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The enactment of knowledge translation: a study of the Collaborations for Leadership in Applied Health Research and Care initiative within the English National Health Service

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Abstract

Objectives—We contribute to existing knowledge translation (KT) literature by developing the notion of ‘enactment’ and illustrate this through an interpretative, comparative case-study analysis of three Collaborations for Leadership in Applied Health Research and Care (CLAHRC) initiatives. We argue for a focus on the way in which the CLAHRC model has been ‘enacted’ as central to the different KT challenges and capabilities encountered.

Methods—A comparative, mixed method study created a typology of enactments (Classical, Home-grown and Imported) using qualitative analysis and social network analysis.

Results—We identify systematic differences in the enactment of the CLAHRC model. The sources of these different enactments are subsequently related to variation in formative interpretations and leadership styles, the implementation of different governance structures, and the relative epistemic differences between the professional groups involved.

Conclusions—Enactment concerns the creative agency of individuals and groups in constituting a particular context for their work through their local interpretation of a particular KT model. Our theory of enactment goes beyond highlighting variation between CLAHRCs, to explore the mechanisms that influence the way a particular model is interpreted and acted upon. We thus encourage less focus on conceptual models and more on the formative role played by leaders of KT initiatives.

Keywords

health care management; knowledge translation networks; social network analysis

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Introduction

The CLAHRC mission

Between 2008 and 2013, the National Health Service (NHS) invested £40 million in the creation of nine Collaboration for Leadership in Applied Health Research and Care (CLAHRC) initiatives across England. The CLAHRC mission was to help ensure that new evidence emerging from medical research was put into clinical practice to improve hospital wards, surgeries and other areas of the NHS. There were four main objectives for the CLAHRCs, set out in the original call for proposals: to improve patient outcomes across the local area; to conduct high quality applied health research; to implement findings from medical research into clinical practice; and, to increase the capacity of the NHS to engage with and apply research. In essence, the CLAHRCs were to create better links between those who conduct applied health research and those who use it in practice and this would subsequently help improve patient outcomes across the area covered by the Collaboration.

The research–practice gap

The concept of ‘knowledge translation’ (KT) was central to the CLAHRCs. More specifically, the CLAHRCs arose from a perceived need to overcome what had been termed by the Cooksey Report as the second ‘translational gap’ between clinical research and practice.¹ While it has long been argued that the translation of research into practice is problematic, traditionally this has been viewed in terms of a linear and unidirectional knowledge transfer, from the production of research (and other forms of knowledge) to its use in practice.² In effect, there was an assumption that research findings would be disseminated from the laboratory through applied research and development and then into clinical practice. This notion of an allegorical ‘gap’ between the knowledge developed by research communities in health care, and health care practice itself, is the subject of an extensive debate and criticism.³⁻¹³

A perceived gap between research and practice is not the sole preserve of health care organizations; indeed other research has signalled the issue as being a wider organizational challenge.¹⁴ The implications of such a gap, however, are extremely serious in the health care setting where the non-adoption of new research evidence and/or the lack of spread of new forms of improved practice may have significant adverse consequences for patient wellbeing.¹⁵⁻¹⁸ These concerns were articulated by the Cooksey report¹ which sought to address the relationship between research and practice as a continuum of activities with Cooksey’s analysis of the translational gap within that continuum helping to inform the establishment of the CLAHRC initiative itself.

To date, research on the KT challenge in health care in terms of a metaphorical ‘gap’ has tended to focus on the development of theoretical models. Indeed, in the period leading up to the establishment of the CLAHRCs, a new set of approaches were emerging that moved away from a linear view of knowledge transfer toward an understanding of the complex and multifaceted configuration of knowledge sharing. These new perspectives highlighted the importance of ongoing interaction, multidirectional knowledge flows, and social network relationships between researchers and practitioners in meeting the challenge of

translation.^{13,19,20} In addition, the approaches sought to advance a deeper recognition and clarification of the processes and practices through which knowledge is translated across different settings.²¹⁻²⁴ The consensus was that KT is crucial for health care improvement as this is the process whereby research evidence comes to inform and influence health care policy and practice, and vice versa.¹⁰

Policy interventions for translational research

Policy makers now recognize that as collaborative working practices facilitate the process through which research findings can come to inform policy and practice,²⁵ deliberate institutional strategies for collaboration can be used to support the utilization of knowledge.¹⁴ Policy interventions designed to support KT in health care and to connect innovations with practical improvements are proliferating and take a wide variety of forms. One approach taken by health research funding agencies has been to commission collaborative entities in which academic researchers work closely with other stakeholder groups (such as health care practitioners, patients, industry and policy representatives). Examples include, in the USA, academic health centres and practice-based networks, and in Canada, a variety of KT initiatives and institutes established by the Canadian Institutes of Health Research (CIHR), such as Canada's Strategy for Patient-Oriented Research networks. In England, various centres and networks (including CLAHRCs themselves, Biomedical Research Centres, Patient Safety Translational Research Centres, Diagnostic Evidence Co-operatives and Academic Health Science Networks) already form part of the National Institute for Health Research (NIHR) infrastructure for connecting innovation with improvement in the NHS.

These policy interventions represent examples of system-level KT interventions where a collaborative arrangement is created to support the production and application of health care evidence in influencing policy and practice.²⁶ Clearly, the objective of system level translational programmes is to facilitate KT between the 'producers' and 'users' of health evidence in policy and practice. However, where large collaborative entities comprise a collection of work programme, it is important to recognize that there also exists potential to facilitate knowledge sharing internally between members of the translational initiative. This can be achieved through organizational conceptual models, for example, by supporting the sharing of experiences and tacit skills about how to 'do' translational work within the ethos of the knowledge environment that is created. KT within the initiative can also be facilitated through an operational management approach, such as linking academic researchers with experts in implementation science to foster initiative-wide KT capabilities. These kinds of policy interventions, while many and varied, are all premised on the assumption that supporting new forms of inter-group collaboration across boundaries will result in the speedier translation of new ideas, research and evidence into practical applications.

Motivation

Previous work on overcoming the translational gap between research and practice, such as the CIHR model so influential in the development of CLAHRCs,²⁷ has been criticized for assumptions of universality. This is seen as being reflected in a lack of attention to institutional contexts, social networks and histories of KT efforts.²⁸ Despite increased

attention within the literature, there is limited evaluation of KT initiatives, particularly that which provides insight for more generalizable use.^{29,30}

In this study, we contribute a more contextualized understanding of KT strategies by analysing the various ways in which the CLAHRC mission, as defined by the NIHR, was operationalized by individual CLAHRC entities.

