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Title

Using the structure of social networks to map inter-agency relationships in public health services

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Abstract

This article investigates network governance in the context of health and wellbeing services in England, focusing on relationships between managers in a range of services. There are three aims, namely to investigate, (i) the configurations of networks, (ii) the stability of network relationships over time and, (iii) the balance between formal and informal ties that underpin inter-agency relationships. Latent position cluster network models were used to characterise relationships. Managers were asked two questions, both designed to characterise informal relationships. The resulting networks differed substantially from one another in membership. Managers described networks of relationships that spanned organisational boundaries, and that changed substantially over time. The findings suggest that inter-agency co-ordination depends more on informal than on formal relationships.

Keywords

Informal networks; relationships; latent position cluster network model

Context

There is a large and diverse literature, stretching back over more than 20 years, that charts the decline of the bureaucratic organisation of public services, and its gradual replacement with de-centralised networks of agencies charged with delivering services to citizens (Bouckaert, Peters and Verhoest 2010, Sorenson and Torfing 2007). These developments are often referred to as examples of network governance. Network governance is a broad term, and authors draw on a range of theoretical traditions including cybernetics, rational choice and governmentality: arguably, the range of traditions reflects genuine difficulties in studying and understanding contemporary developments. It is still not clear, even with the

benefit of some hindsight, why multi-agency arrangements have developed in so many public services in so many countries. Increases in the scale and complexity of social challenges, however, such as providing services to frail older people in their own homes, and supporting disadvantaged families with young children, seem to have played a role. It is still not clear, even with the benefit of hindsight, why the multi-agency arrangements have developed, but increases in the scale and complexity of social challenges, such as providing services to frail older people in their own homes, and supporting disadvantaged families with young children, seem to have played a role. Research evidence has shown however that de-centralised networks have not been a panacea. Multi-agency co-ordination has often been problematic, with the result that citizens have not been receiving the combinations of services that they need.

This article presents a quantitative study of network governance, which focuses on local organisational responses to national health and wellbeing policies in England. Successive governments have funded initiatives aimed at less advantaged communities, where circulatory and other problems are concentrated, and which are a disproportionately large source of morbidity and mortality (Department of Health 2008). In practice, in any given locality, no single statutory, private or voluntary service can deliver effective solutions on its own: effective implementation requires co-ordination among several agencies. We might expect, therefore, to find evidence of de-centralised networks in localities – of local organisations seeking to co-ordinate their work with one another, in order to secure funds from government departments and to direct them effectively to disadvantaged communities.

The network governance literature is characterised by abstract theories, and by narrative studies which focus on negotiations between agencies. There have been few

quantitative studies of network governance, of the kind that are more common in the literatures on social networks, even though multi-agency working clearly raises questions about the patterns of, and dynamics of, those working relationships. This study employs quantitative methods to investigate, (i) the configurations of networks, (ii) the stability of network relationships over time and, (iii) the balance between formal and informal ties that underpin inter-agency relationships. The study presented here forms part of a larger project examining creation and mobilisation of knowledge among managers in health and social care (Ward *et al.* 2014).

Conceptualising networks

Conceptually, the term network has an awkward multiple character. It has been used to refer straightforwardly to patterns of relationships – a diagram of a network tells us who interacts with whom. It has also been used as an explanatory concept, where the behaviour of the network 'produces' some social phenomenon of interest (Clark 2013, Lanham et al. 2013). It can also be used normatively, for example as an ideal type in studies of the governance of organisations, just as bureaucracies were normative ideals in decades past (Lewis, 2011). Our interest here is in part descriptive, and in part designed to shed light on normative assumptions about inter-agency networks. In this study we focused on the managers – sometimes referred to as middle managers – who are responsible for co-ordination. We did not focus on actors involved in strategic planning, or those delivering services to individuals or groups, but on those who sit between the two, and might be expected to be in contact with colleagues in other agencies on a weekly or monthly basis.

A number of authors, including Lewis (2011), Sorensen and Torfing (2007) and Rhodes (2006) have reviewed the substantial and diverse literatures on network governance. While there are differences in the domains studied, and in the theoretical conceptualisations and methods used, it is nevertheless possible to make some general observations. We can say that agencies have become more dependent on one another to deliver services, and therefore need to negotiate with one another in order to co-ordinate their work. By implication they need to have objectives in common, and be able to share knowledge and act upon it. We can also say that networks are typically assumed to arise 'naturally', presumably in response to the developments noted above, but are often co-opted by regional or national policy makers, who seek to formalise them and use them instrumentally to achieve their objectives.

In the case of health and wellbeing services, in this study, monies were allocated on a programme basis by central government, and received initially by a lead agency, which was responsible for co-option and coordination in a locality. On the basis of the literature, therefore, we would expect to observe a mixture of formal and informal relationships in localities. We would also expect to find either successful – and by implication, at least, stable – relationships, or evidence that co-ordination efforts had failed.

In connection with the latter, there is evidence that networks are by no means a panacea, and there are many reports of difficulties with inter-agency and inter-professional working. These include broad alliances of agencies involved in public health programmes (Bauld et al., 2005), health and social care partnerships (Williams and Sullivan 2010) and managed clinical networks (Waring, Currie and Bishop, 2013).

