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Original Article

Application of social network analysis in the assessment of organization infrastructure for service delivery: a three district case study from post-conflict northern Uganda

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Abstract

In post-conflict settings, service coverage indices are unlikely to be sustained if health systems are built on weak and unstable inter-organization networks—here referred to as infrastructure. The objective of this study was to assess the inter-organization infrastructure that supports the provision of selected health services in the reconstruction phase after conflict in northern Uganda. Applied social network analysis was used to establish the structure, size and function among organizations supporting the provision of (1) HIV treatment, (2) maternal delivery services and (3) workforce strengthening. Overall, 87 organizations were identified from 48 respondent organizations in the three post-conflict districts in northern Uganda. A two-stage snowball approach was used starting with service provider organizations in each district. Data included a list of organizations and their key attributes related to the provision of each service for the year 2012–13. The findings show that inter-organization networks are mostly focused on HIV treatment and least for workforce strengthening. The networks for HIV treatment and maternal services were about 3–4 times denser relative to the network for workforce strengthening. The network for HIV treatment accounted for 69–81% of the aggregated network in Gulu and Kitgum districts. In contrast, the network for workforce strengthening contributed the least (6% and 10%) in these two districts. Likewise, the networks supporting a young district (Amuru) was under invested with few organizations and sparse connections. Overall, organizations exhibited a broad range of functional roles in supporting HIV treatment compared to other services in the study. Basic information about the inter-organization setup (infrastructure)—can contribute to knowledge for building organization networks in more equitable ways. More connected organizations can be leveraged for faster communication and resource flow to boost the delivery of health services.

Keywords: Organization infrastructure, post-conflict, health systems development, social network analysis

Key Messages

- Assessing the organization networks for service delivery can provide vital information upon which to benchmark health system developments in post-conflict settings.
- Taking organization networks (diversity, size and function) as an infrastructure for service delivery, the study findings illustrate differences in this resource across post-conflict districts, vital services (HIV treatment, maternal delivery) and health system strengthening (health workforce) roles.
- The methods and findings illustrated here can help decision makers to track and steer health system developments by leveraging and adjusting the organization networks (membership size, connections and roles) to optimize their distribution and increase the integration of service delivery systems and platforms in post-conflict settings.

Introduction

As social and political conflicts continue to emerge or remain unresolved, the health status of populations caught up in these situations remains a major public health challenge. Estimates show that about one-sixth of the world population is resident in conflict-affected situations (Haar and Rubernstein, 2012). There is also a growing interest from the scientific community and policy makers to generate new knowledge about how best to safeguard and reconstruct the systems that provide health and other social goods and services to these communities (DFID, 2008). In this quest for evidence, many research communities have focused rightly on the needs, rights and obligations to preserve dignity and welfare needs of vulnerable communities. Yet, much of the published literature has focused on the short-term health and social needs of the communities, often emphasizing the humanitarian response to crises Blanchet and James (2013). There is still relatively little research about how to reconstruct systems for the sustainable provision of health services in post-conflict situations (Roberts *et al.* 2009; Petit *et al.* 2013).

Restoring health services is an essential component of any recovery program that follows prolonged periods of conflict (Jones *et al.* 2006; Kruk *et al.* 2010). The period following conflict manifests the interim nature of political, social and health systems in these settings, also reflecting the transitional shift between emergency, recovery and reconstruction phases (Hansen *et al.* 2008; Health Systems 20/20 2008; Vergeer *et al.* 2009). The transition from recovery to reconstruction phase forms the context for this study. This transition is characterized by changes in the mix of organizations or a shift in their missions from short-term to longer-term development objectives (Waldman, 2006).

Increasingly referred to as 'fragile states', post-conflict health systems are characterized by high poverty levels, negligible public service provision and weak structures for governance. These settings present unique challenges especially for those concerned with health system strengthening and long-term assurance of other programs that form the social safety net for these communities. The main challenges include (1) the levels of capacity and trust enjoyed by the state, (2) multiplicity of health-related actors, (3) short-term focus of funding organizations, (4) drifting objectives and commitment of humanitarian organizations and (5) dynamic shifts in resources and capacity of the social safety nets that support the communities in these situations (Kruk *et al.* 2010; Petit *et al.* 2013).

Background

The Acholi region in Northern Uganda experienced 20 years of armed conflict (1986–2006) between the Government of Uganda (GoU) and insurgents associated with the Lord's Resistance Army (LRA), which left a legacy of destroyed infrastructure, insufficient workforce and limited state financing for meeting social sector needs (Uganda, 2007). During the conflict, the displaced population was concentrated in internally displaced people's Internally Displaced People camps where basic health services were provided by a mix of government and humanitarian organizations. The workforce was made up of many expatriates and the financing provided by external donors. Some estimates show that, towards the end of the conflict, between 2004 and 2006, there were over 300 health-related organizations in the region, largely concentrated in the Gulu district (IOM, 2006). Despite the absence of a formal peace agreement between the GoU and the LRA, since 2006 there has been a cessation of hostilities that has allowed programs for reconstruction to take root.

