical care providers (organizations 9 and 16), and one is a social service provider (organization 13).

Six organizations—organizations 1, 8, 11, 18, 20, and 29—were not identified as a place from which any of the organizations received more than its mean number of HIV-positive client referrals. Three of these organizations are social service providers, each with a different primary service: research/patient advocacy and vouchers/reimbursement (organization 1), general counseling (organization 8), and transportation assistance (organization 20). The other three each focus on a specific type of health-related service: primary medical care (organization 11), financial assistance with AIDS medications (organization 18), and dental care (organization 29).

Exchange of Care-Related Information

The overall density of the information exchange network was 48.97% (Table 1). The in-degree scores (the in-degree score of an organization is the number of organizations in the network that reported exchanging care-related information about shared adult HIV-positive clients with it) ranged from 6 to 28 (possible range 0 to 29), with a mean of 14.20, standard deviation of 5.52, and median of 14.00. The six organizations with the highest (above 19.60, the 80th percentile value) in-degree scores were organizations 13, 9, 16, 3, 15, and 24 with in-degrees of 28, 22, 22,

21, 20, and 20, respectively (Table 2). Four of these organizations provide social services, with two focusing on housing services (organizations 3 and 15), one on case management (organization 13), and one on vouchers/reimbursement (organization 24). The main service of the two other organizations with high in-degree scores is primary care; one of these agencies is a community health center (organization 9), and the other is a hospital-based clinic (organization 16).

The three organizations with the lowest (below 8.00, the 20th percentile value) in-degree scores were organizations 10, 6, and 8 with in-degrees of 6, 7, and 7, respectively. These three organizations are social service providers, including a program that provides assistance with basic sustenance and emergency needs (organization 10), a program that focuses on case management (organization 6), and an agency that provides primarily general counseling services (organization 8).

The out-degree scores (the out-degree score of an organization is the number of organizations in the network with which it reported exchanging care-related information about shared adult HIV-positive clients) ranged from 7 to 25 (possible range 0 to 29), with a mean of 14.20, standard deviation of 4.99, and median of 14.50. The six organizations with the highest (above 19.80, the 80th percentile value) out-degree scores were organizations 3, 24, 1, 13, 22, and 30 with out-degrees of 25, 21, 20, 20, 20, and 20, respectively. All of these organizations, except organization 30, are social service providers, with each focusing on a particular service: housing (organizations 3 and 22), vouchers/reimbursement (organization 1), and case management (organization 13). Organization 30 is a home health care/hospice agency.

The six organizations with the lowest (below 9.20, the 20th percentile value) out-degree scores were organizations 10, 20, 11, 25, 7, and 16 with out-degrees of 7, 7, 8, 8, 9, and 9, respectively. The main service of four of these organizations is primary medical care; two of these agencies are community health centers (organizations 11 and 25), one is a local health department program (organization 7), and one is a hospital-based clinic (organization 16). The other two organizations with low out-degree scores are both social service providers that focus on assistance with basic needs (organizations 10 and 20).

Based on the original valued data, each of the organizations in the network may be identified by a proportion of the others as a place with which they exchange information about clients above their average level of frequency. These proportions ranged from 0.00 to 0.63, with a mean of 0.23, standard deviation of 0.16, and median of 0.22. The five organizations that were most often (above 0.37, the 80th percentile value) identified as a place with which there was frequent information exchange were organizations 13, 16, 9, 3, and 28, with proportions of 0.63, 0.56, 0.48, 0.44, and 0.41, respectively. Three of these organizations are primary care providers (organizations 9, 16, and 28), and two are social service providers (organizations 3 and 13).

The four organizations that were least often (below 0.07, the 20th percentile value) identified were organizations 11, 25, 10, and 4 with proportions of 0.00, 0.04, 0.04, and 0.04, respectively. The main service of two of these organizations is primary medical care (organizations 11 and 25); both of these agencies are community health centers. One of these organizations is a local health department program that focuses on substance abuse treatment (organization 4). The remaining organization focuses on assistance with basic sustenance and emergency needs (organization 10).