Studying Networks

The majority of studies of network governance arrangements have produced narrative accounts of practices across organisational or professional boundaries. They have typically conceptualised networks as the products of on-going negotiations between actors. Relatively few have used quantitative methods to investigate underlying patterns of relationships. There are conceptual and technical reasons why this has been the case, some highlighted a long time ago by the problems associated with structural functionalism - with its over-emphasis on systems and structures - and others stemming from the difficulties of interpreting quantitative network analyses (Provan et al. 2010).

While narrative approaches avoid a number of problems, though, they arguably do so at a price. In particular, they cannot be used to address two fundamental questions about network governance, namely (i) who are the actors within networks, given that networks may be large and involvement in them informal, and hence invisible via 'official' documents?, and, (ii) what is the dynamic behaviour of networks? Do networks change in size and configuration over time, or are they typically stable over periods of months or years? This study draws on the work of Lewis et al. (2008) and Crossley (2011), who address the two questions in their work. It should be stressed that network governance theories, being abstract in nature, have little to say about the fine-grained characteristics of networks, whether it is the ways in which individuals in different organisations are related in networks, or the ways in which networks change in membership or structure (or both over) time.

The most common approach to network analysis makes use of graph theory to express the pattern of connections between actors. Sociograms are often used to visualise relations

in networks. It is also usual to generate measures of a network to show the importance of actors within it, e.g. by establishing the degree, or number of connections with others, for actors in the network. For our study, identifying degrees was of limited value, because we had limited the number of connections named by participants to five: the method itself would influence the degree statistics. Our principal focus in this study, though, was on collective action. Crossley (2011) argues that a number of important network phenomena occur in clusters, which lie between the 'poles' of structure and agency. For that reason we have focused on clustering, and the stability of clusters over time.

Methods

Setting

The study was conducted at three sites in the North of England. All three were defined by the geographical area covered by a single National Health Service (NHS) commissioning body and a single local government organisation. The three sites had a number of general features in common. Their local authorities were all metropolitan boroughs, each including a number of towns and more rural districts. Each one had more than one Lower Layer Super Output Area as measured by the Index of Multiple Deprivation – a geographical area used for reporting of official statistics in England – that was in the bottom 10% of areas nationally. Details from all three sites are provided (Ward *et al.* 2014). NHS ethics approval was obtained for the study (REC reference number 10/H1307/130).

Sampling Step 1: Landscape mapping

In developing our own study we were aware that there are problems associated with network sampling strategies that need to be minimised. For example, it is a mistake to

assume that the relevant actors are all attendees at a relevant meeting, or staff in a functional unit or management team (Creswick, Westbrook, & Braithwaite, 2009; Currie *et al*., 2010; Dyer & Nobeoka, 2000). The problem with snowball sampling is that the process of asking informants to nominate other people to interview is that their nominations effectively determine network connections: the network may simply be an artefact of the sampling strategy. The resulting data might retrace pre-existing formal relationships – for example, interviewees might identify their own line manager, who they thought they ought to name – and stop short of revealing less formal connections among individuals (Lewis, 2010).

We needed to sample, avoiding the bias inherent in techniques such as snowballing from single individuals, because we wanted to interview participants face-to-face as the most reliable way of obtaining accurate information. Our solution was to develop a method which we called landscape mapping. We interviewed senior managers in NHS and local government organisations who were not directly involved in co-ordinating services, but who knew most of the managers who were, in their locality. Landscape maps were drawn in the course of each interview (see Figure 1), that enabled the interviewee to describe and explain the roles of individuals and organisations in health and wellbeing services (Crilly, Blackwell, & Clarkson, 2006). We also used the interviews to identify the leading health and wellbeing issues at each study site.

We were aware of the difficulties of identifying boundaries in network studies. Network and system theorists both emphasise that social systems are open, in the sense that they do not have well defined boundaries with their 'environments', and are continuously subject to external influences (Crossley 2011, Braha, Minai and Bar-Yam 2006,

Teisman, Gerrits and van Buuren 2009). We addressed the problem in two ways. First, senior managers were asked to identify all of the agencies likely to play a role in health and wellbeing services in the locality. Second, they were asked to identify the people or organisations considered the most important actors in the network, and by implication were not peripheral actors, located close to any boundaries.

Sampling Step 2: initial network interviews

We used the landscape maps to select an initial sample of four health and wellbeing managers who covered key areas of the local landscape- that is, they represented different organisations or teams or had a role in linking organisations or professional groups (Krauss, Mueller, & Luke, 2004; Lewis, 2005). The landscape maps indicated that our networks were large, including several dozen, and possibly over 100, people. Since we could not hope to interview everyone, and some of our participant organisations did not give permission for contact via email, we borrowed a method from a study of criminal networks, and asked interviewees to nominate people that *their nominees* talked with or went to (Chattoe & Hamill, 2005). If we subsequently collected primary data from interviews with those nominees, we used it to replace secondary data. Interviews were conducted over a three month period in the summer of 2011.

