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Information Systems and Health Care-III: Diffusing Healthcare Knowledge: A Case Study of the Care Delivery Network

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INFORMATION SYSTEMS AND HEALTH CARE III: DIFFUSING HEALTHCARE KNOWLEDGE: A CASE STUDY OF THE CARE DELIVERY NETWORK

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ABSTRACT

This article describes the experience of the Care Delivery Network as it promoted the successful diffusion of an innovative stroke treatment protocol across a wide range of healthcare institutions and practitioners in southeastern Ontario, Canada. The article is founded on research by Adler, Kwon, and Signer on knowledge management in professional communities. The Care Delivery Network case provides partial to strong empirical support for 17 Adler et al. research propositions. The article concludes with a summary of lessons learned and strategies for information and knowledge dissemination in professional settings.

KEYWORDS: knowledge diffusion, innovation, healthcare professionals

I. INTRODUCTION

How can a small number of individuals encourage the diffusion of specific innovations and practices not only within a specific organization, but also across organizational and geographic boundaries? Such was the challenge facing the Care Delivery Network (CDN) Project. This article reports a longitudinal case study of the CDN.

In 1997, an interdisciplinary team of researchers and practitioners based in Kingston, Ontario, Canada decided to confront the lack of healthcare service integration in their region and to address perceptions of inconsistency in the levels of service across the approximately 20,000 km^2 region. The Care Delivery Network (CDN) Project, a joint initiative of Queen's University and a private healthcare partner, grew out of the commitment to pursue the team's concerns. The CDN consisted of a group of researchers, physicians, and knowledge managers who were prepared to contribute their time and combined effort. Initial informal conversations rapidly became the foundation for more formal networks. In time, the CDN was founded as a separate legal entity, and formally took on the challenge of spreading information across a wide range of geographically dispersed professionals and existing healthcare networks in southeastern Ontario.

In this article, first we outline past research on the diffusion of knowledge. Then we describe the history of the CDN project, and discuss our findings based on the literature and the CDN experience. We close by summarizing what we have learned, and offering implications for

healthcare and IT practitioners on how the diffusion of knowledge can be managed within organizations and across networks.

II. THE DIFFUSION OF KNOWLEDGE IN HEALTHCARE SETTINGS

Data are context-independent observations or facts. However, information contains meaning. It informs and is context-specific. Knowledge involves accessing and organizing accumulated information through experience, communication, and inference [Zack, 1999].   Knowledge management involves a set of practices that include generating, codifying, and diffusing knowledge [Davenport and Prusak, 1998]. The healthcare literature suggests that personal contacts are particularly important in knowledge transfer and diffusion of innovations among physicians [Coleman et al., 1966]. Coleman et al., in fact, define a medical community as a set of personal relationships, which include hospital affiliations, office partnerships, discussion networks, and friendships. Personal associations among people facilitate knowledge transfer. Although knowledge can flow through technology, it actually resides in people, and expands through sharing and use [Webber, 1993; Allee, 1999].

The flow of knowledge among people and groups either within an organization or external to it has been the subject of much research. Findings show that technology can facilitate the process of making previously unavailable information widely accessible to a broader audience [Farrell, 2003]. However, some diffusion of knowledge is unexplainable except by observing personal relationships among people [Brazelton and Gorry, 2003; Morone and Taylor, 2004; Nonaka and Takeuchi, 1995]. Karl Sveiby [1999] explains this phenomenon by describing the situation between a master and an apprentice:

> *An art that cannot be specified in detail cannot be transmitted by prescription, since no prescription for it exists. It can be passed on only by example from master to apprentice. This restricts the range of diffusion to that of personal contacts.* [Sveiby, 1999]

He also admits that the term he uses, knowledge 'transfer', is not quite appropriate, "since knowledge is not moved as goods. The 'receiver' reconstructs his or her version of the 'supplier's' knowledge."