Limitations

The scope of this paper is limited to a portrait of the CLAHRCs at their formative stage of development over the first 18 months of evolution.

Through an empirical study of three such entities, we develop the notion of 'enactment' to account for such variation, demonstrating how differing enactments shaped each CLAHRC's KT practices. We define enactment here as reflecting the creative agency of the groups and individuals comprising the KT initiatives, and especially the formative role played by their leaders. Thus, the leadership of KT initiatives is viewed neither in terms of implementing a particular KT model, nor in terms of such initiatives being shaped by their local contexts. Rather, leaders are seen as producing a 'persuasive rendition' of the initiative and its context that mandates authority and 'legitimizes a particular form of action'.³¹

In this paper, we attempt to understand how differing enactments evolved from the initial CLAHRC model. For each CLAHRC, the enactment of a particular KT approach was associated with a distinct set of capabilities and challenges and thus highlights the different ways in which collaborative translational research can be undertaken. Our analysis of these enactments goes beyond illustrating variation between CLAHRCs and explores the critical levers that influenced the ways in which the CLAHRC model was interpreted and acted upon. We do not simply argue that context matters, but maintain that the local enactment of a particular KT model, such as the CLAHRC initiative, is central to the way that intervention unfolds in practice.

Methods

Our findings were derived from a comparative analysis of three CLAHRCs using a mixed method approach to study the enactments of KT. Our selection of methods was theoretically informed and designed to address important sources of variation in KT activities. It thus encompassed, first, a qualitative investigation with a sample of individuals playing a variety of roles within the individual CLAHRCs. This enabled us to address the way in which KT was interpreted by key actors and how this was reflected in the actions undertaken by groups charged with realizing the CLAHRC's objectives. Second, to complement this work, we carried out a social network study to address the informal structure of social ties manifested by the membership of our CLAHRC sample. We employ a social network paradigm as an approach to understanding relationships between actors, in this instance, informal KT ties between CLAHRC members.

Research sites

We evaluate three CLAHRC collaborations. These are anonymized to preserve confidentiality as Bluetown CLAHRC, Greentown CLAHRC and Browntown CLAHRC. Ethical clearance was approved from University Ethics Committee and the regional Research Ethics Committee to allow data collection from employees of NHS organizations and universities. A Scientific Advisory Board of health care professionals (internal and external to the CLAHRCs) and a service user also guided the study. The project was implemented over 36 months (2009–12) and commenced around a year after funding for the CLAHRCs had been granted.

Data collection and analysis

We provide a comparative, mixed method analysis of how each enactment relates to the development of KT practices. A typology of enactments (Classical, Home-grown and Imported) is created and we counterpoint this typology to the universalist assumptions of established KT models. The integration of data types was particularly conducive to supporting a detailed understanding of each CLAHRCs' enactment of the KT model.

Our qualitative fieldwork included 67 semistructured interviews with individuals who represented the variety of roles and positions within the CLAHRCs, together with observational data of meetings and activities, and review of key organizational documents. We drew on a hybrid process combining both inductive and thematic analysis to develop broad 'themes' and more detailed codes.³² A structured 'step-by-step' approach was undertaken whereby ideas from initial coding were reviewed by the team, followed by more targeted and detailed coding. This approach facilitated the integration of findings across qualitative and social network sources. In particular, as highlighted in this paper, the importance of leadership, governance structures and epistemic differences emerged as interesting themes of our analysis.

Our theory and analysis were grounded in the work of Knorr-Cetina,³³ who argues that epistemic differences can be identified and understood through the study of knowledge practices. Structures, processes and environments are considered to contribute to the make-up of epistemic settings,³³ and thus these types of features were the focus of our thematic coding. However, the actual work practices of individuals are also illustrative of epistemic differences since power relations and the persuasive rhetoric of a profession are often more important in shaping work practices than specific training.³⁴ Our analysis considered the interplay of these pre-existing professional influences within the new CLAHRC environments and how this was reflected in individual accounts of the performance of work practices. We considered how the epistemic composition of CLAHRC members might also impact upon KT activity. Professionally diverse teams may generate creative advantage through the cross-pollination of interdisciplinary ideas, whereas professionally homogeneous teams may find it easier to readily 'get on with' KT work because they already share community practices, technical terminology and epistemic outlooks.^{35,36} Mixing professionals from different epistemic backgrounds adds an element of compositional diversity to social networks that is often associated with opportunities for knowledge brokering.³⁷

For the social network study, membership lists were collated in collaboration with CLAHRC administrators and the individuals named on these lists became the target sample. An online social network survey featuring questions about the nature and quality of knowledge relationships was developed. The roster of member names was built into the electronic survey so that respondents were able to see the names of other CLAHRC colleagues via a drop-down menu. The social network survey was sent by email to a total of 367 individuals across the three CLAHRCs with a final average response rate of 71%.

The aim was not to yield a network of all social relationships, or to ascertain who worked with whom, but to draw out the ties that were most meaningful in the context of CLAHRC KT. To elicit data on these key knowledge relationships, we used the following name generator question, 'who are the most important (people) for you to have contact with in order to be effective in your CLAHRC work?' Following other studies of informal advice giving and seeking activities as the key processes of KT in professional settings, we also asked about the type of knowledge resource provided by these informal network ties, for example, scientific advice, access to contacts and organizational backing.³⁸⁻⁴⁰ This yielded three separate KT networks, one for each CLAHRC. Analysis of the structure of each network was conducted in UCINET,⁴¹ with findings assessed comparatively. However, rather than rely on direct comparisons between CLAHRCs, we recognize that these networks are case-study contextualizations, so the data have been interpreted in a way that acknowledges the local enactment of the CLAHRC model.

Social network analysis (SNA) techniques were applied to study the informal knowledge sharing networks underpinning CLAHRC work in each setting and to explore what consequences any variation might have for KT. Specifically, we highlight how the different enactments relate to the distribution (or spread) of knowledge ties between individual members within the CLAHRC. This distribution means that in some instances CLAHRC members will have differential access to, or control over, knowledge. In this paper, we refer to two measures used to study the distribution of knowledge ties in each CLAHRC network: centralization and core actors.