The interview format

The interviews combined free recall and fixed choice strategies. We started by asking interviewees to list up to five people they interacted with, responding to two different questions - 'who do you *talk with* about [the pressing local topic/problem]' and, 'who do

you *go to to get things done* [about the pressing local topic/problem]?' We also asked interviewees to provide details (e.g. organisation, job title) about those they named. Following Lewis *et al.* (2008), we considered that both questions would capture communications about day-to-day work issues. They would both reflect informal relationships, though the first would be less formal than the second which would capture a more deliberate form of contact (although we did not assume a 1:1 correspondence between question and formality of relationship).

Analysis Step 1: partial network modelling

Having interviewed our initial sample we modelled the partial network, using the concepts of latent position network models (Hoff, Raftery, & Handcock, 2002, Wasserman and Faust 1994) and latent position cluster models (Handcock, Raftery, & Tantrum, 2007). A model within two-dimensional latent social space was fitted to the initial interview data, which calculated the probability that individuals were connected. Analysis was undertaken in the R language and environment (R core team 2014 version 3.1.0), using the variational Bayes latent position cluster model (VBLPCM version 2.4.3) library (Salter-Townshend & Murphy, 2012, 2013).

Groups of actors were identified by imposing an additional condition, to associate individuals with clusters. The number of clusters was strongly guided by calculating a Bayesian Information Criterion (BIC) for an increasing number of clusters, starting with one large cluster. The smallest value of the Bayesian Information Criterion suggests the optimum fit, least information lost relative to the complexity, and indicates the strongest candidate for the number of clusters.

Sampling Step 3: interviewing further informants

We used our models of the partial network, combined with the landscape maps, to select a further sample of four interviewees at each site, on the basis that they were on the edges of clusters and may be linked to areas of the landscape that was not covered in the initial interviews. We used the additional data to model the network again, and then selected a third sample of four interviewees, this time focusing on well-connected individuals who had not yet been interviewed. The landscape maps were referred to again at this point, to ensure that we achieved good coverage of it. The overall effect of this sampling strategy was to reduce the bias due to snowball recruitment, in effect by snowballing from a number of starting points and cross-matching the names that came up.

Analysis Step 2: Network analysis deriving latent clusters

The modelling approach described in Step 1 was repeated for the full set of interview data. Once we had produced cluster diagrams, we sought a finer-grained understanding of the network models by focusing on the attributes of individual actors. To do this we used the details collected during network interviews and membership lists from relevant meetings, which we also collected in the course of the fieldwork. The landscape maps, and meeting membership lists, were populated mainly by middle managers - managers who were not also delivering services, nor executives in their host organisations (Shi, Markocsy and Des 2009). In the interview programme, though, interviewees were free to name junior or senior colleagues.

Follow up interviews

The network interview process was repeated approximately eight months after the initial round of network interviews, in the summer of 2012. We re-interviewed all round one participants. Where this was not feasible (mainly due to interviewees having left their posts), interviewees were replaced with individuals who were currently performing the same or a similar role in their host organisation.

Results

The network characteristics, and changes over time, were broadly similar at the three sites. For clarity we therefore present the results from one site in detail. The main focus of multi-agency activity at the site was tobacco control.

Landscape mapping

Interviews with two key informants produced background for the landscape map shown in Figure 1. Dots have been added to the figure: square to indicate that a person from that organisation has been interviewed, and circular to show that a person from that organisation has been mentioned in at least one network interview. This provides a clear representation of the coverage of our interview data.