Where the state has been a major party to the conflict, as in Northern Uganda, the commitment, capacity and trust it garner to offer programs may be limited early in the post-conflict period. This is often exacerbated by early recovery conditions (Waldman, 2006; Kruk *et al.* 2010) characterized by transitioning from well-financed humanitarian objectives and expatriate workforce to new circumstances and require different programming approaches for re-establishing state capacity and sustainable programs. To build sustainability and resilience in health system reconstruction, the OECD (2012) proposed principles that include, among others, the rebuilding of state institutions and their legitimacy, local ownership of development programs, prioritization and appropriate sequencing, and coherence in both aid instruments and policy. Kruk *et al.* (2010) identified structural dilemmas during the transition from short-term humanitarian objectives to sustainable and resilient health systems (Kruk *et al.* 2010). These include reduced financing of social services after the active phase of conflicts and the exodus of humanitarian organizations early in the post-conflict period. In northern Uganda, as the conflict waned in 2006, many providers of humanitarian services were phased out, a situation that created a depletion of service availability and capacity and generated discontinuities in health system functioning (Namakula *et al.* 2011). Nonetheless, evidence in Uganda and elsewhere shows that a multiplicity of development oriented organizations become mobilized and ~~proceeded to~~ initiate programs to fill the gaps created by the departure of humanitarian agencies (Fujita *et al.* 2011; Petit *et al.* 2013).

These studies also illustrate the opportunities and challenges centred on how to steer the proliferation of organizations and development agendas in post-conflict settings. Although standard protocols for health service delivery have been developed to guide humanitarian providers (Sphere Project, 2011), humanitarian agencies have often inadequately supported indigenous capacity during

either the emergency or rehabilitation periods thus increasing the risk of little being left behind when they exit (Waldman, 2006; Newbrander *et al.* 2011; Harvey, 2013) leaving a deficit of capacity and experience. Effective stewardship of health systems requires that the capacity of domestic institutions be strengthened to lead the transition from short-term humanitarian response to long-term reconstruction and development stages. Among the central elements in building state capacity for steering health systems development is access to information about the means and outcomes of development programs (Harris *et al.* 2008), including, as noted by the OECD (2012:69), 'local aid information management systems [which] should be charged with mapping resource flows against priorities'.

Although strong evidence exists about short-term outcomes, the evidence about the means—the underlying systems and processes (i.e. the infrastructure) that support and sustain program implementation—is scanty (IOM, 2006; Dijkzeul, 2005). Strategic steering of health systems development in the post-conflict phase would benefit from greater attention to the means—particularly the process of how organizations create and cultivate networks across public and private sectors to address public health goals (Palmer *et al.* 2006) and the contribution they make to re-establishing the wider health system during the post conflict period.

Inadequate management of a dynamic and 'congested' set of actors, however, is not unique to post-conflict settings (Commission, 1998; Rier and Indyk, 2006), for example, highlight the 'severe fragmentation' of HIV services in New York, which 'render crucial the capacity to develop, modify, and maintain rich inter-organizational and inter-system linkages'(Rier and Indyk 2006). While innovations such as establishing inter-organization partnerships and coalitions to deliver coordinated health services across many actors have been evaluated outside post-conflict settings (Rier and Indyk, 2006; Blanchet and James, 2013; Wasche, 2015); the main challenge in post-conflict settings is that state institutions operate with weaker stewardship capabilities. State capacity to steer these partnerships remains essential (Audit Commission, 1998; Harris *et al.* 2008; Lewis *et al.* 2008). Jones *et al.* (2006) recommend that programs aimed at rebuilding the health system should invest in state-led coordination of health actors as a means to achieving stronger ownership by the government or local authorities. Affected post-conflict states, therefore, need to rapidly acquire capacity to coordinate the multitude of organizations engaged in reconstruction programs. This becomes particularly complex with multiple organizations entering and exiting post-conflict settings, affecting the composition, function and performance of the health system. Information about these dynamics and their impacts on the health system developments is rarely available to decision makers. With a few exceptions (Blanchet and James 2013), diagnostic tools to aid decision makers in assessing the organizational infrastructure and function for service delivery are scanty. Given the rapidly changing organizational dynamics in post-conflict health systems, designing and deploying diagnostic tools to fill this information gap is vital for the overall purpose of building capacity for system stewardship for local and national governments.

In this study, we investigated the organizational infrastructure supporting the provision of selected priority health services in three post-conflict districts in northern Uganda. A more thorough understanding of the organizational architecture may lead to strengthened collaboration as well as contribute to wider benefits. As emphasized by Wasche (2015, p. 542), 'cooperation in inter-organizational networks can generate benefits through sharing resources, knowledge and core competencies of involved actors, which may lead to accomplishment of common goals, increased performance and innovative behaviour' (Wasche, 2015). Our aim in this paper is to examine, through social network analysis, the type, size and relational networks among state and non-state organizations involved in the provision of services for HIV treatment, maternal delivery and workforce strengthening functions at a district level. This research was led by the following research questions:

- Which organizations support the three selected services—i.e. maternal delivery, HIV treatment and workforce strengthening functions?
- How are the inter-organization relationships structured (centrality and integration) in each district to support the selected services?
- What service roles and objectives are played by the most central organizations in these networks?

This study draws on social capital and social network theories to understand the inter-organizational relationships and dependencies in providing health services at a district level. Lin and Erickson (2008) defines social capital as 'resources embedded in one's social networks, resources that can be accessed or mobilized through ties in the networks' (Pfeffer and Salancik, 1978; Lin and Erickson, 2008). Social network theory uses the structure and density of relational connections to explain variation in capacity and performance of member organization and the network as a whole (Provan *et al.* 2011). This study is based on the positive notion of organizational networks—where more connection with other organizations is perceived to generate superior collaborative capital for the provision of health services to the communities (Hjern and Porter, 1981).