Knowledge is partially in the mind of the beholder. That tacit knowledge is an inherent and essential element of an organization's intellectual assets is widely accepted [Lawson and Lorenz, 1999; Sveiby 1999]. Lawson and Lorenz [1999] define tacit knowledge as just that: internal knowledge embodied in organizational routines and procedures. Tacit knowledge is what allows members of an organization:

> *To co-ordinate their actions and act capably without needing, or necessarily being able, to articulate in words or diagrams exactly how they accomplish this. For this to be possible, members must draw upon knowledge that they have come to hold tacitly by acting within, and reproducing, the organization's routines.* [Lawson and Lorenz, 1999]

Other factors influence how well and how quickly knowledge transfer occurs. For example, boundary-spanning individuals and people who champion an innovation are key [Adler et al., 2001; Brazelton and Gorry, 2003]. So are established and technology-facilitated lines of communication that provide pathways for new knowledge to make its way through an organization or among communities [Farrell, 2003; Russell and Hoag, 2004]. Similarly, shared values, trust, and a common purpose [Brazelton and Gorry, 2003] assist with knowledge flow. Informal and formal professional affiliations provide existing forums for knowledge diffusion [Cowan and Jonard, 2004]. Finally, carefully designed structures can influence the purposeful diffusion of knowledge throughout organizations and networks [Adler et al., 2001; Selamat and Choudrie, 2004].

The diffusion of knowledge has been studied extensively in many areas – in business [Farrell, 2003], urban and industrial change [Redmond, 2003], and technology adoption [Morgan, 2003; Russell and Hoag, 2004], among others. Adler, Kwon, and Signer [2001] provide particularly helpful insights on knowledge transfer in healthcare settings. They contribute a series of propositions related to the diffusion of information and knowledge in professional bodies, thereby offering a useful lens through which knowledge flows can be examined. The Adler et al. propositions, summarized in Table 1[1], set the direction for this paper. We use the CDN experience to examine the flow of information and knowledge in diverse healthcare settings, and to test the Adler et al. propositions.

Table 1: Adler et al.'s Propositions and the CDN Experience

Proposition	CDN Experience	Conclusion
1. Professionals have more control than non-professionals over the diffusion of innovations affecting their work.	Physicians set the pace of discussions, and held the final decision whether to enact the protocol or not. Nurses held process information vital to diffusion, but could not stop the process. Ambulance attendants were informed of the innovation and educated in its use, but had little control over its diffusion. Autonomy may be an overstated issue. In the stroke initiative, professional autonomy was constrained by the popularity of the new drug therapy. It was inconceivable that any professional would block its successful implementation.	Supported
2. Innovations generated within the professional community will diffuse more effectively than those coming from without.	The CDN's founding participant stipulated from the beginning that innovations would be developed at the grass roots, and that the CDN's activities would seek to nurture ideas emanating in the field. The view was that healthcare professionals were more likely to believe that the motivation behind the innovation was aligned with their own interests if the innovation came from within the professional community.	Supported
3. When professional actors play an active role in championing innovations, diffusion will be more effective.	The CDN champion and the neurologist widely seen as championing the stroke protocol were both physicians held in high regard in the region. They were largely responsible for securing the participation of all appropriate professionals in the development of the protocol. They initiated this action through influential dialogue with Medical Directors from all hospital organizations.	Supported
4. When acknowledged experts play an active role in promoting innovations, diffusion will be more effective.	Professionals, namely physicians in this case, are conscious of their sphere of activity. When an innovation touched on an area they knew about but were not comfortable with, they clearly took the view and opinions of acknowledged experts.	Supported
5. When boundary-spanning individuals facilitate information flow across boundaries, innovations will diffuse more effectively.	The CDN as a whole was seen as a boundary spanning entity by members of the broader provider community. Individuals working for the CDN were held in the same regard. They were able to bring to each organization a consistent, if evolving, view of the innovation, and were able to carry out a dialogue that enabled participants to further define the innovation in language that was relevant to their own context. There were instances when extensive boundary spanning activity uncovered problems about the innovation that actually slowed diffusion until they were resolved.	Supported
6. Boundary-spanners will be more important to effective diffusion in professional than non-professional settings.	At the outset, the CDN made a deliberate decision to avoid tackling governance issues, organizational structure issues, or resource allocation issues. They placed themselves in a position where they could not force any issue, needing to broker a consensus on all matters. One CDN member observed that "…it was no one else's job to coordinate the discussions and negotiations that ultimately led to adoption of the protocol." Managers	Supported

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[1] Table 1 provides a synopsis of the Adler et al. propositions related to the CDN experience. It does not present four propositions that could not be tested directly in our case study.