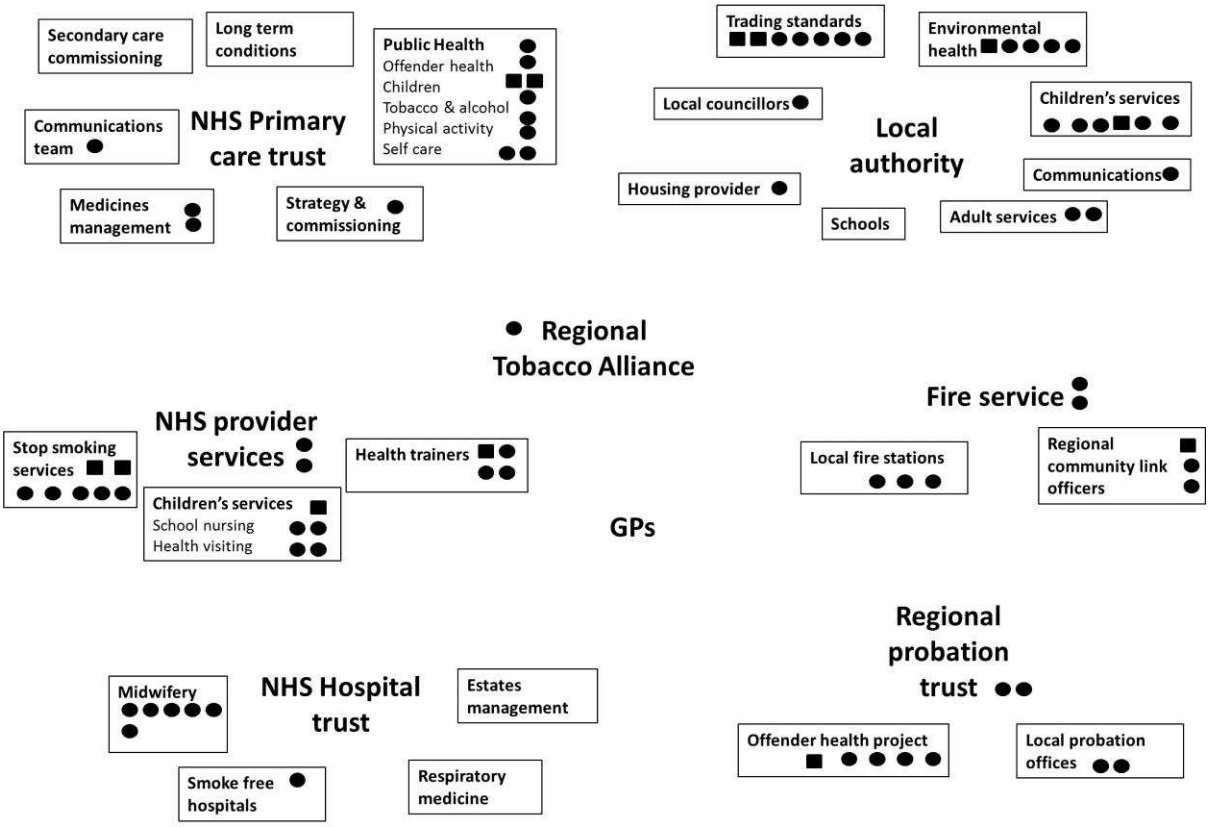

Figure 1: Landscape map for Site 1 showing agencies involved in relevant services

The *Talks With* Network

Visual representations of the results were produced, where individuals were placed close together in the social space diagram when they were more likely to be connected. The *Talks With* network generated from data collected at Time 1 [August and September 2011] is in Figure 2. A dot indicates an individual, and the organisation for which that person works is shown as an abbreviation. A key to organisations is given at the top left of the Figure. Lines joining the dots (individuals) represent relationships identified in the network interviews. Where there is no line between individual actors then there is no *talks with* relationship. The emphasis is on the colour of the dots and the associated large circles, with

the colours representing clusters. Arrowheads show the direction of the relationship: who talks with whom. Arrows can be double-headed.

Dots are placed within a 'latent space'. This convenient spatial arrangement is designed so that individual actors of the network are placed closer together where there is a relationship, and are grouped together when they are common to the same cluster. Other than constrained to be isometric, the same in each direction, the scales on the two axes are arbitrary: they are simply convenient axes for the latent space.

The network comprised 61 people with 124 connections between them. A total of four clusters represent the situation well, since the four are clearly separated. Each cluster has a core of strong connections with fewer connections between clusters. People nearer the centre of each circle are more typical exemplars of the network cluster's membership than those on the cluster periphery. The cluster radii were equal to 1 standard deviation, so that when circles did not overlap in the diagrams, the clusters were well separated by 'two=one plus one' standard deviations. This provided further support for the number of clusters identified. The standard deviations are different for each cluster but this gives a convenient guide to when the clusters are well separated.

Inspecting the labels present within each cluster, we observe that there is a range of organisations represented in each one. There are situations where individuals from the same organisation are placed close together, but the overall picture is that of clusters comprising individuals from a number of different organisations.

Figure 3 shows the *Talks With* network derived from the interviews 8 months later [Time 2, April and May 2012]. The network comprised 68 people with 165 connections between them. Five well-separated clusters can be identified, each of which has a core of

strong connections, with fewer connections between clusters. Note that the colours of the clusters are generated by the algorithm and are randomly assigned. There is no necessary relationship between clusters of the same colour at Time 1 and Time 2.