Written Formal Linkage Agreements for Client Referrals

The overall density of the formal linkage agreement network was 28.85% (Table 1). The in-degree scores (the in-degree score of an organization is the number of organizations in the network that reported having a written formal linkage agreement for adult HIV-positive client referrals with it) ranged from 0 to 23 (possible range 0 to 29), with a mean of 8.37, standard deviation of 5.26, and median of 8.00. The six organizations with the highest (above 13.80, the 80th percentile value) in-degree scores were organizations 13, 16, 15, 9, 22, and 29 with in-degrees of 23, 17, 15, 14, 14, and 14, respectively (Table 2). Three of these organizations 15 and 22) and one on case management (organization 13). The main service of two of these organizations, a hospital-based clinic (organization 16) and a community health center (organization 9), is primary medical care. The remaining organization with a high in-degree score is a dental care program (organization 29).

The six organizations with the lowest (below 3.20, the 20th percentile value) in-degree scores were organizations 6, 18, 11, 7, 25, and 27 with in-degrees of 0, 0, 2, 3, 3, and 3, respectively. The main service of four of these organizations is primary medical care; two of these agencies are community health centers (organizations 11 and 25), one is a local health department program (organization 7), and one is a health maintenance organization (organization 27). One of the other two organizations with the lowest in-degree scores is a local health department program that focuses on case management (organization 6), and the remaining is a health department program that provides financial assistance with AIDS medications (organization 18).

The out-degree scores (the out-degree score of an organization is the number of organizations in the network with which it reported having a written formal linkage agreement for HIV-positive adult client referrals) ranged from 0 to 20 (possible range 0 to 29), with a mean of 8.37, standard deviation of 5.36, and median of 7.50. The four organizations with the highest (above 12.00, the 80th percentile value) out-degree scores were organizations 13, 22, 15, and 9 with out-degrees of 20, 19, 18, and 16, respectively. Three of these organizations are social service providers, including two agencies that focus on housing services (organizations 15 and 22) and one that focuses on case management (organization 13). The remaining organization is a community health center (organization 9); its main service is primary medical care.

The six organizations with the lowest (below 3.20, the 20th percentile value) out-degree scores were organizations 6, 18, 25, 7, 10, and 27 with out-degrees of 0, 0, 1, 2, 3, and 3, respectively. Three of these organizations are primary care providers, including a community health center (organization 25), a local health department program (organization 7), and a health maintenance organization (organization 27). Organization 18 provides financial assistance with AIDS medications. The remaining two organizations with low out-degree scores are social service providers; one focuses on case management (organization 6) and the other on assistance with basic sustenance and emergency needs (organization 10).

Joint Programs

The overall density of the joint program network was 5.00% (Table 1). The indegree scores (the indegree score of an organization is the number of organizations in the network that reported sharing a direct service delivery program with it) ranged from 0 to 5 (possible range 0 to 29), with a mean of 1.43, standard devia-

tion of 1.67, and median of 1.00. The five organizations with the highest (above 3.00, the 80th percentile value) in-degree scores were organizations 9, 14, 13, 15, and 19 with in-degrees of 5, 5, 4, 4, and 4, respectively (Table 2). Two of these organizations (organizations 9 and 14) are community health centers that focus on primary medical care. Three of these organizations provide social services, with one focusing on case management (organization 13), one on housing services (organizations, 14 had in-degree scores of 0.

The out-degree scores (the out-degree score of an organization is the number of organizations in the network with which it reported sharing a direct service delivery program) ranged from 0 to 8 (possible range 0 to 29), with a mean of 1.43, standard deviation of 2.56, and median of 0. The six organizations with the highest (above 2.8, the 80th percentile value) out-degree scores were organizations 9, 22, 13, 30, 16, and 14 with out-degrees of 8, 8, 7, 7, 4, and 3, respectively. The main service of three of these organizations is primary medical care; two are community health centers (organizations 9 and 14), and one is a hospital-based clinic (organization 16). Two of these organizations are social service providers; one focuses on housing-related services (organization 22), and the other on case management (organization 13). Organization 30 provides home health care/hospice. Of the organizations, 19 had out-degree scores of 0.