Proposition	CDN Experience	Conclusion
	in non-clinical or administrative roles played no part in coordinating and advocating the diffusion of the innovation. Interviewees stated that "we didn't so much force the issue, as remove all the obstacles to success." In other provincial jurisdictions, where the regional authorities have the jurisdictional power to force this sort of collaboration and coordination, there is little evidence of success at doing so.	
7. In professional organizations as in other settings, innovations that are high on relative compatibility, simplicity, trialability, and observability will diffuse more effectively than those that are not.	The new drug therapy represented such a significant improvement that it captured people's imagination and made the tougher discussion about integration of care and coordination more possible. As one participant indicated, "…tPA needed an organized approach, but an organized approach doesn't need tPA." Later, when the CDN moved on to other innovations, it was easier to get to the more difficult decisions affecting professional practices and routines, having built on the success of the first innovation. Note: Most participants referred to the new drug as tPA, though the complete acronym is rtPA (recombinant tissue plasminogen activator).	Supported
8. Compared to innovations in non-professional settings, the diffusion of innovations in professional settings will be less sensitive to the innovation's cost advantages for the organization and more sensitive to quality advantages for the client.	The motivation behind the stroke protocol, as expressed by the professionals, was the desire for expansion of service to a greater pool of residents, and the safe application of a new drug therapy to improve disease-specific outcomes. The CDN champion spoke of "…removing the disparity in level of service available to residents in the KGH (tertiary hospital) catchment area." Regarding a later innovation ('same day cardiac service'), professionals could easily explain the innovation as granting access to more people in need. Others in managerial or administrative positions could look at the changes in the system as increasing efficiency.	Supported
9. When the organization devotes resources to diffusion activities, offers incentives for participation in diffusion, and otherwise makes diffusion a strategic priority, diffusion will be more effective.	From the perspective of CDN as the focal organization, supporting the diffusion of these initiatives was their raison d'ȩtre. From the perspective of each hospital organization, the degree of support they offered to the diffusion effort was unclear. The organizations provided a high degree of access for CDN staff to meet their professional staff, but it is not clear that such access was theirs to grant. Many meetings, with the exception of day-long seminars, took place outside of normal work day hours. No organization was in a position to allocate full time resources to support the diffusion activities, nor was it evident that any of the hospitals allocated resources to support the initiative. However, the matter was raised at board meetings of each hospital organization on more than one occasion, implying that some degree of strategic visibility was given to the diffusion initiatives.	Partially supported
10. When professional organizations involve professionals more actively in the strategy process, diffusion will be more effective.	Active involvement by professionals throughout the diffusion process ensured that they made the interventions necessary to allow the adoption of the innovation into their practice and related processes. The stroke care protocol needed to be articulated in language that suited each facility's context, so that each provider would be motivated to enact the protocol in the appropriate situations. The active involvement of the Medical Advisory Committee in each hospital during development of the stroke protocol ensured that each hospital board would provide their support when it was sought.	Supported
11. When structures are designed to facilitate horizontal information flow across professional and organizational boundaries, innovations	Given the diffused accountability and matrix style responsibilities distributed amongst a differentiated set of providers, a strong integrative structure supporting horizontal communication was vital. When the stroke protocol was activated, the charge nurse in the emergency department in Kingston served as the 'quarterback', coordinating the actions of	Supported