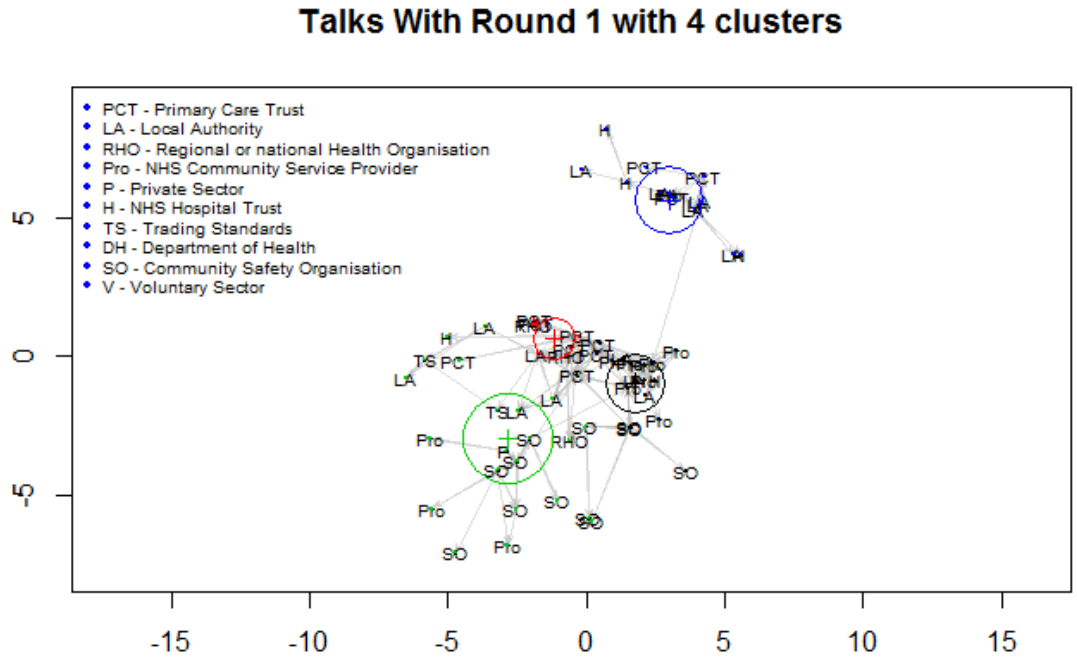

Figure 2 *Talks With* network for Site 1 Time 1

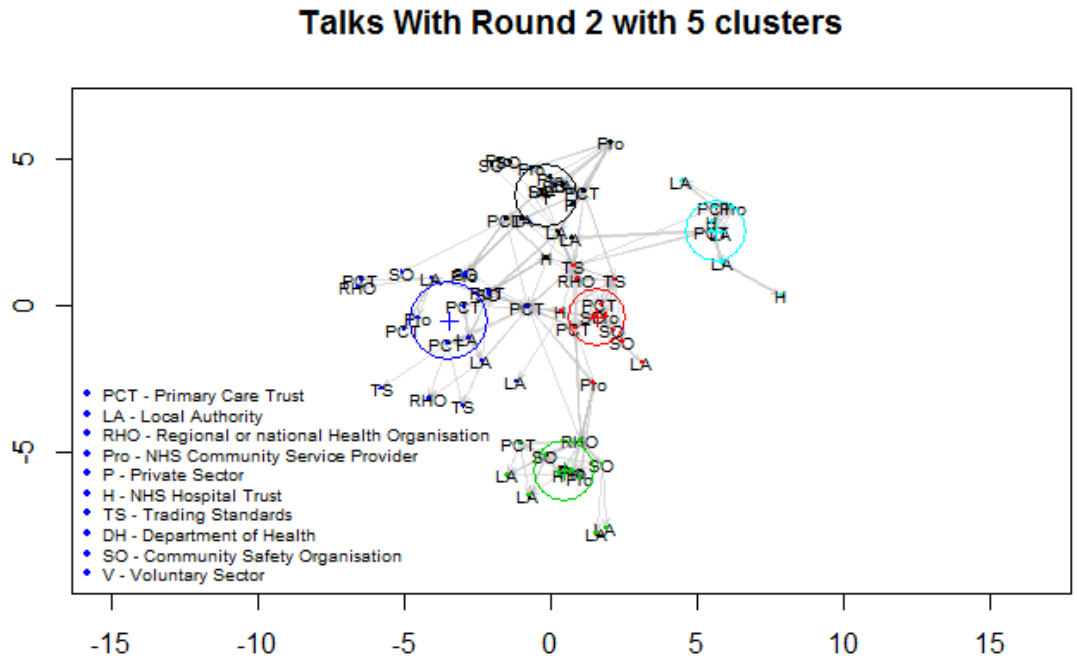

Figure 3 *Talks With* network for Site 1 Time 2 showing five clusters

Table 1: Flow of participants in the *Talks With* networks

		Cluster membership at Round 2						
		Black 2	Blue 2	Cyan 2	Green 2	Red 2	Exit network	
Cluster membership at Round 1	Black 1	0	3	0	1	5	9	
	Blue 1	1	0	0	3	0	10	
	Green 1	4	1	3	0	0	14	
	Red 1	1	0	0	0	2	4	
	Enter network	11	15	5	8	5		37
							44	

Table 1 shows the flow of named people from the *Talks With* network at Time 1 and at Time 2. 23 people appear in both networks, 37 people appear only at Time 1 (and so exit the network by Time 2) and 44 appear only at Time 2. Given that 12 people were interviewed on both occasions and so must appear in both networks, this indicates that there is marked turnover of named individuals between the two periods. This said, many people in the black cluster at Time 1 go to form the red cluster at Time 2, and many from the green cluster at Time 1 are found in the black cluster at Time 2. There is, therefore consistency of membership and relationships within some clusters.

The *Goes To* Network

The *Goes To* networks are displayed in Figures 4 and 5. At Time 1 there are 64 actors and 127 connections between them. As with the *Talks With* networks, a number of organisations are represented in each cluster. Table 2 offers evidence that the membership of the *Goes To* network changes over time, with 31 people present in both networks, with 33 people only at Time 1, and 40 only at Time 2. There is, though, more consistency than for the *Talks With* network, with continuity of membership from Black 1 cluster to Black 2 cluster, from Green 1 to Red 2.