Internetwork Correlations

The referrals to and information exchange networks were most highly correlated (r = 0.52, P < .000). The joint program network had the lowest correlations with each of the others, with the exception of the formal linkage agreement network (Table 3).

CONCLUSIONS

All of the networks, except the network based on joint programs, were relatively well connected, with most organizations either directly or indirectly linked. The specific level of connection varied among the different types of networks, with the network based on information exchange most dense and the one based on joint

	Referrals to	Referrals from	Information exchange	Formal linkage agreement	Joint program
Referrals to		.28 (P < .001)	.52 (<i>P</i> < .001)	.35 (P < .001)	.14 (P < .01)
Referrals from			.45 (<i>P</i> < .001)	.30 (<i>P</i> < .001)	.12 (P < .01)
Information exchange				.39 (P < .001)	.16 (<i>P</i> < .001)
Formal linkage agreement					.29 (P < .001)

TABLE 3. Correlations (QAP) between interorganizational networks ofHIV/AIDS service organizations, Baltimore, MD, 1997

QAP, quadratic assignment procedure.

programs least dense. The findings from this study suggest that there is a group of service organizations in Baltimore that have developed various types of working relationships to meet the many needs of people living with HIV/AIDS. The higher densities of the networks based on information exchange and client referrals suggest that "as needed" interorganizational relationships occurred more frequently than did the formal types of linkages. Most of the interorganizational collaboration that occurred seems to be on a rather ad hoc basis, for the purposes of meeting the more immediate needs presented by clients. Highly structured coordination involving substantial investment of resources and ongoing interagency activities appears to be less common. The relatively high correlations between the information exchange network and both the referrals to and referrals from networks also suggest that these Baltimore organizations were more likely to have multiple types of ad hoc ties with each of the others in the community.

These results are similar to those of Bolland and Wilson,⁹ who found in their study of six elder service systems in Alabama that integrative coordination is consistently higher for service delivery networks than for administrative or planning networks. Unlike client referrals and exchange of information, joint programs often require a significant expenditure of resources (see Reid, 1964, as cited in Ref. 18) and call for ongoing interagency collaboration. Given that resource scarcity is a challenge often faced by health and human service organizations, it is not surprising that, of the types of networks studied, jointly operated service delivery programs occurred least often among these HIV/AIDS service agencies, and few organizations were connected through this type of tie.

The findings from this study also suggest that the providers in Baltimore tend to work directly with others as client needs arise, rather than negotiating through "clearinghouse" types of organizations. All of the organizations were identified by at least one of the other network agencies as a place to which clients were referred, from which they were received, and with which information was exchanged. Only two organizations were not identified by any of the others as a place with which they shared a formal linkage agreement. For each of these four types of ties, the vast majority of organizations had direct ties with several of the other network agencies. Clearly, the providers at these organizations have made significant efforts to build relationships with their colleagues throughout the city to provide care and thus compensate for the lack of more structural and administrative modes of coordination, such as jointly run programs.

The importance of personal relationships in facilitating interorganizational relationships was further evidenced by insights provided by the respondents during the survey interviews. At the end of the interview, in an open-ended format, when asked about what factors motivate coordination, respondents almost unanimously spoke of the value of personal ties in promoting linkages among organizations. Respondent comments about their formal linkage agreements also provided invaluable insight into the role of interpersonal ties. Informants repeatedly explained during the interviews that the vast majority of interorganizational formal linkage agreements were completed only for the purposes of meeting CARE Act Title I funding requirements and thus were essentially meaningless as mechanisms to promote referrals. To fulfill the Title I requirement, providers and their peers in other organizations with whom they already worked closely signed mutual referral agreements. Ironically, these formal linkage agreements thus may almost be considered an indicator of the more personal working relationships that have developed among providers in these HIV/AIDS service organizations. Organizational centrality also provides insight into the network and how it functions. Of the 30 HIV/AIDS service organizations, 5 were highly central in at least four of the five different types of networks. These 5 organizations included an AIDS service organization that provides case management and a variety of other social services, two community-based programs that offer housing and related supportive services, and two organizations that focus on primary medical care. These agencies may be considered the most connected and involved in the network, and together provide the services that people living with HIV most often need.