Centralization measures the extent to which the structure of knowledge sharing relations in a whole network is 'dominated by a few places'.⁴² A highly centralized knowledge network will feature an asymmetric, or unequal, distribution of ties and is viewed as 'hierarchical' because the majority of knowledge relations are focused around a few well-connected individuals at the centre of the network.⁴³ Conversely, decentralized networks distribute connections between individuals more equally so CLAHRC members will have relatively equal access to, and control over, knowledge.

The importance of centralization for the enactment of KT has implications for internal efficiency, coordination and dissemination of information.^{44,45} Centralized networks make it easier to disseminate key messages and to encourage standardization of practice but this emphasis is likely to mobilize existing protocols rather than radical, innovative or experimental change.⁴⁶ Decentralized networks support the cross-pollination of knowledge and the generation of new ideas through boundary spanning, but people are more likely to

receive mixed messages or diluted information from multiple sources resulting in a lack of operational clarity.⁴⁷

Core actors are a set of dominant individuals in a network who frequently translate knowledge to each other, in contrast to peripheral actors who only translate to the core (on an un-reciprocated basis), but not to each other. The presence of a set of core actors indicates that some individuals dominate the KT network, and the skills and experiences of more peripheral actors may be relegated as a consequence.

The composition of core actors in terms of their organizational role is important because it identifies the professional types leading the knowledge network. If senior CLAHRC members (such as directors, managers or team leads) are found to be the most dominant core actors, then this structural trait is especially interesting because it would suggest some management control over KT relating to organizational hierarchy. The converse may be true if we find that core actors occupy a mix of organizational roles (such as directors alongside operational support staff) as such network diversity suggests the organizational inclusiveness perhaps found in a horizontal governance structure. We calculate 'coreness' scores for each actor using a core-periphery algorithm⁴⁸ and plot these on a graph to delineate 'high coreness'. A cut off score of 2.00 was deemed suitable as scores evened out after this point (indicated by a drop in scree plot). Actors with scores above 2 were, therefore, distinguished from all others as being closest to the knowledge network core.

The qualitative and social network data were initially analysed independently, and then considering the key ideas from both sets of findings, targeted exploration of particular topics of interest was undertaken. We present these findings from qualitative and social network analyses under their emergent thematic categories. In addition to utilizing a mixed method approach to validate our research, over the course of the project life-cycle we also fed-back the results of our study and the emerging typologies to the CLAHRCs and the NIHR Health Services and Delivery Research Programme.

Results

We identify systematic differences in the enactment of the CLAHRC model. The contributory features of these different enactments are analysed in terms of the following: formative interpretations and leadership styles; the implementation of different forms of governance structures; and the relative epistemic differences between the professional groups involved. Our case analyses, outlined below, are structured according to these categories. Table 1 provides an inductively derived typology of enactments (Classical, Home-grown and Imported) based on the synthetic mixed method analysis data for each CLAHRC.

Formative interpretations and leadership styles

This section qualitatively unpacks the shared interpretations of the CLAHRC mission, as sponsored by CLAHRC leaders, and how these influenced approaches to KT. The CLAHRCs were similarly organized in terms of having a central management group and a number of teams working on sets of work packages around a related clinical theme.

Extensive flexibility in how they interpreted the NIHR remit, however, led to some distinct differences in subsequent enactments.

From its inception, the Bluetown CLAHRC was formed around a dominant interpretation of KT that sought to support improved patient outcomes and inform service delivery through the production and distribution of rigorous scientific evidence. This formative interpretation is described here as a 'Classical' Enactment.

This Classical Enactment was founded upon a conventional model of the relationship between research and practice. The Director was integral to developing the vision for this CLAHRC and embedding it within the different clinical projects. In particular, most clinical projects were designed as prospective clinical-academic research evaluations linked by a common scientific approach. Thus, clinical scientific tradition was incorporated into the design of study protocols at the start of the programme, with particular attention to methodological rigour and high quality publications. As the Director put it:

Publishing all this information in top quality journals is absolutely, absolutely key. Not just to the academic credibility of CLAHRC but to the managerial credibility of CLAHRC (BLUETOWN001)

The overall focus of the initiative was more aligned to delivering research output than building translational capacity. As a result, beyond the requirement to publish and contribute to implementation, the Classical Enactment did not specify an overarching CLAHRC-wide strategy to support KT. Project teams were provided with extensive flexibility to organize clinical studies and disseminate outputs autonomously.

In contrast, the Greentown CLAHRC explicitly aimed to achieve KT through the purposeful engineering of integration, co-production and boundary spanning activities. Its leader came from a business school rather than a medical school background, and had developed a model of KT based on a sophisticated analysis of organizational learning and knowledge brokering. We refer to this as the 'Home-grown' Enactment. This was designed to provide all members with an approach that explicitly instructed the doing of CLAHRC work. In effect, the enactment itself delineated the 'how to' of KT practice through the strategies, roles and mechanisms it employed. Although it built upon established clinical-academic research links with partner organizations, of the three CLAHRCs, Greentown was thus the most flexible and experimental.

The Browntown CLAHRC sought to apply a conceptual model of KT based on that of the CIHR. This encouraged KT across professional boundaries at all stages of the innovation process. We refer to this as the 'Imported' Enactment. The Browntown CLAHRC's leadership was largely from an allied health and nursing background. The Director's vision of this CLAHRC was consequently informed by the practice-based approaches traditionally used within allied health professions, including an operating model centred on applied activities:

Implementation work is really a cross between action research and participatory research, and you need to shape the projects as you work with the key stakeholders. (Browntown 001)

A key goal of the Imported Enactment was to build new collaborative relationships between usually distinct research and practice communities by spreading an evidence-based, applied health research culture across the Browntown region. The initiative united academics and practitioners who had not previously worked together and aimed to foster cultural change by building the capacity of its members to engage with applied health activities.

The implementation of governance structures

The enactment of different CLAHRC governance structures was reflective of the distinct approaches to KT relating to the formative models and processes preceding these institutional arrangements. Such enactments can be illustrated by their social network configurations.

We provide four network level indexes of centralization for each CLAHRC in Table 2 and a glossary for these in Table 3. For each index, a score of 0% represents an entirely decentralized network where all actors are directly connected to all others and so knowledge flows equally, while a score of 100% indicates a maximally centralized, hierarchical network where all knowledge ties bypass a central actor. Table 4 lists individuals with highest coreness scores (core actors) alongside their role in the CLAHRC.