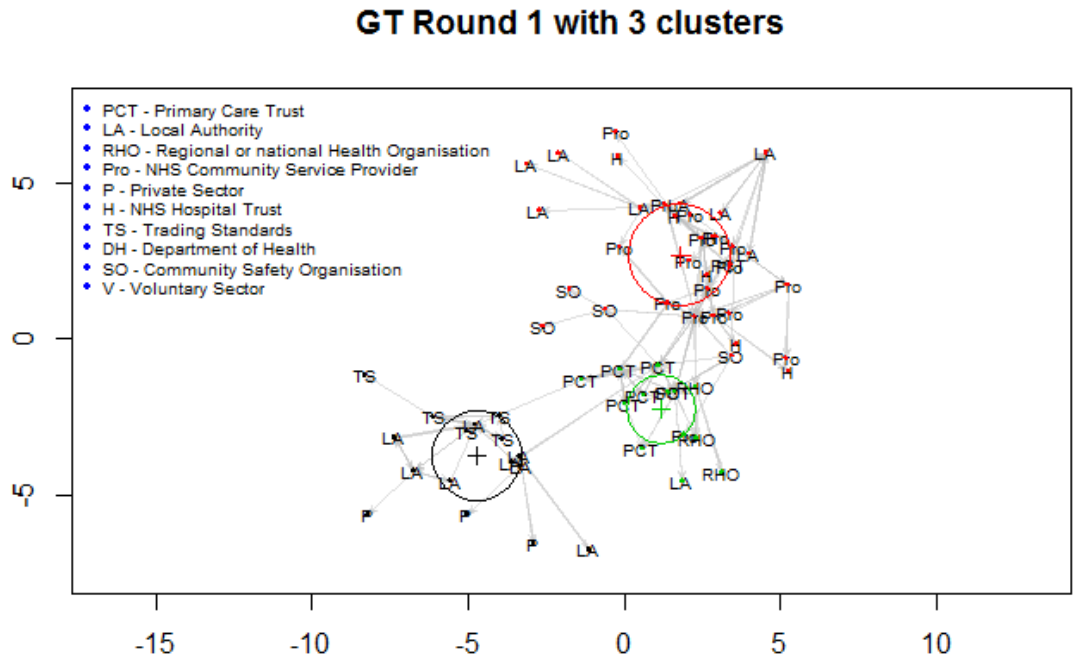

Figure 4: *Goes To* network at Time 1

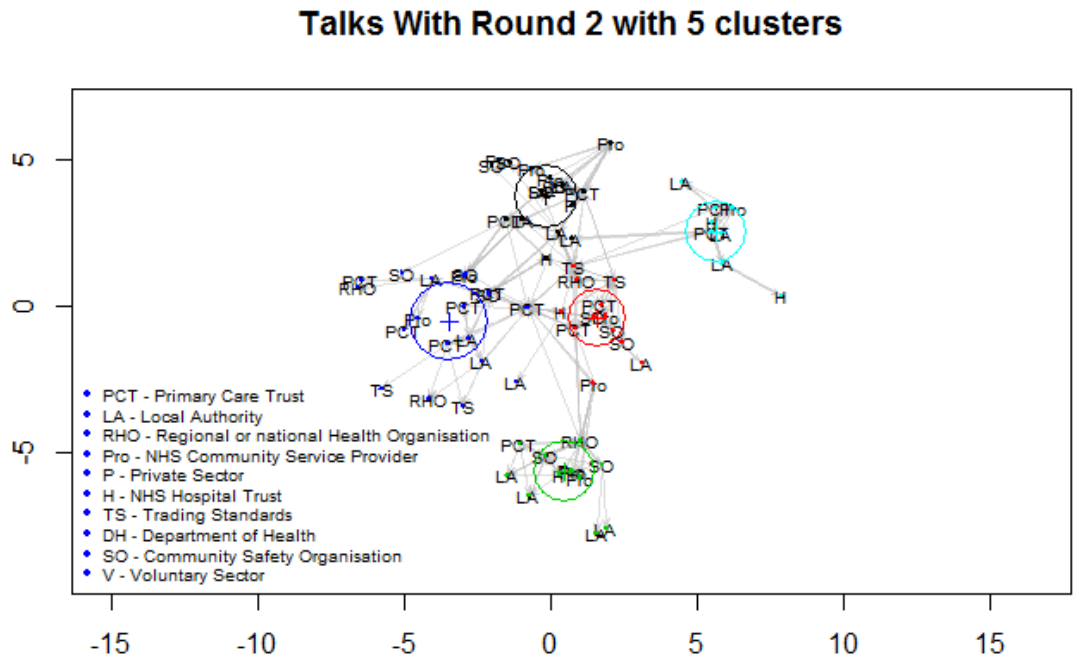

Figure 5: *Goes To* network at Time 2

Table 2: Flow of participants in the *Goes To* networks

		Cluster membership at Round 2				
		Black 2	Blue 2	Green 2	Red 2	Exit network
Cluster membership at Round 1	Black 1	6	4	0	0	6
	Green 1	0	2	1	4	6
	Red 1	0	9	5	0	21
	Enter network	7	10	13	10	33 / 40