The AIDS service organization that provides case management and other services was the most central in the network, with high scores on all but one of the degree centrality measures. Services that this agency provides in addition to case management include counseling, support groups, legal assistance, volunteer and "buddy" support, and vouchers/reimbursement. This organization may be considered the most "prestigious" in that it is the object of the most ties in several of the different types of networks. The importance of this organization is further evidenced by the fact that many organizations reported not only the existence of relationships with this agency, but also high levels of interaction. Information is frequently exchanged with this agency, and large numbers of clients are referred to and received from it.

The centrality of two housing programs suggests that this service is often critically needed by people living with HIV/AIDS in Baltimore. Housing agencies have an important role in the service delivery system not only as recipients of clients, but also as initiators of client referrals and other interorganizational linkages. The staff at these programs often interact with their clients on a relatively frequent, even daily, basis and thus have the opportunity to recognize needs as soon as they arise and to work proactively with other organizations to meet these needs.

Both of the most central primary care organizations specialize in HIV-related care and are community leaders in state-of-the-art treatment. The centrality of these two primary care organizations in providing critically needed services and ensuring that overall health needs are addressed is further evidenced by data that indicate they were each identified by a large proportion of the others as a place with which information about clients is frequently exchanged. A third primary care program, also considered to be a "center of excellence" in Baltimore, is also involved in frequent exchanges of information. Together, these three organizations may be considered the core of the HIV/AIDS-related primary care delivery network in Baltimore.

Another interesting subset of organizations was comprised of those that were core in one or more networks, yet quite peripheral in others. For example, a large program that provides financial assistance with HIV/AIDS medications is one of the most central in the referrals to network—in other words, this organization is a place to which many of the others refer their clients, and relatively large numbers of clients are frequently referred to this program, yet it is simultaneously peripheral in several of the other types of networks. Similarly, the data suggest that one of the two dental care programs in this study also has a dual role in the network. Although many organizations report referring HIV-positive clients to this program, few report receiving them from it. The dual role, most central and most peripheral, of these organizations is likely a result of the types of services they provide. Each provides a very specialized, and greatly needed, service that few organizations in the network have the capacity to offer on the same scale as these agencies. Thus, many providers often refer their clients to these agencies. However, the services offered by both of these organizations tend to be accessed once an individual has already become enmeshed in the health care delivery system. These types of organizations thus are more likely to provide their service without becoming involved in ongoing management and referral of the client.

In sum, a set of five organizations—each having a critical role in the continuum of care—may be considered the most central core of the HIV/AIDS service delivery network in Baltimore. These organizations tend to be those that have been created specifically to provide HIV-related services or that specialize in HIV/AIDS care. In this network of HIV/AIDS service organizations, client needs seem to be the main motivation for providers to establish direct interorganizational linkages (see Ref. 12 for a similar discussion). As such, the type of service offered by an organization and its expertise in providing care seem to be major factors in determining its level of centrality in general and in a specific network.

POLICY IMPLICATIONS AND FUTURE DIRECTIONS

This research can help policymakers understand how a network may function and delineate key features of a network. In all communities, this type of assessment is critical to designing interventions to promote collaboration that are reasonable within the context of existing interorganizational relationships. For example, information about the overall structure of an HIV/AIDS service delivery network is an important tool in making decisions about the feasibility and impact of major system-changing efforts, such as creating a single point of entry for clients or consolidating many services into a "one-stop shop." If such efforts are deemed suitable for a community, policymakers can use data about the existing network to determine the role each organization will have in the restructuring process and in the new system itself.

This type of data also has implications for informing activities to build the capacity of specific HIV/AIDS service organizations, with or without large-scale systemwide changes. Policymakers and community planners might target organizations that are more peripheral in a network, yet operate in underserved parts of the community, to assist them in improving their capability to provide state-of-the-art care. Policymakers may also take steps to ensure that the more central agencies are able to maintain and enhance their capacity to meet client needs. Moreover, this type of research is also useful in identifying interpersonal relationships among providers—a key component in any effort to promote systemwide coordination.