Proposition	CDN Experience	Conclusion
will diffuse more effectively.	regional medical staff, ambulance attendants, and the neurologists. The protocol embraced the need for horizontal information flow across organizations and professions.	
12. When structures are designed to facilitate two-way vertical flows of information and influence across professional status and authority rank boundaries, innovations will diffuse more effectively.	The stroke protocol required that patients move up and down the supply-chain-like continuum of care, from community-based primary care physicians to tertiary care specialists and back. The protocol development facilitated the specialist/primary care provider interface. Physicians got the chance to develop and use assessment tools that worked for them. This in turn meant that specialists received more appropriate referrals from these primary care providers. Specialists needed to be able to influence the primary care end of the care continuum, but did not have direct access to it. Given the interactions supported by the stroke protocol, they could exert effective influence through primary care physicians. Within individual hospital organizations, CDN members were able to take issues raised during protocol development up the hierarchical ladder quickly, and bring decisions made back to professional working groups.	Partially supported
13. The greater the importance of professionals in the organization, the greater will be the effect of participative structures on diffusion effectiveness.	Individual professionals will make individual as well as group decisions about use of an innovation. Participative structures provide an opportunity for the risks and opportunities of the innovation to be discussed with respect to the beliefs and values of each professional. The regional meetings and workshops provided a structured opportunity for professionals to discuss the ramifications of adopting the innovation, and for increasing each individual's confidence in enacting the protocol when the opportunity presented itself.	Supported
14. When horizontal and vertical trust is strong in the organization, diffusion will be more effective.	There was sufficient vertical trust in the region to provide a high level of access for CDN staff to meet Board Chairs, CEOs, and professional staff. Working groups accorded sufficient trust in CDN members to allow the CDN to present the work, issues, and recommendations to the regional executive. The initial work by CDN members was about building trust and relationships, first between CDN and providers, and then between providers that did not routinely come into contact with each other.	Supported
15. The greater the importance of professionals in the organization, the greater will be the impact of trust on diffusion effectiveness.	Professionals engaged in the discussions surrounding development of the protocol were not uniformly able to pass judgment on the appropriateness of the steps to be taken. Regional providers placed trust in the expertise of specialists with respect to adoption of the clinical evidence. The Boards were put in a position to make decisions respecting adoption of the new care protocol. They placed their trust in the professional judgment of professionals working for their institutions.	Supported
16. When accountability systems support collaborative learning, diffusion will be more effective.	Accountability systems supported by individual organizations did not nurture or support collaborative learning, nor did they discourage it. However, CDN interventions were structured to encourage learning and monitor collaboration between professional groups.	Partially supported
17. When information systems make it easy for professionals to access information, diffusion will be more effective.	During the development of the stroke protocol, communications regularly took place through fax and phone transmissions and e-mails. Feedback on activity, and results from the overall process, were primarily provided using computer-generated text forms. Preliminary discussions were held to explore making current stroke practices, clinical evidence, and assessment tools web-available. Participant providers indicated that such steps would assist them to remain current with state-of-the-art practices.	Supported

III. RESEARCH MOTIVATION AND METHOD

A key objective of our research was to investigate, learn from, and disseminate a local knowledge transfer "success story" in a healthcare setting. We chose to document the approach the fledgling CDN group took to develop, diffuse, and promote the acceptance of an innovative healthcare protocol throughout a large geographical region. What was particularly interesting to us was the absence of any coordinating or unifying organizational structure spanning the approximately 36 organizations providing healthcare services in this region[2]. In addition, we sought to determine the extent to which the CDN experiences supported the knowledge transfer findings described in the literature in general and the Adler et al. "best practice" propositions (given in Table 1) in particular.

We carried out a longitudinal case study on the diffusion of a new stroke protocol by the CDN. One of the authors attended project meetings and gathered documentation over a multi-year period. Another conducted multiple interviews with various CDN participants and stakeholders over a period of months, as the project was being brought to a successful close. Each interview lasted between 45 and 90 minutes, and was taped. The authors individually and collectively reviewed interview transcripts, and also examined historical documents (files in the public domain and project documents). Our research findings are described in the sections that follow.

IV. THE CARE DELIVERY NETWORK PROJECT

The CDN was a regional healthcare initiative focused on an area of southeastern Ontario covering some 20,000 km[2]. (Figure 1.) The Southeastern Ontario Health Sciences Centre in Kingston provides tertiary care services for this region. Financial cuts and mandated restructuring
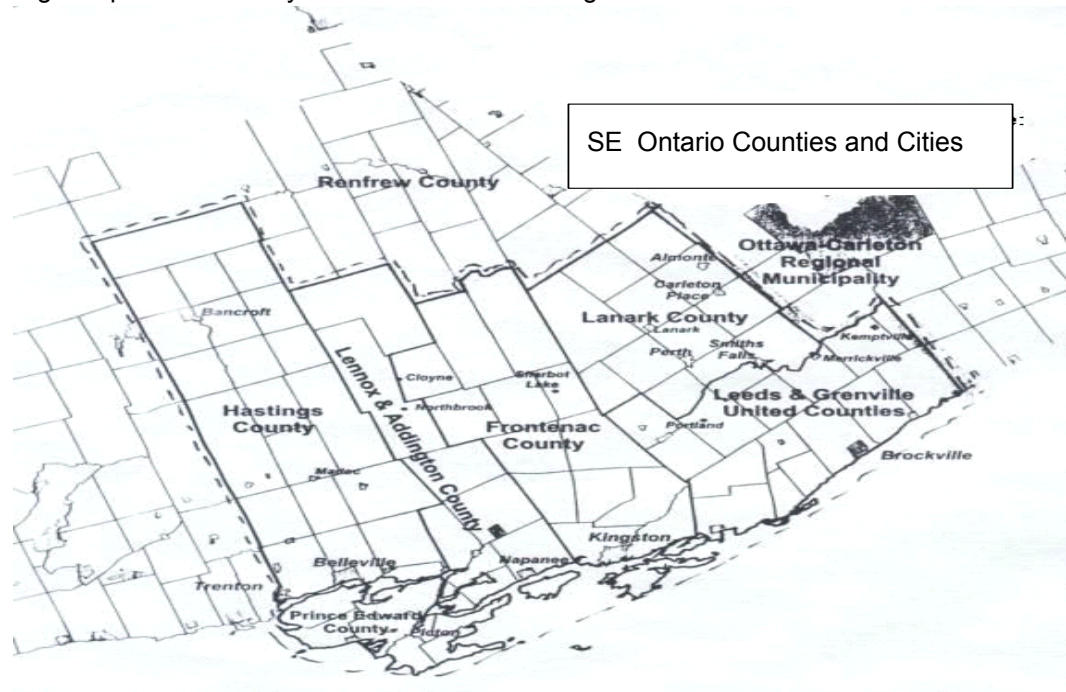