Comparison of *Talks With* and *Goes To* networks

The same 12 people were interviewed to derive both the *Talks With* and the *Goes To* networks, but there are clear differences between them when they are inspected at the cluster level and the network level. Tables 3 and 4 show the distributions of people between *Talks With* and *Goes To* clusters at Times 1 and 2. At Time 1 there are 31 individuals who appear in both networks, 30 who are reported only in the *Talks With* network, and 30 only in the *Goes To* network. The main link between the clusters in the two networks appears to be through the Black *Talks With*, Blue *Talks With* and Red *Goes To* networks. The same comparison at Time 2 shows that 41 people are common to both networks, 27 are in the *Talks With* network only, with 30 only in the *Goes To* network. While some people drop out of the network and new people enter between the two time periods, membership of the *Goes To* networks is more consistent than the *Talks With* networks.

Table 3: Cluster memberships at Time 1

		Cluster membership of *Goes To* at Round 1				
		Black GT	Green GT	Red GT	Not in GT	
Cluster membership of *Talks With* at Round 1	Black TW	0	4	10	4	
	Blue TW	0	0	5	9	
	Green TW	4	1	3	14	
	Red TW	1	3	0	3	
	Not in TW	11	5	17	33	30

Table 4: Cluster memberships at Time 2

			Cluster membership of *Goes To* at Round 2				
		Black GT	Blue GT	Green GT	Red GT	Not in GT	
Cluster membership of *Talks With* at Round 2	Black TW	9	3	0	1	4	
	Blue TW	0	12	0	0	7	
	Cyan TW	0	0	0	4	4	
	Green TW	0	0	4	0	8	
	Red TW	0	3	1	4	4	
	Not in TW	4	7	14	5	28	27

We compared the lists of people in each cluster at Time 1 with lists of people invited to meetings, to evaluate the overlap between the two, and hence indicate the extent to which network membership might be explained by formal arrangements. The comparison suggested that, while some people in each cluster attended the same meeting, most did not. For example, for the *Talks With* network at Time 1, between approximately a third of actors (21 out of 61) of the network were invited to one of the three relevant meetings at the site. Similarly, 15 of the 64 actors in the *Goes To* network at Time 1 were invited to meetings. The majority of network actors were not, therefore, attending meetings.

Patterns at the other two sites

Results from the other two sites were similar to those presented here. Specifically, at the other two sites:

1. The methods used were the same, with between 12 and 16 people being interviewed to obtain data for both networks;
2. The networks were well represented within a latent space with between 3 and 5 well-separated clusters.
3. All clusters, in both time periods at both sites, included people from a number of organisations.
4. Both the *Talks With* and *Goes To* networks varied between Time 1 and Time 2, with marked turnover of participants.
5. The *Talks With* and *Goes To* networks differed from each other.

Discussion

This article adds to the relatively small literature which uses quantitative network methods to investigate underlying patterns of inter-organisational and inter-professional relationships in health care. In common with Lewis *et al.* (2008), our findings suggest that it is possible to describe networks that have over one hundred actors efficiently, by interviewing a sub-set of the network actors. These networks are larger than those typically reported using social network analytic methods (Yousefi-Nooraie, Dobbins, & Marin 2012, 2014). In contrast with most authors, but in common with Crossley (2011), we focused on clusters, on the basis that they would allow us to characterise arrangements that lay between structures on the one hand and agency on the other. The consistency of clusters

that we observe suggests that they represent meaningful groupings of people who co-ordinate their work with one another to address problems that they have in common.

The study has three main limitations. First, the methods used to produce the sociograms are probabilistic, and re-fitting the data will therefore produce different arrangements. In practice, we explored long runs of the Markov Chains, and ran the models from the start on a number of occasions, and found that the differences in cluster outputs were trivial. The runs did not affect cluster membership, and resulted only in individuals being in slightly different locations in the latent spaces. Second, the study sites were relatively similar, and it is not clear whether we would have observed the same results in localities with different histories of health and wellbeing services, although the similarity in configurations across the three gives us some confidence that our findings might be generalizable to other health and wellbeing services in the UK. Third, we assumed that the two networks would capture formal and informal ties. As Lewis and colleagues (2008) found, the networks do seem to reflect different kinds of relationships, but it remains unclear how confident we can be in making inferences aboput them, particularly if we are interested in intervening in them in some way. This raises questions for those interested in organisational networks, such as those working on communities of practice and disruptive innovation, as to whether it is practically possible to capture and represent underlying networks of informal relationships (Braithwaite 2010, Sabel 2006).