A critical direction for future research is to address the impact of different types of interorganizational linkages on client outcome. Are ad hoc relationships less effective than more structured and formalized ties in promoting access to care? What constitutes an effective and efficient interorganizational network, and how should social network researchers measure the efficiency of a network? Should HIV/AIDS service delivery networks be centralized? The question that underlies this research direction is one of the most important issues facing researchers interested in coordination: What is the relationship between the structure of HIV/AIDS service delivery systems and client outcomes such as satisfaction with care, improved quality of life, and decreased morbidity and mortality. This poses a significant challenge in that this type of research bridges the organizational and client levels of analysis.

Along these lines, study of the qualitative nature of client referrals—the basic component of coordinated care in a system composed of many autonomous organizations—is another important area for future research. Although the information

exchange and client referral networks were the most highly correlated among these Baltimore City organizations, this study did not ascertain the temporal relationship between these two types of linkages. Although the network question about information exchange inquired about shared clients-namely, those clients who had already been referred and were clients of both organizations—it is possible that reported information exchange occurred only as part of the initial referral process. In other cases, providers may have referred their clients to another agency to address a specific need, but did not have any direct communication with them about the shared client until a situation requiring collaboration arose. It likely that the responses about information exchange in this study reflect a combination of both circumstances. Further study is needed to determine what motivates information exchange between providers, as well as the key features of the relationship between information exchange and referral linkages. Does interorganizational information exchange at the time of referral facilitate a client in accessing care at another organization? What is the content of information exchanges among organizations, and what determines this content? What impact do confidentiality laws have on communications between medical care providers? What comprises a "successful" referral, and what factors contribute to a successful referral?

Just as this study does not assess network structure and position beyond the 30 studied organizations, its findings cannot be generalized to HIV/AIDS service delivery systems in other communities. The lack of generalizability is particularly relevant in the HIV/AIDS arena, in which local responses to the epidemic have varied so tremendously. Network analysis studies to describe and compare quantitatively the structure of interorganizational relationships among HIV/AIDS service organizations in different economic and social environments is an important next step, as is study of the ways in which service delivery systems respond to the constantly evolving HIV/AIDS epidemic and other contextual circumstances and pressures.

In sum, these analyses together provide the first analytic picture of key aspects of the HIV/AIDS service delivery network in Baltimore. This descriptive analysis provides important information necessary to understanding the structure of one system of HIV/AIDS care and the role of different types of organizations within the system. This study also provides an important basis of comparison for future studies to assess changes in the network and the relationship between network structure and the ultimate goal of any medical care system—improved health and quality of life for those it aims to serve.

ACKNOWLEDGEMENT

We thank the service providers who so generously gave their time, making this research possible. Support for Dr. Valente was provided by grant DA-10172.

APPENDIX

Legal Designation, Type, and Primary Service of Organizations by Number

- 1. Private, not-for-profit, social service agency—research/patient advocacy and vouchers/reimbursement
- 2. Private, not-for-profit, social service agency-housing services
- 3. Public, local department of social services-housing services