Methods

This is a 3-district case study using the social network approach to data collection and analysis. Data collection sought to establish the relational architecture or networks among organizations supporting the provision of HIV treatment, maternal delivery services and organizations contributing to strengthening the health workforce in post-conflict northern Uganda. In this study, a relationship was defined as any linkage [support/activity/engagement] between the respondent organization and another external organization for any of the three services above. Four types of relationship were defined; administrative, fund holder, service delivery, community mobilization see Figure 1. The districts of Gulu, Kitgum and Amuru were purposively selected from the Acholi sub-region, the epicenter of the armed and social conflict in northern Uganda (Namakula *et al.* 2011). Among the three districts, Amuru is a relatively 'young' district having been split off from Gulu district in 2006 (Namakula *et al.* 2011), while the other districts are older and better established. Data were collected from January to March 2013—a period that can be characterized as the recovery or reconstruction phase in the post-conflict discourse in Acholi sub-region (Uganda, 2007).

Table 1 provides a comparative picture about key indices across the three study districts.

The services selected for this study were (1) treatment for HIV; (2) Maternal delivery, and (3) health workforce strengthening. These services were selected on the basis of their prominence in post-conflict health system reconstruction in Uganda and the expected integration among them that is necessary to ensure optimal system effectiveness. Programs for the treatment of HIV were highly visible, enjoying relatively high donor financing and participation of many state and non-state organizations in Uganda (IOM, 2006). Relative to the national average of 7.3, the HIV prevalence in study areas was 10.1% (MOH

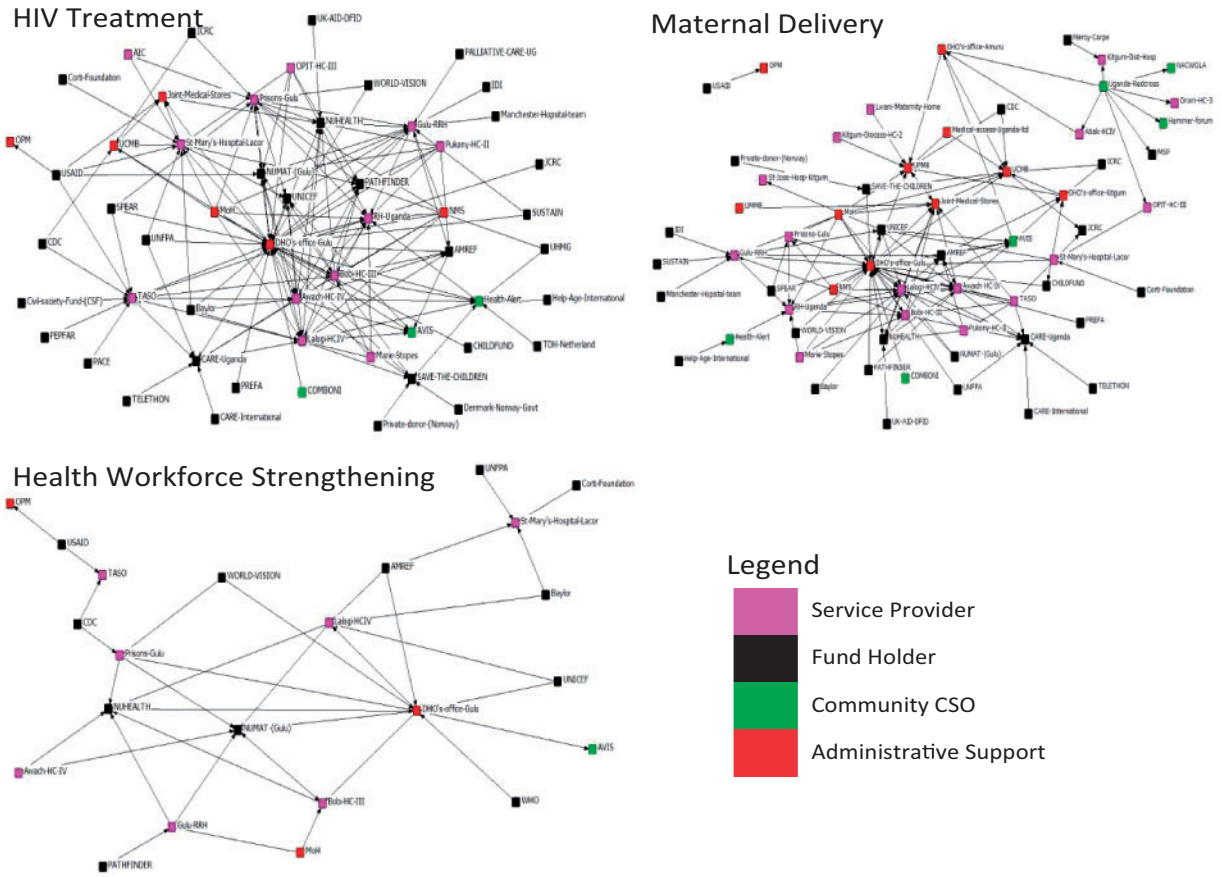

Figure 1. Network graphs for organizations supporting different services in the three districts