Study Aims

This study has investigated the configurations of networks in health and wellbeing services and the stability of network relationships over time, and provided evidence about both formal and informal relationships between network actors. The networks exhibited

common general features, which spanned the *Talks With* and *Goes To* networks, the three sites and the two time periods. We identified three, four or five distinct clusters of actors in each network, where each cluster represented distinct sub-groups of between 20 and 40 actors. The findings revealed the heterogeneity of cluster membership. The clusters at all three sites comprised actors from different organisations and different levels of seniority within their host organisations. In some clusters one organisation dominated, but even here other organisations were still represented. Overall, our findings suggest that the networks and clusters reflected multi-professional and multi-organisational relationships. The finding is at odds with the observations of some studies, who found that people with the same organisational or professional background or similar levels of seniority tend to go to one another for advice and information (Creswick *et al*., 2009; Currie *et al*., 2010; Lewis, 2005). It is, though, consistent with narrative descriptions of networks which report effective cross-organisational relationships (Hudson 2006, 2007; Swan and Scarbrough, 2005).

At all three sites the actors in the networks and the configuration of links between them changed over time, with a high proportion of actors exiting and entering the network between the two time points. This is consistent with narrative accounts which suggest that networks can be dynamic and impermanent (Amin & Roberts, 2008; Araujo, 1998), but is not consistent with leading network governance theories (Bouckaert, Peters and Verhoest 2010, Sorenson and Torfing 2007). The latter are either silent on the question of the 'turnover' of network actors, or assume that negotiations take place over time between actors of networks, implying at least a measure of stability of network membership. Viewed in the context of extant theories, then, the findings were not expected.

Our two questions were designed to capture insights about formal and informal relationships. The findings are clear in one respect – the two types of network are very different from one another. The differences were observed even though our method ensured some overlap, because our interviewees must have been actors in both networks. The fact that the same two or three people were central to the networks at each site might also point to similarity rather than difference between networks, but it did not in practice. The findings therefore serve as a reminder that there is no such thing as *the* network of relationships, but rather that people are actors of overlapping networks, and therefore offer different answers to different questions when they are asked about them.

If formal networks had played a significant role, we would have expected to find that the *Goes To* networks mapped onto formal structures, such as regular programme meetings, but in practice none of our clusters mapped onto the membership of any single meeting at any site. We would also have expected to observe stability in the *Goes To* networks, on the basis that these would be underpinned by meetings and other formal processes – but we did not. (As noted earlier, we did not expect the *Talks With* networks to map onto formal meetings, and they did not.) Insofar as we are able to interpret the differences between our networks, then, it seems reasonable to say that neither type of network could be described as formal. Indeed, the sizes of our clusters alone (up to 40 actors) are suggestive of informal sets of relationships, developed outside formal meetings or structures – meetings are just not this large. It may be, as Gilson, Sabel and Scott (2009) argue, that formal and informal relationships are braided, or interweaved, with one another.

Implications

The observations about dynamic network membership, and the differences between the *Goes To* and *Talks With* networks, may have theoretical and policy implications. Viewed through a network governance lens, the findings suggest that inter-agency networks may be more dynamic than most authors allow for. As noted at the start of the paper, theories of inter-dependency (e.g. Rhodes 2006) and governability (e.g. Teisman, Gerrits and van Buuren 2009) have little to say about the ways in which negotiating inter-agency relationships affects the find-grained relationships between the individuals and teams involved. They do not, either, shed much light on the balance between formal and informal relationships. Network governance needs to be formal insofar as networks – of the kind we studied here – receive public money. But, as we have seen, our findings emphasise the importance of informal over formal relationships in practice. Conversely, the findings suggest that participants perceived themselves to be actors in networks: they can form and persist over time, albeit with changes in membership and structure. Given this, they offer a modest corrective to the many accounts of failures of network governance (e.g. Jessop 2009, Williams and Sullivan 2010).

There are also implications for the re-vivified debate about social structures, exemplified by papers in the recent special issue on complexity in this journal (Clark 2013, Lanham *et al.* 2013). The thrust of a number of the papers is that it is useful to conceptualise health systems as complex systems, that those systems correspond to the events in the world, and that it is possible to study their dynamic properties. Our findings offer both good and bad news. The good news is that they offer support for the view that organisations are dynamic, and can be studied quantitatively. The bad news is that, as far as

we are able to judge, complex system theories do not offer explanations for our findings. The papers in the special issue, and those that they cite, do not take into account the contingent nature of network models, do not suggest explanations either for the commonalities or for the differences observed over time that we report here, and do not entertain the possibility that network configurations depend on the questions that you ask actors.

We end with comments about the role of centrally determined policies, in contexts where success can only be achieved via inter-agency co-ordination in localities. They need organisations which are capable of managing and accounting for those resources. Our findings suggest that formal partnership working, in the sites that we studied, may be a convenient fiction. While there was some continuity between time periods, relationships appear to be more labile, and more fragile, than policy makers assume. In practice, inter-organisational and inter-professional networks are based on local relationships, at least as much as on the formal relationships assumed by the bodies that hand out money. In common with Lewis and colleagues (2008), we suggest that this implies that there is a need to support the development and maintenance of long-term relationships on the ground. This stands in sharp contrast to the uncertainty of project-based funding at the time of the study, and indeed today, in health and wellbeing services in England. Our findings have obvious implications for understanding the challenge of knowledge creation and mobilisation, which we explore in other publications.

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