Figure 1. Map of Southeastern Ontario

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[2] Regionalization of the healthcare delivery system, the bringing together of proximate institutions under the governance of regional authorities, occurred in virtually every province and territory of Canada, but Ontario did not follow suit.

of publicly funded health services by the provincial government highlighted the growing usefulness – even necessity – of voluntary collaboration among otherwise unrelated health service providers. A multinational pharmaceutical organization (called Glaxo Wellcome at the time, but now known as GlaxoSmithKline) agreed to fund a one-off, time-limited healthcare "demonstration project" to attempt to illustrate the benefits of voluntary collaboration amongst healthcare organizations and providers.

A Board of Directors, including representation from key stakeholders (e.g., the pharmaceutical firm, the hospital community, community health initiatives, and Queen's University), governed the CDN. It employed a Project Director, a Project Manager, and other professionals who worked under contract on the project (e.g., the Regional Stroke Coordinator). Project goals and a clear direction were determined from the very outset to increase the likelihood of project success. The project created a formal vision statement, documented what it hoped to accomplish, and demonstrated how healthcare in the region could benefit. (Table 2 and Sidebar 1.) We noted this approach was in keeping with Satinsky's research finding: "Because organization may be the first activity in which previously unrelated parties participate, it offers the potential for both positive opportunity and peril. … Ideally, integrated healthcare delivery systems … achieve consensus *before* making other decisions that may facilitate or obstruct their achievement" (emphasis in original) [Satinsky, 1997].

The CDN project's vision was to demonstrate, within specific programs, services and conditions (beginning with stroke care[3]), improvements in the coordination and delivery of regional healthcare and prevention activities. The belief was that a more targeted approach would better demonstrate the value of service integration. Generic system issues would be identified along the way, and general integration of health services across the continuum of care would also be achieved.

Table 2. An Overview of CDN's Goals and Motivations

Vision	The vision of the CDN project is to demonstrate, within specific programs, services and conditions, improvements in the coordination and delivery of regional health services and prevention activities.
Objective	CDN's objective for the project over its three-year mandate is to demonstrate a fully integrated system of health service delivery, within selected conditions or programs, and to determine the state of readiness for greater integration across Southeastern Ontario.
Expected Benefits	• Maximize the effectiveness and efficiency of service delivery. • Maximize the positive outcomes for patients. • Maximize prevention and health promotion to reduce the need for lengthy or costly interventions. • Maximize opportunities to provide care in the most appropriate setting, as close to home as possible, by the most appropriate provider, using evidence to guide decision-making. • Enhance education, communication, and research to support and facilitate the process of integration.

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[3] The CDN identified stroke care as an area with significant potential to benefit from their attention because: 1) Stroke spans the continuum of care, and was therefore a good proxy for system integration issues and relevant for health service providers throughout the system. 2) The impact of stroke on primary care physicians was deemed to be significant; they were invaluable as the front line of defence in providing risk factor assessments and in pre- and post-stroke care and follow-up. 3) Circulatory disease, which includes stroke, is the leading cause of mortality in all parts of southeastern Ontario. 4) Stroke care was relevant to all CDN partners not only because of population needs, but also because many professionals recognized the opportunity to address generic issues such as access, communication, and coordination of care. Lastly, 5) there were new approaches to care, particularly the application of new drugs that provided more treatment options for stroke patients.

Sidebar 1. The CDN Project Principles

- The project will use a developmental rather than a blueprint approach. It will use the perceptions and experiences of providers within Southeastern Ontario to guide how the project will evolve.