The Classical Enactment of the Bluetown CLAHRC was established around a simple 'hub-and-spoke' model of a small central management team and nine clinical project teams. The central management team, a small yet dominant group of senior managers, set the Bluetown agenda and reinforced the CLAHRC vision to produce high quality, methodologically rigorous scientific evidence.

The manner in which knowledge-sharing relations were managed within the CLAHRC itself was important. We found that the Classical Enactment 'hub and spoke' model materialized into a comparably centralized and somewhat hierarchical knowledge network (see Table 2). KT activity became focused around the small central management team, who, in our SNA emerged as 'core actors' in the knowledge network. This social network structure enabled senior managers to disseminate clear messages about the Bluetown vision and maintain strong control over output.

With no overarching CLAHRC-wide strategy to support KT activity, each Bluetown team developed a distinct approach tailored to its own local clinical context. Within the broad remit of producing high-quality scientific evidence through a rigorous methodological approach, project teams were able to exercise extensive flexibility in the operational management of their work and devise independent approaches to translating project findings into practice. Management legitimized teams to spend time developing their own day-to-day operational approach that included fostering strong collaborative relationships with relevant local groups. This enabled the mobilization of knowledge through teams' own programme of work and was based on a dominant CLAHRC-wide view that stronger local engagement would better enable implementation of project findings. However, in the absence of a CLAHRC-wide KT strategy, members struggled to share experiences and skills around managing their engagement and translational work. Our SNA revealed, for example, that

members of the Bluetown CLAHRC preferred to use external networks to seek advice on management issues.

On the other hand, there were positive effects to allowing project teams the flexibility to develop independent approaches. Each Bluetown team developed strong working relationships with partner organizations that were crucial in supporting its programme of work. This was especially conducive to the work of project teams located in health care organizations, and resulted in projects (and the CLAHRC) being well-placed for local impact. The clustering of Bluetown project teams thus supported KT with external groups by evolving more autonomous relationships with local health care partners and developing tailored approaches for disseminating outputs.

The Home-grown Enactment of the Greentown CLAHRC utilized an explicit CLAHRC-wide organizational structure to facilitate KT activity. This structure emphasized a common operational strategy championed by CLAHRC management. An organizational learning model helped to facilitate a change in how research was conducted and utilized within the region. A key component of the model was to use the research experience of member organizations as a foundation from which expertise could be geographically dispersed to, and developed in, other areas.

Reflecting the emphasis on an inclusive, learning-centred KT approach, the Home-grown Enactment produced a comparatively decentralized knowledge network (Table 3), with individual members having relatively equal access to and control over knowledge. Interestingly, Table 4 shows that the CLAHRC leadership, although part of the network core, was not a highest ranked core actor. This was a notable contrast to our other CLAHRC cases. Indeed, members held more equal positions in the knowledge network irrespective of management position and knowledge could be translated along a multitude of alternative paths that did not need to pass through the network core. The mixed role composition of core actors and thus relative equality of network positions suggests that Greentown was enacting KT differently and this was consistent with the Home-grown Enactment vision of boundary spanning and co-production.

Governance at Greentown involved explicit interventions to achieve KT across groups. Most notable was the allocation of formally designated 'knowledge broker' roles to specific individuals. This purposeful engineering of KT activity aimed to support the development of new working practices. The impact of this innovation can be gauged from our social network data, which shows that the Greentown CLAHRC knowledge network would have been centralized (hierarchical) without the formal boundary spanning work undertaken by CLAHRC members in knowledge broker roles. This is important because individuals in boundary spanning roles facilitated KT activities by creating channels for information dissemination that bypassed central management. Knowledge brokers were ensuring members' equal access to knowledge, but not conducting this activity in a strategic or planned way (i.e. according to need). Table 2 shows that there was little discrepancy in terms of prestige positions or control over knowledge in members' immediate networks (degree and betweenness centralization). There were some restrictions in accessing information via more distant sources (closeness centralization).

Given that the Home-grown Enactment specified that members perform new roles and build new networks associated with these roles, it was sometimes difficult for project teams to form direct relationships with local health care groups that would naturally form part of their usual 'day-to-day' working practices. Moreover, the added-emphasis on building new networks meant that members did not fully exploit pre-existing knowledge ties. The Greentown model stipulated that knowledge brokers act as 'intermediaries' who conduct the translation work for outputs and this limited the networking between project teams and external groups. Thus while the Home-grown model helped to support the building of relationships through 'knowledge brokers' and 'translation mechanisms', it better supported translation within the CLAHRC itself rather than networks between project teams and external groups.

In accordance with its internally distributed leadership model, the Browntown CLAHRC employed a large central management team dispensed across the CLAHRC. Indeed, our SNA revealed a centralized knowledge network focused around these 'core' senior managers. The coreness results in Table 4 illustrate that the Browntown Director and three Theme/Programme Leads who were at the core of the knowledge network led KT. The Imported Enactment crafted a relatively centralized structure: CLAHRC members held the most differential positions in terms of their access to knowledge (see Table 2 for closeness centralization and flow betweenness scores). It was difficult for some individuals to access information beyond their immediate knowledge contacts or via routes that circumvented the senior managers at the network core.

The vision of the Browntown CLAHRC was for all programme of work to engage with diverse perspectives and traditions. This Imported Enactment involved incorporating different types of knowledge within all programme of work. Operationally, teams of mixed professional backgrounds were implanted within local partner organizations to conduct CLAHRC work. An inherent challenge to the imported model stemmed from the heterogeneous make-up of CLAHRC partners (a diverse combination of academic disciplines and clinical groups from across various NHS Trust directorates). Browntown managed to successfully avoid this potential problem by fostering a strong CLAHRC culture from the onset and continuing to reinforce this collective ethos over time. From the start of project work, CLAHRC management encouraged members to develop the remit of work programme collaboratively with end-user stakeholder groups and to foster true co-production relationships. The existence of a centralized knowledge network backbone thus helped to support CLAHRC integration despite the occupational heterogeneity and overlapping community memberships of the initiative.