Table 1. Descriptive information of the study districts - 2012–2013 (Source MOH, 2011)

	Gulu	Kitgum	Amuru
Population (est. mid year 2012)	385 600	238 300	174 000
Number of estimated annual pregnancies	20 051	12 392	9048
Percent pregnant women covered by HIV testing	81%	44%	42%
Percent of pregnant women delivering in a health facility	66%	41%	29%
Number of eligible persons for HIV treatment (include children)	16,046	9916	7240
Percent coverage for HIV treatment programs	175%	73%	7%
Proportion of filled Health Workforce posts compare to approved posts	77%	67%	77%
Number of health centres	51	35	35

and ICF, 2012)—thus providing opportunities to leverage HIV funds for broader systems improvements (Atun *et al.* 2011). Concerns for improving maternal delivery services in the study region were high among national stakeholders especially because the population was moving away from a refugee camp model of service provision to a rural settlement model where service delivery systems had collapsed (Uganda, 2007). Given the enormous health workforce shortage in post conflict areas, insights about recruitment, re-skilling and retention of the health workforce in the rural settings was considered vital to re-establishing the health system for the transition from camps of internally displaced population to rural resettlement in the Acholi sub-region (Namakula *et al.* 2011)

Sampling of organizations

The findings are based on 87 organizations, which were identified from 48 interviews using a 2-step snowball approach (Doreian, 1992; Wasserman and Faust, 1994). The purpose of the 2-step snowball was to generate a fairly complete set of organizational relationships (network) in each district. A complete set of organization relationships is a requirement for the socio-metric approach to the data analysis (square matrices) used in this study. The step-1 interviews involved the District Health Offices (DHOs) and service provider organizations (SPOs) such as hospitals and level III and IV health centres. The list of organizations generated from step-1 (first order) interviews was used to identify the respondent organizations for step-2 interviews. Most organizations interviewed in step-2 (second order) were those involved in supporting the DHOs and SPOs. Broadly, step-2 interviews involved fund-holder, civil society, and administrative organizations that were providing finances, community mobilization and coordination activities respectively. If not already interviewed in steps 1 and 2, organizations generated from step-2 interviews (third order) were not followed up for interviews

but information about the roles they play in supporting the respondent organizations was collected and analyzed. Most of the third-order organizations were located outside of the study area and many were located outside Uganda.

Senior staff member in respondent organizations were interviewed after securing their informed consent and permission from the organization. In a few instances, the required information about the organization was generated by interviewing 2–3 different people. At each stage, respondents were asked to list separately, all organizations that supported (1) HIV treatment, (2) maternal delivery and (3) workforce strengthening functions in the previous financial year (2011–12). For workforce strengthening, actions such as recruitment, salary payment, in-service training, and provision of incentives were used to list organization. A standard set of questions (Likert-scale 1–10 lowest to highest) was used to generate information about how vital each relationship was to the performance of the respondent organization. Finally, alongside the socio-metric interviews above, open-ended questions were asked to establish the main objectives at the centre of the relationship between the respondent agency (ego) and each listed partner (alter). For respondent organizations that had many partner organizations, the interviews were conducted in two separate appointments each lasting about hour.

Data transformations, analysis and visualization

For this paper, the relational (socio-metric) data were organized in symmetrized and dichotomized square matrices and analyzed using UCINET analytical software for social network analysis (Borgatti *et al.*, 2002). Separate matrices for HIV treatment, maternal delivery and for district workforce strengthening were created for each district. Two data transformations were made to facilitate the comparative analysis of the service networks (matrices). First, the data for each service network (matrix) was converted to a square matrix (a matrix with the same number of rows and columns.) that had a full list (87) of organizations found across the three districts. This was aimed at generating comparable matrices for analysis. Secondly, a fourth matrix (network) was created by adding all the three (HIV, Maternal and Workforce) matrices in each study district. This created an aggregated matrix in each district (composed of all the three services) and enabled the comparison of organization structure across the three study districts. Structural differences in the district-level and service-level networks were explored using correlations matrices in UCINET analytical software (Borgatti *et al.*, 2002). The extent the network ties were addressing each of the three selected services was explored by the proportion of ties in each service network compared with the overall (aggregate network for each district (see Figure 4). For visualization and applied interpretations, the matrices are displayed as networks made up of nodes and ties that respectively represent each organization and the inter-organizational relationship. The core-periphery algorithm in UCINET analytical software (Borgatti and Everett, 1999) was used to identify organizations that were more highly connected (core) from those that were less connected (periphery)

Also analyzed was the qualitative data generated from the open questions regarding the purpose served by the listed organization (alter) with regard to HIV treatment, maternal delivery and strengthening the health workforce in the respondent's organization (ego). Instead of covering all the 87 organizations, the qualitative analysis focused on 38 organizations that were identified as core (high degree of connections) within the district networks. Transcripts about organization with a centrality measure of 3 (and above) were used for the qualitative analysis. For the purpose of identifying the main functional areas supported within each relationship (dyad), manual coding and categorizing the data was done separately for each service. Organizations were categorized into four functional types according to the most prevalent functions they served in the network. As shown in Table 3, these functional categories are (1) Service providers, (2) Fund holders, (3) Community-based Civil society organizations (CSOs) and (4) Administrative organizations.