- The project will use a voluntary partnership approach to solicit and maintain participation by providers and organizations.

- The project will incorporate and adapt to environmental changes such as the Ministry of Rural Health's Rural and Northern Healthcare Framework and directions of the Health Services Restructuring Commission.

- The project will focus on people identifying themselves as active participants within an evolving and articulated system of care. They will have a clear understanding of their roles and responsibilities within the system.

- The project will build on current and changing patterns of care being provided by individuals and organizations throughout Southeastern Ontario.

- The project will focus on facilitating the provision of the highest quality care, as close to where people live as possible.

- The project will focus on providing demonstrable outcomes with respect to improving access to the range of care within the region; improving quality of care; increasing efficiency; reducing the burden of illness; increasing both provider and patient (client) satisfaction; improving patient clinical outcomes; and improving the quality of life of clients.

Figure 2 illustrates the continuum of care as it pertains to stroke. The Regional Coordinated Stroke Strategy was initiated in 1997. Its goals were generally to decrease the incidence of stroke in the region, to reduce the risk factors, to improve care and access to care, to improve the flow of information, and to improve patient outcomes. Collaboration and information management strategies were the key to these objectives.
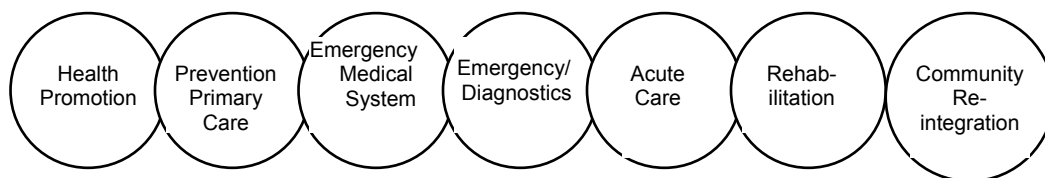

Figure 2: Continuum of Care for Stroke

The presence of a new stroke intervention drug, recombinant tissue plasminogen activator (rtPA), underscored the need for collaboration and coordination across the region. The administration of rtPA had been successful in reversing some of the damaging effects brought on by some types of stroke. Most strokes are due to a sudden blockage of blood flow in the brain by a clot, and rtPA has the ability to dissolve such clots. Administration of the drug was recommended within three hours of onset of stroke symptoms. Moreover, the drug needed to be administered in a tertiary care facility, under the care of neurological specialists. However:

> *Well the way it was before the [new stroke] protocol was [patients] would go to their community hospitals first and if they were lucky enough they would get transported in to [the tertiary centre] within the time window.* [CDN staff member]

Prior to the formation of CDN and the acceptance of the new protocol, regional officials estimated that 75 percent of the region's residents were ineligible for the rtPA drug because of time delays in moving patients to the tertiary care facility. The new protocol required that ambulance paramedics bypass local hospitals so that the majority of patients could be eligible (time-wise) to receive rtPA.

CDN staff could envision resistance to elements of the protocol, and sought an approach that would maximize the cooperation of healthcare providers, whose participation was vital to the plan. A staff member reported:

> *The stroke protocol was effectively implemented before it was implemented officially, before it was official to come on line, because of the process that the group went through engaging everybody in the development of the protocol … We took the time and effort that would have been required after the fact and put it in up front and encouraged that dialogue and encouraged the participation and encouraged the collaboration while we were designing the outcome. The stroke protocol is a really good example of this.* [CDN Project Manager].

To accomplish its goals, the CDN operated in partnership with the organizations that make up the Health Care Network of Southeastern Ontario (HCNSEO)[4], the Heart and Stroke Foundation of Ontario, and with its private sector sponsor. The CDN developed partnerships strategically based on its definition as a facilitative time-limited entity within the health services environment in southeastern Ontario. Given that the CDN did not have autonomous power or authority, it recognized early the importance of appearing credible, competent, and relevant to those with whom it worked. Furthermore, given its time-limited status, the CDN recognized it needed to ensure that the changes it facilitated and implemented were not CDN-dependent, but became incorporated into the evolving functioning of the health services system. Effective partnerships, therefore, were essential.