Epistemic differences between the professional groups

Beyond organizational features of the CLAHRCs, the epistemic differences between groups within them also influenced the enactment of KT work. Thus, the Bluetown CLAHRC was led by a research-active university hospital with CLAHRC work centred on a high profile medical school. Prominent stakeholders in the partnership were clinical directorates drawn from NHS Trusts professionally associated with clinical academic departments. The health care partners included acute hospital, primary care and mental health providers.

Epistemologically, members of this CLAHRC had strong expertise in clinical science, and both partner organizations and members tended to agree with the principle that only rigorous evidence should be used to inform service developments.

The focus upon conducting rigorous research was supported by a great deal of technical advice obtained from networks of colleagues within the CLAHRC itself. Specialist support services were a CLAHRC-wide resource, providing each clinical project team with access to people who could contribute expertise in medical sociology, health economics, systematic reviewing and statistics.

An outcome of the combined focus on research rigour and centralized network governance was the Bluetown CLAHRC's ability to collaborate readily with communities that were closely aligned epistemically. This had the positive effect of supporting collaboration within conventional institutional constraints so as to make rapid progress. Yet, it also constrained Bluetown CLAHRC's ability, and willingness, to work across epistemic boundaries in a way that would widen participation and foster cultural change as seen with the Greentown and Browntown enactments. The latter, of course, requires building new social networks between individuals and groups that do not ordinarily engage in collaborative research in a more nuanced, longitudinal endeavour, perhaps more sensitive to clashes of epistemic cultures.

The Bluetown CLAHRC activity also supported new operational approaches and in particular emphasized the need for project teams to develop collaborative relationships with external communities, especially management and decision-makers. Our SNA results revealed that Bluetown built knowledge networks beyond the NHS and academia to local authorities, central government, third sector and private industry.

The Greentown CLAHRC was led by an NHS mental health Trust and centred on established research links between the Trust, a university hospital NHS acute Trust and a university. Its epistemology was embodied in a clinical-academic paradigm that integrated different types of knowledge, including clinical, health sciences and social science academic traditions. Academia was the most dominant knowledge institution for this CLAHRC (based on the number of knowledge ties). Of the three CLAHRCs, the Greentown's Home-grown model was the least NHS-facing at the early stages of its development.

Brokering knowledge was encouraged across teams and organizations to develop support for coproduction and the integration of knowledge as outlined in Greentown's formative model. Deliberate efforts were made to translate knowledge between settings. This was not only through the design of explicit knowledge brokerage roles within the CLAHRC, but also, as the Director put it; 'to bring in people who have different backgrounds and different experiences who understand the world in a different way'. One strategy was to recruit local stakeholders as 'CLAHRC associates' in an attempt to engender community tendencies around specific clinical domains in which Greentown intended to make an impact. The aim was to establish the CLAHRC as an indispensable part of the regional health scene by building close alliances through communities of practice.

The Home-grown Enactment was strongly reliant on boundary-spanning actors to provide bridging mechanisms in support of KT. In practice, there were some issues with the effectiveness of this during the CLAHRC's early development. Members faced challenges in balancing CLAHRC work with pressures from their host organizations. For example, the clinical academics faced pressure from within the university, and the NHS members encountered pressure due to resource issues, and so for both it was difficult to prioritize time engaging with CLAHRC work. Moreover, it was difficult to integrate the roles prescribed by the model into existing working practices of members who were not readily able to adapt the way their skills and experiences were translated.

This was a factor in the failure of some members to fully engage with the CLAHRC's remit, purpose and mechanisms, depicted in the original Home-grown model. Some members (including team leads) failed fully to engage with the work of the CLAHRC as they struggled to understand certain elements of Greentown's structure and roles. This lack of clarity developed into further confusion around general questions such as how to integrate the Home-grown model in a way conducive to achieving clinical academic programme of work.

The Browntown CLAHRC was led by a university hospital and centred on a partnership of universities and health care organizations that had historically engaged in research activity but also developed a number of new collaborative relationships. Unlike the other two CLAHRCs, it was not university-centric, and was, instead, centred on allied health and nursing academics and practitioners, with the key stakeholders being nursing and allied health directorates from NHS Trusts. A range of health care organizations were involved as partners, including NHS acute hospital Trusts, primary care Trusts and mental health services. The model for CLAHRC work included an extensive focus on achieving impact through focusing collaborations from the 'bottom-up', with KT activities aimed at directly influencing clinical services and wardlevel practices.

As highlighted previously, the dominant KT interpretation for Browntown was the production and dissemination of applied research. For example, the majority of Browntown knowledge networks were with NHS contacts. As the CLAHRC was based upon the traditions of allied health academics and practitioners (rather than university-centric), this helped to privilege health services' concerns in shaping the programme of work.

The ethos of the Imported model was to blur the boundary between research and practice, and the Browntown CLAHRC enacted this by incorporating members with heterogeneous professional expertise. These multiple backgrounds were crucial to supporting the model as one Browntown member describes:

You see everyone has got a different perspective. Whether you're a commissioner, you know, perhaps coming from a public health or social services background, but you're commissioning. Or a manager in the NHS, perhaps social services seconded to NHS. Or a doctor or a nurse or a psychologist or a GP or a service user. You've all got a different understanding of what the care pathway is and what needs to be done to improve it. And so very much we deliberately wanted to incorporate a collaborative project between all those different groups. (Browntown 008)

The Imported Enactment built its competence in boundary spanning on the pre-existing relations of members, which overlapped across multiple professional communities. This was integral to achieving cultural change and supported a capability to build knowledge across health care communities that would otherwise have been disconnected. The strength of this enactment was, therefore, in deriving innovative networking building capabilities by incorporating a diversity of ties through the mixing of professionals from different epistemic backgrounds. A member of the Browntown central management team commented:

I think CLAHRC is a boundary spanner. That's its job, that's what it is. Because the organisations, the NHS organisations, I mean, they do talk to each other because of, you know, Department of Health policy and stuff but they all have different ways of implementing policy. And so they don't necessarily talk to each other but through us there's work happening that can be, you know, translated across the different organisations. So we do act as kind of a, it's almost like a phone exchange. (Browntown 017)

Despite the benefits of a heterogeneous membership, a challenge arose in that the predominant allied health focus influenced the types of networks in which this work was situated. This has consequently somewhat limited the CLAHRC's ability to draw on high profile clinical academic research networks.