Findings

Table 2 provides the total number of organizations that were participating in the provision of HIV treatment, maternal delivery and contributing to health workforce strengthening services across the three study districts. The table also provides the mean number of organizations relating with the respondent unit (Degree), the density of the interconnections in the network and the total inter-organizational ties that existed for each service in the study districts.

Gulu district had the highest number of organizations participating in maternal delivery and HIV treatment services. In contrast, Amuru district had the least. The network size for HIV treatment and that of maternal delivery services involved a large set of organizations compared to the network supporting health workforce strengthening services. The density of a network here refers to the total number of ties divided by the total number of possible ties in the network. To enable comparison for network density, a square matrix for each service and workforce consisted of all the 87 organizations found in the three districts. The number of ties and density of the collaborating organizations in Gulu was about four times higher than the ones in Amuru. The ties and densities in Kitgum district lay in between the measures in Gulu and Amuru.

Network structure and membership

The visual graphs of the network (Figure 1) illustrate the relational structure of the organizations supporting HIV treatment in the three study districts, while Figure 2 illustrates the structure for organizations that were supporting each service in Gulu district. Different colours are used for different organization categories and their position in the network. For instance, the Gulu district graph shows more organizations in the HIV service network compared with other districts. Gulu also has relatively more fund-holders both at the centre and at the periphery of the service networks. Figure 2 shows that the service network structure for strengthening workforce activities is more sparse compared with the networks supporting HIV treatment and Maternal services in Gulu district. Similar patterns of network structure were observed from the perspective of the three districts and the three services. (Other network graphs are available from the authors on request).

To further explore which organizations are central to the networks for service delivery in each of the three districts, we present below the results of a core-periphery analysis (Borgatti *et al.*, 2002). In theory, the organizations with high index (core) are those that are potentially most efficient in terms of mobilizing the district network for the delivery of the selected services. Figure 3 shows the list of organizations and the extent to which they are contribute to the core set of organizations in the network providing the three focal services in Gulu and Kitgum districts. For Amuru district, the density connections were too low to form a core and peripheral structure. For Gulu district, there are more fund-holder organizations among the core organizations compared with Kitgum district. Unlike Gulu district, where the District Health Office is the most highly connected organization, AVSI, a community-based civil society organization, is most core in Kitgum district. The presence of

Table 2. Number, density, degree and network ties in study districts

	No. active organizations	Mean degree[a] (StdDev)	Total network ties[b]
Maternal Services—Gulu	52	3.5 (5.0)	260
Maternal Services—Kitgum	34	2.5 (4.5)	192
Maternal Service—Amuru	24	1.0 (2.0)	64
HIV Treatment Services—Gulu	54	4.0 (6.2)	300
HIV Treatment Services—Kitgum	39	2.7 (4.4)	198
HIV Treatment Services—Amuru	24	1.0 (2.0)	64
Workforce Functions—Gulu	23	1.0 (2.0)	70
Workforce Functions—Kitgum	24	1.0 (1.9)	90
Workforce Functions—Amuru	18	0.5 (1.2)	40

[a]Mean degree is the average number of organizations connected to each in the network.
[b]These are reciprocal ties created by dichotomization.

Table 3. Relational objectives by core network organizations in Gulu and Kitgum

Relational objectives	Service providers	Fund holders	Community CSOs	Admin. organizations
Maternal Health				
1. Service provision for family planning	++++	+	+	–
2. Support logistics—drugs, transfusion	++	++++	+	+
3. Funds for support supervision	+	+++	+	+
4. Support maternal delivery services	++++	+	+	++
5. Provides Funds for operational expenses	–	++	+	+
6. Support PMTCT services	++++	++	+++	+
7. Provide transport/communication	+	++	+	+
HIV Treatment				
1. Support service provision in HIV	++++	++++	+	++
2. Provide tech assistance to the district	–	++++	+	++
3. Supports logistics, ARVs and guidelines	+	++++	++	++++
4. Health information and records	+++	++++	+	++
5. Coordinate district health programs	+	+		+++
6. Supports infrastructure/building	–	++	++	++
7. Support laboratories e.g. CD4 Machines	–	++++	+	++
8. Provide food for HIV infected persons	–	++	++	–
Support to Health Workforce				
1. Support recruitment of laboratory staff	–	+++	+	+
2. Support capacity building/training	++	++	+	+
3. Pay Salary/incentives for retention	++++	+++	+	+++
4. Training of workers in HIV/Maternal	++	+++	++	++
5. Recruitment of Midwives	++	++	+	++

Key: (++++) highly addressed tasks; (+++) moderately address tasks; (++ and +) less addressed tasks and (−) tasks not addressed at all.

more fund-holder organizations in Gulu district suggests a higher potential for financial resource mobilization for health programs in that district compared to Kitgum and Amuru. Among the core organizations, 9 out of 19 in Gulu district and 7 out of 17 in Kitgum district were international organizations with perceived short-term (1–2 year) commitments to the roles they were serving in these districts.

Differences in network structure

Figure 4 shows that inter-organization networks are mostly focused on HIV treatment in Gulu and Kitgum and least for workforce strengthening functions. In these two districts, the network ties contributing to workforce strengthening functions were 6–10% while ties contributing to HIV treatment activities ranged from 69 to 80%. Despite sparse organizations and interconnections in Amuru district, the three services were fairly covered. This indicates that the few service organizations in this district were able to support a more integrated service programs across the three services compared to Gulu and Kitgum districts with a lot more organizations.