V. KNOWLEDGE MANAGEMENT AND THE CARE DELIVERY NETWORK PROJECT

PARTICIPATION AND INVOLVEMENT

Diffusion of knowledge is expected to be most effective when professionals are invited to participate actively in the strategy process, an Adler, Kwon, and Signer [2001] proposition that received strong support in the CDN case[5] (Table 1 in Section II). The CDN engaged the many professional stakeholders who were integral to the success of the initiative, beginning at the onset of the project:

> *We did a lot of work informally identifying needs, interests, we tried to flag champions, predominantly practitioners, predominantly doctors who were prepared to, who had an idea and were prepared to stand behind it, because that was a requirement to get things cemented or fixed in the system. So, we tried to be very cognizant of vision, of vision statements or mission statements and sort of anywhere where someone identified objectives. We tried to always look for opportunities to fit what we were trying to do within … the benefits or the framework that they had articulated.* [CDN Project Manager]

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[4] A voluntary partnership of the hospitals, Community Care Access Centres, Public Health Units, District Health Council, Queen's University, Kingston Regional Cancer Centre, and the Health Information Partnership of the Eastern Ontario Region.
[5]Our discussion highlights Adler et al. propositions that are most relevant. See Table 1 in Section II for a complete listing of the propositions and the support received for several, but not all, of these propositions by our examination of the CDN experiences.

CHAMPIONS AND CATALYSTS

Adler et al. emphasize the importance not only of organizational and group support, but also of essential key individuals, respected professionals with a track record in the community, who champion an innovation. As anticipated, a champion was crucial to the spread of the innovative stroke protocol by the CDN.

> *Ethically, we could not get involved in an activity that mandated a particular practice. It's sort of like the fine line between decision support and almost like a black box of decision making ... What we could get involved with were initiatives that made opportunities available based on best practice, but still left the decision making, the autonomy, in the hands of the practitioners and providers.* [CDN Project Manager]

CDN staff attempted to position the CDN as a catalyst to support regional providers in implementing new ideas and initiatives emanating from the region. This provided support for propositions 2 and 3 in Table 1.

EDUCATION AND NEGOTIATION

It is standard practice within a healthcare organization to develop and implement care guidelines and protocols to ensure that recommended treatment approaches are clear, concise, and unambiguous. However, because the CDN did not know if such an approach would be feasible and effective on a regional basis it first set about assessing regional readiness to accept care protocols. The CDN recognized that standardized protocols could be seen as limiting the freedom of health service organizations and the professionals within them to treat conditions as they saw best. Two things were required to lay the necessary foundation:

1. Education about the benefits of standardized care (e.g., improved integration of service, exposure to best practices, improved access to the same quality of care throughout the region); and

2. Given that professionals and institutions had related but somewhat divergent practices throughout the region, negotiation as to the details of the care protocols.

Education was required to continue until:

> *People understood how [the protocol] worked and what each of the pieces was supposed to do … We really tried to … meet our needs in terms of planning for the future of the coordinated stroke strategy ... Having all of those people from across the region together [helped].* [Regional Stroke Coordinator]

BOUNDARY-SPANNING INDIVIDUALS

'Boundary-spanning' individuals are especially important to the diffusion of knowledge (propositions 5 and 6 in Table 1), and the CDN was prepared to work directly with such individuals within the health sectors of southeastern Ontario to facilitate exchanges across professional and organizational boundaries. First, they had to assess the willingness of professionals from various healthcare communities (e.g., primary providers, nurses, specialists, emergency response personnel) to embrace the stroke care protocol innovation, and to expose their practice, knowledge, and potential gaps in knowledge to other professionals.

FORMAL AND INFORMAL INFORMATION EXCHANGES

CDN project staff appraised regional readiness through a series of information-sharing presentations, meetings and discussions with healthcare providers during the spring and summer of 1998. Staff found a generally receptive attitude towards the principles and objectives of the CDN project:

> *I expected more than anything that they would be extremely critical. They are not. They are very supportive … they feel that by following the protocol that they can make a difference.* [CDN staff member]

SHARED PURPOSE

Integration of services was generally seen as a positive innovation, and the focus on patient care rather than governance or management seemed to create a 'non-political' focal point. Providers appreciated the focus on the patient and the family.

CHANGE MANAGEMENT

> *During the first year … we focused our efforts on the education required within the protocol. So all the work that I did in the region with the nurses in the various hospitals to give them the process updates on the work that I did here [at the stroke centre] was part of that ... We had an acute stroke workshop in November of 1999 … where we brought people together from across eastern Ontario. … A lot of the staff were saying that we really needed an update on stroke. We really don't understand stroke that well.* [Regional Stroke Coordinator]

In effect, CDN members conveyed the need for improved, integrated stroke care so effectively that many providers welcomed the protocol, some even requesting additional education and change.