Achieving CLAHRC outcomes

The enactments of the CLAHRCs not only entailed a particular understanding of their purpose, but also identified the appropriate outcomes of their activities. Our study involved a formative rather than summative assessment of their development. However, if 'intervention integrity be defined as evidence of fit with the theory or principles of the hypothesized change process',⁴⁹ it becomes clear that enactments had implications for the CLAHRCs' common efforts to achieve an impact on health care policy and practice.

The Classical Enactment observed at Bluetown CLAHRC was associated with a high-profile academic community with strong links to national policy making. This tended to support project-level capabilities in linking evidence and policy. The Classical enactment model achieved some wider impact associated with these project-level outcomes, especially in terms of outputs linked with clinical academic approaches such as journal publication and disseminating to national networks, but was not as well positioned for locally applied impact (such as influencing local nursing practices).

For the Home-grown Enactment, the organization and governance of the initiative as a whole was important in differentiating expertise for target-related activities, for example, using structural mechanisms to influence the clinical service in the local area. The Home-grown enactment relied to a greater extent on its own newly developed mechanisms, rather than established personal relationships between project teams and local networks, with the innovative knowledge broker roles particularly conducive to the generation of new ideas.

Finally, the Imported Enactment was situated predominantly within allied health and nursing communities, and utilized heterogeneous teams and activated pre-existing (non-CLAHRC) ties. It produced organization-level KT capabilities to link research and practice at the local

level as evidenced, for example, by the practical testing of an intervention in situ. The capacity to blur the boundary between research and practice was enabled by the mixed professional composition of CLAHRC members. As such, the CLAHRC itself was able to benefit from its members' partial memberships in diverse epistemic groups and their subsequent ability to translate knowledge across multiple professional settings.

Discussion

Our study has highlighted the level of variation in the way the CLAHRC initiative has been realized by different groups. This level of variation is seen as underlining the importance of 'enactment' for policy initiatives aimed at supporting KT. The notion of enactment is often used quite loosely in existing literature to denote putting something into practice. It is sometimes equated with 'implementation'.⁵⁰ The analysis of the CLAHRCs in our study, however, seems to demand a richer understanding of this term. The notion of enactment is not simply about an act of implementation in context, but rather draws attention to the way in which actors, and especially leaders, help to create a persuasive and constitutive interpretation of the mission and context of their initiative.⁵¹ This helps to mandate certain forms of authority and legitimates particular practices.

Our view of enactment, therefore, goes beyond highlighting variation between CLAHRCs, but explores the critical mechanisms that influence the way a KT model is interpreted and acted upon. Enactment, as we see it in our cases, centres on the linkages between formative interpretations, governance structure and epistemic commitments. The implication is not only that KT practices diverge from any universalist or underpinning conceptual model, but also that their divergence needs to be explained in terms of differing enactments and not different contexts.

The varying 'formative interpretations' of the CLAHRC mission were creatively shaped and reflect the agency available to their founding groups and leaders. In this sense, the variation seems to emphasize the 'interpretive flexibility'⁵² available to CLAHRC leaders and directors in their efforts to develop and apply innovative organizational forms. It has also highlighted the importance of the ideas and discourses which different groups drew on in exploiting that flexibility, be they locally sourced or imported.

Our analysis also emphasizes the close interdependence between management structures and social networks as being critical to the way KT governance was enacted by different CLAHRCs. This interdependence is reflected, for example, in the social network structures observed and, particularly, the extent to which they expressed hierarchy through centralization. Thus, the different CLAHRC enactments influenced the evolution of networked governance structures, which, in turn, created varying distributions of knowledge ties. The Traditional and Imported Enactments produced the most centralized (hierarchical) knowledge networks, in that many ties went to a small number of people in the centre of the network, while there were fewer ties between other individuals. In contrast, the Home-grown enactment produced the most decentralized network (where members had relatively equal access to, and control over, knowledge).

The presence of 'core' actors had implications for the extent to which senior management within the CLAHRCs could directly shape KT efforts. Management control over KT was strongest in the Traditional and Imported Enactments where knowledge-related ties were mostly focused on directors, senior managers or theme leads. In the Home-grown model, by contrast, we found the lowest levels of management control over KT.

We highlight the importance of the epistemic composition of CLAHRC members in influencing the types of knowledge prioritized and the ability to translate knowledge across multiple settings. The Imported Enactment drew upon members' pre-existing networks across diverse professional communities to produce organization-level KT capabilities that blurred the boundary between research and practice. Such hybrid roles were perceived as integral to the formative interpretation of the NIHR mandate and hence became a sapient feature of the governance model itself. For the Home-grown enactment, the governance of the initiative as a whole was important in defining newly developed structural mechanisms to broker knowledge between epistemic groups. The agreement to apply a clinical sciences paradigm in the Classical Enactment supported project-level actions such as the capability of teams to produce journal publications. Together, these findings illustrate qualitative nuances linking management styles, governance networks and epistemic compositions to the enactment of KT.

We draw attention to the variations in enactment across CLAHRCs so that other health care KT initiatives may learn from these experiences. Our findings support the view that future research should seek to understand better the ways in which these models are adapted, re-interpreted and applied within particular contexts. We highlight critical levers for policy makers to consider in their funding decisions. Moreover, in relation to further research, our findings suggest that attempts to answer questions such as, 'which type of KT network is best?' are unlikely to be successful unless they focus not only on objective, designed features, but also explore, more interpretively, the enactments which lead to such features.

In respect of KT, it is clear that each CLAHRC developed its own distinctive approach, some aspects of which were managed and articulated through top-down processes (such as the strong directive of the Classical enactment and governance mechanisms of the Home-grown enactment), while others make a more implicit contribution (for example, the implications of hybrid roles in the Imported Enactment). These differences in enactments show, first, that there are multiple routes by which new evidence and improvements can be put into practice. Second, it tells us that the particular route adopted and its effects will depend on certain complex features of the collaboration, including how it is led and managed, and the nature of the relationships between the groups involved. The CLAHRC initiative, therefore, represents a 'complex intervention'.⁵³ The fixed aspects of the initiative are the essential functions (in this instance the CLAHRC mission/aims); the variable aspect is their form (or enactment) in different contexts. Recognizing this complexity means liberating non-standard health care interventions both to be 'responsive to local context' and to provide 'meaningful evaluation in controlled designs'.⁴⁹

Conclusion

Our study of the three CLAHRCs helps to explain the way in which the broad CLAHRC remit has been appropriated in distinctive ways according to formative processes and leadership, governance structures and the epistemic expertise of membership groups. We illustrate how the NIHR mission was enacted in the formative stages of CLAHRC development. These variations in the interpretation and enactment of the CLAHRC mission underline the importance of their contrasting organizational and network structures and varying epistemological priorities.