Functional roles and objectives in networks

From the qualitative findings (Table 3), most central (Core) organizations (in Figure 3) served various roles and functions for each of the services in the study. The pattern of these roles and functions indicates that fund-holder organizations played more diverse roles than other organization categories. In particular, fund-holders were perceived to play prominent roles especially in supporting logistic functions, medicines, laboratories, technical assistance and information systems. Service providers and administrative organizations were perceived to focus mostly on service delivery and logistics functions, respectively. Community level CSOs were perceived to play a wide range of roles but with little consistency across the networks. Although this study did not assess the funding directly, in districts with more fund-holding agencies like Gulu, opportunities exist for more financing of service delivery platforms.

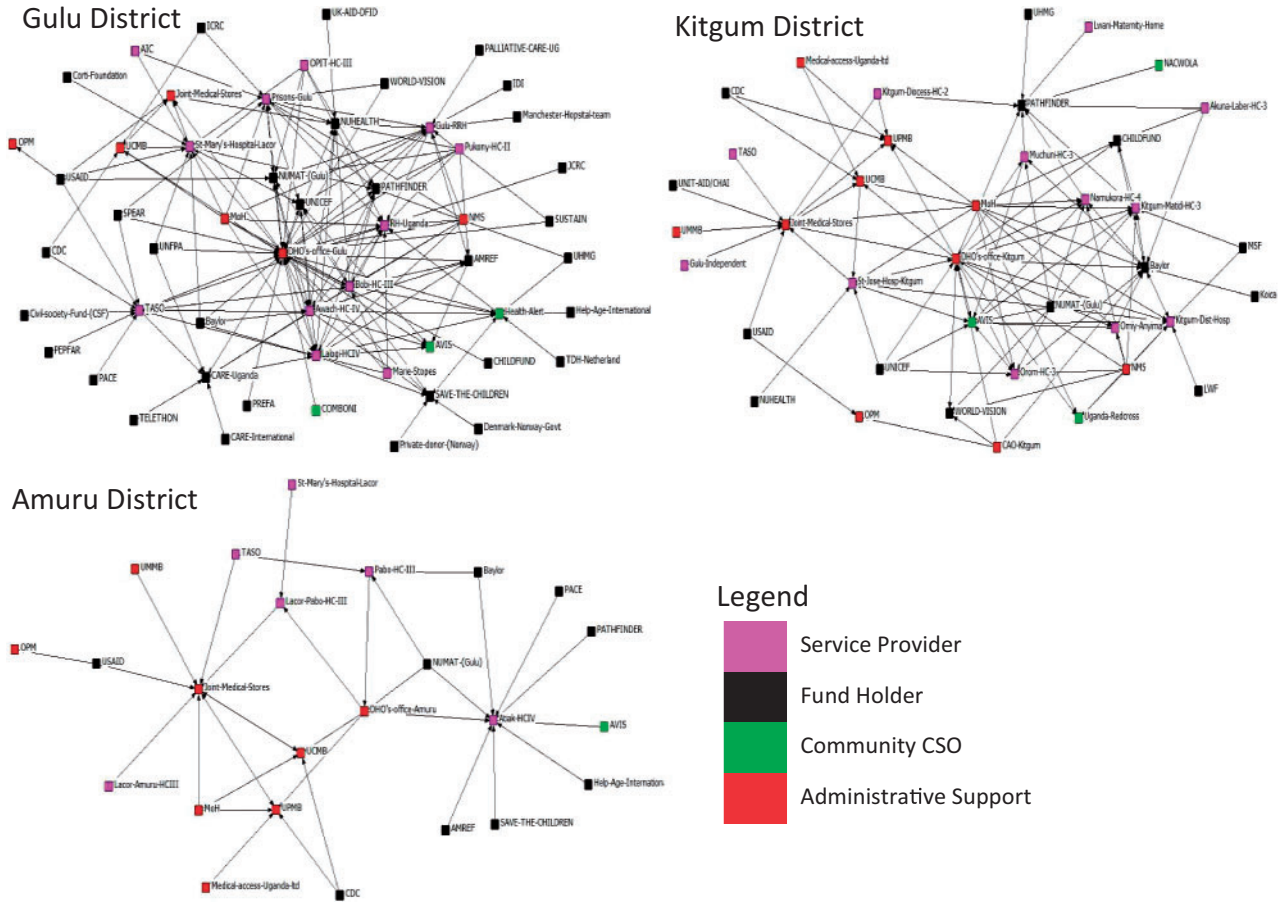

Figure 2. Network graphs for organizations supporting the three services in the Study districts