- 4. Public, local health department—substance abuse treatment
- 5. Public, local health department-dental care
- 6. Public, local health department-case management
- 7. Public, local health department—primary medical care
- 8. Private, not-for-profit, social service agency-general counseling
- 9. Private, not-for-profit, federal- or state-qualified community health center—primary medical care
- 10. Private, not-for-profit, social service agency—no primary service, provides services to meet basic sustenance and emergency needs
- 11. Private, not-for-profit, federal- or state-qualified community health center—primary medical care
- 12. Private, not-for-profit, federal- or state-qualified community health center and methadone treatment program—no primary service
- 13. Private, not-for-profit, social service agency-case management
- 14. Private, not-for-profit, federal- or state-qualified community health center—primary medical care
- 15. Private, not-for-profit, social service agency-housing services
- 16. Private, not-for-profit, hospital-based clinic-primary medical care
- 17. Private, not-for-profit, hospital-based clinic-primary medical care
- 18. Public, state health department—financial assistance with AIDS medications
- 19. Private, not-for-profit, social service agency—home-delivered meals
- 20. Private, not-for-profit, social service agency-transportation assistance
- 21. Private, not-for-profit, federal- or state-qualified community health center—primary medical care
- 22. Private, not-for-profit, social service agency-housing services
- 23. Private, not-for-profit, hospital-based clinic—primary medical care
- 24. Private, not-for-profit, social service agency-vouchers/reimbursement
- 25. Private, not-for-profit, federal- or state-qualified community health center—primary medical care
- 26. Private, for-profit, home health care/hospice agency—skilled home health care
- 27. Private, not-for-profit, federally qualified health maintenance organization—primary medical care
- 28. Private, not-for-profit, hospital-based clinic-primary medical care
- 29. Public, state-qualified dental school-dental care
- 30. Private, for-profit, home health care/hospice agency—skilled home health care and home hospice care

REFERENCES

- 1. Sonsel GE. Case management in a community-based AIDS agency. *Qual Rev Bull*. 1989; 15(1):31–36.
- 2. Perrow C, Guillén MF. The AIDS Disaster: the Failure of Organizations in New York and the Nation. New Haven, CT: Yale University Press; 1990.
- 3. Mechanic D, Aiken LH. Lessons from the past: responding to the AIDS crisis. *Health Aff*. 1989;8(3):16–32.
- 4. Fleishman JA, Piette JD, Mor V. Organizational response to AIDS. Eval Prog Plann. 1990;13(1):31-38.
- 5. Mulford CL, Rogers DL. Definitions and models. In: Rogers DL, Whetten DA, Associ-

ates, eds. Interorganizational Coordination. Ames, IA: Iowa State University Press; 1982:9-31.

- Doreian P, Woodard KL. Fixed list versus snowball selection of social networks. Soc Sci Res. 1992;21:216–233.
- Boje DM, Whetten DA. Effects of organizational strategies and contextual constraints on centrality and attributions of influence in interorganizational networks. *Admin Sci* Q. 1981;26:378-395.
- Morrissey JP, Hall RH, Lindsey ML. Interorganizational Relations: a Sourcebook of Measures for Mental Health Programs. Washington, DC: US Government Printing Office; 1982. DHHS Publication (ADM)82-1187.
- Bolland JM, Wilson JV. Three faces of integrative coordination: a model of interorganizational relations in community-based health and human services. *Health Serv Res.* 1994;29(3):341-366.
- Morrissey JP, Calloway M, Bartko WT, Ridgely MS, Goldman HH, Paulson RI. Local mental health authorities and service system change: evidence from the Robert Wood Johnson Program on Chronic Mental Illness. *Milbank* Q. 1994;72(1):49–80.
- 11. Wright ER, Shuff IM. Specifying the integration of mental health and primary health services for persons with HIV/AIDS: the Indiana integration of care project. *Soc Networks*. 1995;17:319–340.
- 12. Provan KG, Sebastian JG, Milward HB. Interorganizational cooperation in community mental health: a resource-based explanation of referrals and case coordination. *Med Care Res Rev.* 1996;53(1):94–119.
- 13. Seidler J. On using informants: a technique for collecting quantitative data and controlling measurement error in organizational analysis. *Am Soc Rev.* 1974;39:816–831.
- 14. Van de Ven AH, Ferry D. *Measuring and Assessing Organizations*. New York: Wiley; 1980.
- 15. Borgatti S, Everett M, Freeman L. UCINET IV [computer program]. Version 1.0. Boston, MA: Analytic Technologies; 1992.
- Borgatti S, Everett M, Freeman L. UCINET IV. Version 1.0. Reference Manual. Boston, MA: Analytic Technologies; 1992.
- 17. Hubert LJ, Schultz J. Quadratic assignment as a general data analysis strategy. Br J Math Stat Psychol. 1976;29:190-241.
- Marrett CB. On the specification of interorganizational dimensions. Sociol Soc Res. 1971;56:83–99.