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References

1. Cooksey, D. A review of UK health research funding. HM Treasury; London: 2006.
2. Duncan, R.; Weiss, A. Organizational learning: implications for organizational design. In: Staw, BM.; Cummings, L., editors. Research in organizational behaviour. JAI Press; Greenwich: 1979.
3. Newell S, Edelman L, Scarbrough H, et al. 'Best practice' development and transfer in the NHS: The importance of process as well as product knowledge. Health Serv Manage Res. 2003; 16:1–12. [PubMed: 12626022]
4. Dopson, S.; Fitzgerald, L. Knowledge to action? Evidence-based health care in context. Oxford University Press; Oxford: 2005.
5. Lomas J. Connecting research and policy. Can J Policy Res. 2000; 1:140–144.
6. Gkeredakis E, Swan J, Powell J, et al. Mind the gap: understanding utilisation of evidence and policy in health care management practice. J Health Organ Manag. 2011; 25:298–314. [PubMed: 21845984]
7. Greenhalgh T, Wieringa S. Is it time to drop the 'knowledge translation' metaphor? A critical literature review. J R Soc Med. 2011; 104:501–509. [PubMed: 22179293]
8. Nicolini D, Powell J, Conville P, et al. Managing knowledge in the health care sector. A review. Int J Manag Rev. 2008; 10:245–263.
9. Pope C, Robert G, Bate P, et al. Lost in translation: a multi-level case study of the metamorphosis of meanings and action in public sector organizational innovation. Public Admin. 2006; 84:59–79.
10. Lang ES, Wyer PC, Haynes RB. Knowledge translation: closing the evidence-to-practice gap. Ann Emerg Med. 2007; 49:355–363. [PubMed: 17084943]
11. Davis D, Davis ME, Jadad A, et al. The case for knowledge translation: shortening the journey from evidence to effect. BMJ. 2003; 327:33–35. [PubMed: 12842955]
12. Graham ID, Tetroe J. Some theoretical underpinnings of knowledge translation. Acad Emerg Med. 2007; 14:936–941. [PubMed: 17967955]
13. Crilly, T.; Jashapara, A.; Ferlie, E. Research utilisation and knowledge mobilisation: a scoping review of the literature. Report for the National Institute for Health Research Service Delivery and Organisation Programme. NIHR SDO; Southampton: 2010.

14. Rynes SL, Bartunek JM, Daft RL. Across the great divide: Knowledge creation and transfer between practitioners and academics. *Acad Manag J.* 2001; 44:340–355.
15. Ferlie E, Fitzgerald L, Wood M, et al. The nonspread of innovations: the mediating role of professionals. *Acad Manag J.* 2005; 48:117–134.
16. Grol R. Successes and failures in the implementation of evidence-based guidelines for clinical practice. *Med Care.* 2001; 39:II46–54. [PubMed: 11583121]
17. Lomas J. Using research to inform health care managers' and policy makers' questions: from summative to interpretive synthesis. *Healthc Policy.* 2005; 1:55–71. [PubMed: 19308103]
18. Schuster MA, McGlynn EA, Brook RH. How good is the quality of health care in the United States? *Milbank Q.* 2005; 83:843–895. [PubMed: 16279970]
19. Swan, J.; Clarke, A.; Nicolini, D., et al. Evidence in management decisions (EMD) – advancing knowledge utilization in healthcare management. Final report. NIHR Health Services and Delivery Research programme; 2012.
20. Crilly, T.; Jashapara, A.; Trenholm, S., et al. NIHR Health Services and Delivery Research programme; 2013. Knowledge mobilisation in healthcare organisations: synthesising the evidence and theory using perspectives of organisational form, resource based view of the firm and critical theory.
21. Graham ID, Logan J, Harrison MB, et al. Lost in knowledge translation: time for a map? *J Contin Educ Health Prof.* 2006; 26:13–24. [PubMed: 16557505]
22. Grol R, Grimshaw J. Evidence-based implementation of evidence-based medicine. *Jt Comm J Qual Improv.* 1999; 25:503. [PubMed: 10522231]
23. Kontos PC, Poland BD. Mapping new theoretical and methodological terrain for knowledge translation: contributions from critical realism and the arts. *Implement Sci.* 2009; 4:1–10. [PubMed: 19123945]
24. Nicolini D. Stretching out and expanding work practices in time and space: the case of telemedicine. *Hum Relat.* 2007; 60:889–920.
25. Denis JL, Lomas J. Convergent evolution: the academic and policy roots of collaborative research. *J Health Serv Res Policy.* 2003; 8(Suppl 2):1. [PubMed: 14596741]
26. Boyko J, Lavis J, Abelson J, et al. Deliberative dialogues as a mechanism for knowledge translation and exchange in health systems decision-making. *Soc Sci Med.* 2012; 75(11):1938–1945. [PubMed: 22938912]
27. Canadian Institutes of Health Research. Developing a CIHR Framework to Measure the Impact of Health Research: A synthesis report of meetings; 23 and 24 February and 18 May 2005;
28. Oborn E, Dawson S. Knowledge and practice in multidisciplinary teams: struggle, accommodation and privilege. *Hum Relat.* 2010; 63:1835–1857.
29. Mitton C, Adair CE, McKenzie E, et al. Knowledge transfer and exchange: review and synthesis of the literature. *Milbank Q.* 2007; 85:729–768. [PubMed: 18070335]
30. Grimshaw JM, Eccles MP, Lavis JN, et al. Knowledge translation of research findings. *Implement Sci.* 2012; 7:50. [PubMed: 22651257]
31. Grint K. Problems, problems, problems: the social construction of 'leadership'. *Hum Relat.* 2005; 58:1467–1494.
32. Fereday J, Muir-Cochrane E. Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development. *Int J Qual Meth.* 2008; 5:80–92.
33. Knorr Cetina, K. Epistemic cultures. How the sciences make knowledge. Harvard University Press; Cambridge: 1999.
34. Friedson, E. Profession of medicine. Dodd, Mead; New York: 1970.
35. West MA, Wallace M. Innovation in health care teams. *Eur J Soc Psychol.* 1991; 21:303–315.
36. Reagans R, Zuckerman EW. Networks, diversity, and productivity: the social capital of corporate R&D teams. *Organ Sci.* 2001; 12:502–17.
37. Obstfeld D. Social networks, the tertius iungens orientation, and involvement in innovation. *Admin Sci Q.* 2005; 50:100–130.
38. Cross R, Rice RE, Parker A. Information seeking in social context: structural influences and receipt of information benefits. *Appl Rev Part C IEEE Trans Syst Man Cybern.* 2001; 31:438–448.