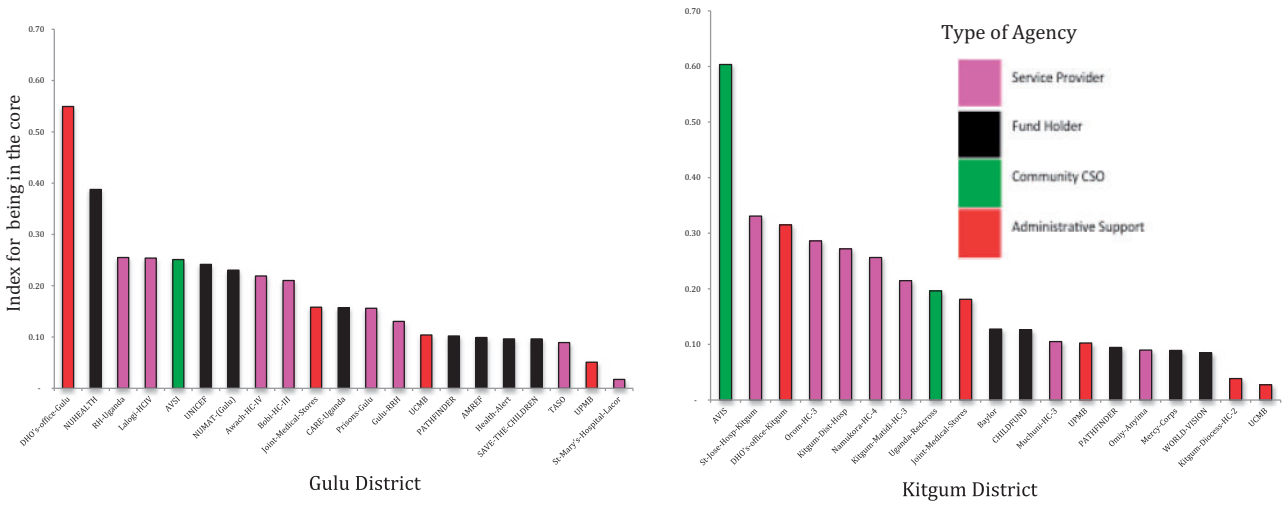

Figure 3. Most central organizations in Gulu and Kitgum districts for the three services in the study

Discussion

Strategic stewardship of development in post-conflict health systems requires attention to the process of how organizations inter-relate in re-establishing the wider health system functionality for service provision at national and sub-national levels (Krauss *et al.*, 2004; Lewis, 2005). From this perspective, this study empirically demonstrates the existence and pattern of organizational relationships for service delivery in post-conflict northern Uganda (Namakula *et al.*, 2011). In general terms, the findings show that the three study districts have different organizational infrastructure to support service delivery. If viewed from the social capital lens, Gulu and Kitgum districts have a rich organizational 'capital' to support service delivery relative to Amuru district. Earlier

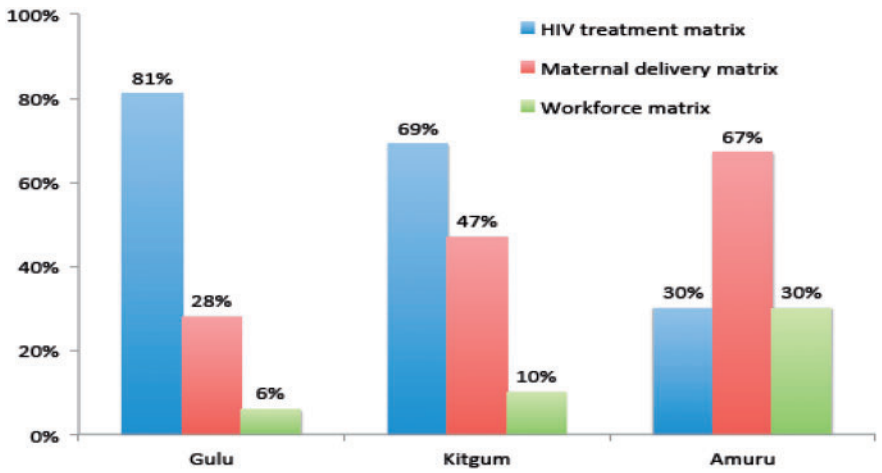

Figure 4. Proportion of organization ties focused on each service per district

post-conflict studies (Namakula *et al.*, 2011; Namakula and Witter, 2014) in the ReBUILD Consortium (https://rebuildconsortium.com) show a similar pattern—especially the limited investments in the workforce for health and the underlying incentives for their retention and motivation. They also show the dominance of HIV programs of international aid agencies especially in the reconstruction phase after the conflict (NUMAT, 2004; Westerhaus *et al.*, 2008).

The study approach provides a diagnosis of density of organization networks across three key health service domains—HIV treatment, maternal delivery and strengthening the health workforce. These three are among global and national health priorities that formed part of the millennium development goals and Uganda's health sector plan (MOH, 2011). In the post-conflict setting where this study was done, there is clear difference in composition of the inter-organization networks that supported health workforce strengthening compared with those supporting HIV treatment and maternal delivery as well as significant disparity in inter-organizational ties across all services in the two older districts, Gulu and Kitgum, and the younger Amuru district. This is despite Amuru district's greater development needs for service delivery and system strengthening if the objectives of decentralized service delivery and post-conflict reconstructions are to be achieved (Table 1). Nonetheless, the few organizations in Amuru demonstrated more comprehensive ties to all the three services compared to Gulu and Kitgum districts with a lot more organizations. As Figure 4 illustrates, 70–80% of the organizational ties in Gulu and Kitgum were focused on HIV treatment services. This may be interpreted as duplication or inefficient allocation of organisations in one service area. This finding may also suggests that fewer organizations such as in Amuru district, with a broader and comprehensive program may be more effective than having many agencies with a narrow focus at district level.

Networks for HIV treatment are generally more 'congested' in the study districts relative to the maternal delivery and workforce strengthening. Although this case study is limited to three districts, our proposition is that districts that serve as hubs for humanitarian programs at the peak of the conflict (e.g. Gulu) may attract/retain a dense network of organizations during the post-conflict phase. Gulu town is also the most economically established trading centre in the Acholi sub-region. The inequality reflected in network size and roles calls for purposive approaches for the distribution of organizations to uphold fair health system developments. In particular, these findings show the relative neglect of workforce strengthening despite the urgent demand to build human resource capacity in post-conflict settings as well as the need to redirect state and non-state health organizations towards geographic or administrative zones (districts) that may not be prioritized through voluntary choice. In Uganda, like many developing countries, the allocation of health development organizations to different roles in the health system and to different geographical zones/districts is done without sufficient evidence to inform these decisions. In many situations, the allocation of new grants (and affiliated organizations) is driven by criteria such as 'good performing districts' and availability of capable organizations—a situation that is bound to institutionalize and fuel inequalities in the organizational architecture and development of the health systems at the sub-national level. This is also partly a result of prioritizing HIV service provision by heavily funded development and humanitarian NGOs—while workforce investments are usually seen as the responsibility of the national government in both conflict and non-conflict situations (Stierman *et al.*, 2013)

Studies by Pavignani (2013), Palmer *et al.* (2006) and by Health System 20/20 (2008) report coverage and sustainability dilemmas that arise from building health systems on temporary and inconsistent capacity of organizations(Pavignani, 2013). Although this study does not cover issues of sustainability, it indicates the vulnerability of service delivery networks in the event that the core organizations with more dense connection have short-term or temporary commitments in the districts, a model that continues from the conflict period (Rowley *et al.*, 2006).

We demonstrate that profiling of core organizations can aid in understanding why some organizations occupy central positions in the network. By profiling these organizations, their contribution to system capacity can be clarified for synergistic developments. Role mapping (Tsasis *et al.*, 2013) if added to the diagnostic tools used in this study can aid the steering of service implementation processes by adjusting the roles where required. As reflected in Figure 3, some organizations are central to the network and may provide opportunity for leveraging the rest of the network as well as providing opportunity for strategic information and channelling of resources to the rest of the members. Collaborative interventions to link users and providers of HIV services, to control of tobacco in the USA, to reduce fragmentation of government bodies in United Kingdom, to implement primary health care programs in Australia and to provide eye care services in Ghana - have all applied similar social network

methods to generate information for steering these developments. Given the more dynamic and complex reconstitution of health system actors in post-conflict settings, prospective approach to generating such information can enable the monitoring of trends and patterns in health systems strengthening.

One major gap that this paper sought to fill is the inadequate focus on the inter-organization networks that in reality form the 'organization' that implements social programs in a given community or district. Hjern and Porter (1981) also recommend an empirical construction of 'organization pools' or networks that are responsible for implementing programs (Hjern and Porter, 1981). Among other methods, snowballing among members working collaboratively is widely used along with social network analysis techniques to undertake this task (Wasserman and Faust, 1994). This approach avoids pre-determining the organizational structure within which services are provided. Instead of using the formal script about the constituent organizations in a particular district, this study empirically generated the organizational networks from the perspective of delivering HIV treatment, maternal delivery and health workforce strengthening. Most importantly, this approach provides an opportunity to assess membership and structure of the collaborating organizations. The intention is to repeat this study in the near future and compare with the baseline findings reported here. This variation over time will be used to assess how organizational networks change in post-conflict northern Uganda. Generating panel data from repeated surveys, if linked to decision making, can help to redirect the organizations (number size, roles and capacity) in a manner that strengthen district-level health systems. Many analyses of health systems present the formal structure of service delivery systems as prescribed by formal design in government documents. When faced with the objectives of building health systems in highly dynamic settings such as post-conflict setting, decision makers need to find information that is able to reflect the organizational structure and the collaborative capital that different organizations bring in terms of connections and functions.

Like any study of relationships, the limitations related to recall of organizations or biases about the roles and functions can arise from study respondents. This was mitigated to some extent by a validation meeting in the study districts and by symmetrizing the matrices—an approach that allowed a connection to be established if one respondent indicated an existence of a relationship. The assumption that more dense networks are more able to raise social capital to deliver services was made in this work (Hjern and Porter, 1981). This assumption may require empirical testing in the study districts. Likewise, the assumption of efficiency with increasing size of the network may not be realistic in all situations.

Conclusion

In post-conflict health systems, like other situations characterized by congested system actors and very dynamic patterns of organization-level participation, an empirical method like the one used here can be applied to assist governments and humanitarian organizations in establishing an information system for making a 'diagnosis' of the organizational infrastructure to support effective decision making for health system developments. Effective health system stewardship in complex and dynamic settings will benefit from tools that are able to monitor the density, relational structure and roles of health system actors to support more equitable health system developments especially in highly dynamic setting similar to post-conflict settings. Decision makers can commission and use findings similar to what is presented in this paper to redirect the organization infrastructure and architecture to address priority health goals especially among communities underserved by inter-organization networks and the social/resource capital that these represent. By recognizing the more central organizations in the service networks, decision makers can gain strategic leverage of these for more effective influence of other network members and boost sub-national health system development and performance.

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