39. Hanson J, Krackhardt D. Informal networks: the company behind the chart. *Harvard Business Rev.* 1993; 71:104–111.
40. Cross R, Borgatti SP, Parker A. Beyond answers: dimensions of the advice network. *Social Netw.* 2001; 23:215–235.
41. Borgatti, SP.; Everett, MG.; Freeman, LC. UCINET 6 for Windows. Analytic Technologies; Harvard: 2002.
42. Irwin MD, Hughes HL. Centrality and the structure of urban interaction: measures, concepts, and applications. *Soc Forces.* 1992; 71(1):17–51.
43. Scott, J. *Social network analysis.* 2nd ed. Sage Publications; Thousand Oaks: 2000.
44. Tichy NM, Tushman ML, Fombrun C. Social network analysis for organizations. *Acad Manag Rev.* 1979; 4(4):507–519.
45. Turk, H. *Organizations in modern life.* Jossey-Bass; San Francisco: 1977.
46. Baldassarri D, Diani M. The integrative power of civic networks 1. *Am J Sociol.* 2007; 113:735–780.
47. Friedkin, NE. *A structural theory of social influence.* Cambridge University Press; Cambridge, MA: 2006.
48. Borgatti SP, Everett MG. Models of core/periphery structures. *Soc Netw.* 2000; 21:375–395.
49. Hawe P, Shiell A, Riley T. Complex interventions: how “out of control” can a randomised controlled trial be? *BMJ.* 2004; 328:1561. [PubMed: 15217878]
50. McGivern G, Lambrianou A, Ferlie E, et al. Enacting evidence into clinical practice: the case of coronary heart disease. *Public Money Manag.* 2009; 29:307–312.
51. Weick, KE. *Sensemaking in organizations.* Sage; Thousand Oaks, CA: 1995.
52. Pinch, TJ.; Bijker, WE. The social construction of facts and artifacts: or how the sociology of science and the sociology of technology might benefit each other. In: Bijker, WE.; Hughes, T.; Pinch, TJ., editors. *The social construction of technological systems.* MIT Press; London: 1987.
53. Campbell M, Fitzpatrick R, Haines A, et al. Framework for design and evaluation of complex interventions to improve health. *BMJ.* 2000; 321(7262):694. [PubMed: 10987780]

Table 1

A typology of CLAHRC enactments.

	Formative interpretations and leadership styles	Governance structures	Epistemic base/professional groups involved	Capabilities	Challenges
Classical (Bluetown)	Research and dissemination model KT via dissemination of rigorous high-quality scientific research.	KT activity focused around a small core set of senior managers. Centralized KT network.	Clinical-sciences paradigm. NHS facing. Led by university hospital with strong research reputation.	Production of research evidence. Management presents a clear CLAHRC vision and strong control over output. Teams support local implementation.	No CLAHRC-wide strategy to support KT. KT efforts localized to particular projects.
Home-grown (Greentown)	Organizational learning model.	Decentralized KT network.	Clinical-academic paradigm. Academic-facing.	Idea/theory generation.	Confused CLAHRC mission/member roles.
Imported (Browntown)	Purposefully engineers KT mechanisms. Adaptation of Canadian KT model.	KT activity distributed across the CLAHRC organizational hierarchy. Distributed leadership: KT activity focused around a larger core set of senior managers.	Led by mental health trust. Allied-health & nursing paradigm. NHS-facing.	Builds research capacity in localities further away from the CLAHRC core. Implementation/applied work.	Professional/disciplinary focus limits ability to draw on high profile clinical-academic research networks.
	Pre-existing hybrid roles of members to encourage natural KT.	Centralized KT network.	Led by a university hospital.	Builds capacity for 'bottom-up' engagement with 'ward-level' allied-health & nursing healthcare communities.	

CLAHRC: Collaborations for Leadership in Applied Health Research and Care; KT: knowledge translation; NHS: National Health Service.

Table 2
Centralization scores of CLAHRC networks.^a

	Bluetown	Greentown	Browntown
Degree (prestige)	34.5%	10.2%	28.7%
Betweenness (control)	37.6%	11.1%	37.5%
Closeness (access)	49.0%	30.8%	46.6%
Flow betweenness (alt. path)	4.2%	2.8%	8.1%

CLAHRC: Collaborations for Leadership in Applied Health Research and Care.

^aScores based on undirected symmetrical relations.

Table 3
Glossary of centralization indexes.

Degree centralization	The extent to which there is asymmetry in the number of direct ties that a node has in a given network (i.e. if some individuals have a disproportionately larger number of knowledge ties than others creating for them a position of prestige).
Betweenness centralization	The extent to which there is asymmetry of influence or control over knowledge in the network (i.e. if some individuals are better positioned as intermediaries in the network than others).
Closeness centralization	The extent to which there is asymmetry in access to knowledge beyond one's immediate set of contacts (i.e. if some individuals are better able to access information from distant sources whereas others are constrained).
Flow betweenness	The extent to which knowledge can be translated via a range of alternative paths that circumvent the network centre.

Table 4
Individuals with highest coreness scores (core actors) alongside their role in the CLAHRC.^a

Bluetown		Greentown		Browntown	
Score	CLAHRC role	Score	CLAHRC role	Score	CLAHRC role
0.467	Theme/Programme Lead	0.33	Theme/Programme Lead	0.442	Theme/Programme Lead
0.300	CLAHRC Leadership	0.253	Project Manager/Researcher	0.304	CLAHRC Leadership
0.229	Project Manager/Researcher	0.241	Support role	0.247	Theme/Programme Lead
0.221	Theme/Programme Lead			0.216	Theme/Programme Lead

CLAHRC: Collaborations for Leadership in Applied Health Research and Care.

^aHighest scores represent individuals who are closest to the knowledge network core. Calculated using continuous coreness model. Reporting scores > 2.