PLANNING, IMAGINATION AND PERSISTENCE

For the CDN, getting the knowledge or message out throughout the region was the focus of careful thought and planning. A diverse range of people needed to be told in as many different ways about the potential benefits of the stroke protocol. CDN staff were creative and persistent in the methods they chose:

> *There are 36 different organizations involved and no 'one size fits all' approach for communication so that you know the posters, the newsletters, all of those different things … all were in response to the needs identified. So the brochure for the paramedics to use in the ambulance if the family asks, "why are we being taken directly to Kingston?" is in response to a question from paramedics. The community provider brochure was in response to how do we get community providers like in-home nursing, in-home housekeeping, that type of thing. How do we let them know what to do and, well, we could do sessions with many people, [but] we could never reach all of them. So, it was a way of working through their organizations that they got that information out. So it started off fairly small, tight and then it grew in response to [needs]; it's a very big system in itself.* [CDN staff member]

INFORMATION TECHNOLOGY INFRASTRUCTURE

Technology was an essential tool for the communication of information to various stakeholders in the Care Delivery Network (proposition 17 in Table 1). Given that people were widely spread out across organizations and geography made it impossible to institute one standard IT system for the management of CDN information. CDN stakeholders, therefore, were heavily dependent on e-mail, fax, and telephone modes of communication that would allow for instant and broad communication across a network. This dependence on what may be viewed as fairly rudimentary examples of technology was partly due to the fact that the CDN was creating structures as it went along, albeit carefully and purposefully, but still as an ongoing process. In addition, some of the knowledge involved in the CDN case was factual in nature (and hence explicit), and therefore easily transmitted using technological means – in essence using technology as a pipeline. However, much of it was tacit. That tacit knowledge is an inherent element of intellectual assets is

widely accepted [Lawson and Lorenz, 1999; Sveiby, 1999]. Tacit knowledge requires different methods of diffusion from concrete, easily repeatable types of knowledge. The CDN experience was a case in point.

> *There were fax-based forms too and that was part of the reason why some of this discussion was necessary because we are trying to limit the amount of paper … I think what we could do if we had a web-based form, with embedded hypertext … I would love to take the fax-based forms that we had … and create a web-based one. Really simple to maintain because it can be maintained in one spot where it is accessible, but what we have also done is we have increased the access because if you think of that form as … disseminating knowledge, we have created something where we can create as much detail as required and we are putting it in a medium that pushes it out as far as we want.* [A staff member speaking about the value of technology in diffusing knowledge]

TRUST

The diffusion of knowledge is influenced by both the audience and the method of delivering information to each affected group. Receptivity, therefore, is a key aspect of diffusion and adoption. Regardless of media, motivation, or message, one factor seems to have much to do with the effective communication of a message: trusting relationships (propositions 14 and 15 in Table 1). Given that the transmission or movement of knowledge is intrinsically linked to interpersonal relationships, the structuring of these relationships takes on remarkable significance.

> *One of the key things is developing trust, and once that relationship and the trust is established … you have to sort of put a lot of time and effort … you [have] got to be able to engage [people].* [CDN staff member]

FLEXIBILITY AND AUTONOMY

The vast array of interactions between widely differing people make flexibility of paramount importance. Organizations and bodies such as the CDN also must promote a range of knowledge diffusion systems. Reliance on cross-functional teams alone can lead to an unforeseen side effect of isolation among people of like responsibilities who may belong to different teams [McDermott, 1999]. McDermott observes that a "double-knit organization" can capture both the positive attributes of cross-functional teams and those of "within function" communities of practice (COPs). Communities of practice have a learning focus, and teams have an output orientation. The CDN's actions needed to combine the best of both team and COP structures to achieve effective and meaningful exchanges of knowledge and ultimately learning.[6] Despite the rich knowledge sources, a CDN staff member explained that physician autonomy remained (proposition 1 in Table 1). Physicians could override input from professional communities and cross-functional teams if they deemed it necessary. In any given case, accountability rested ultimately with them: "It would be their medical judgment to make the [final] decision."

ACKNOWLEDGED EXPERTS

Adler et al. [2001] note that knowledge contains as great a social aspect as a personal component. Their discussion is in keeping with what was manifest in the CDN experience. For instance, the CDN Project Manager admitted that he could be swayed by the actions and messages of those he respected: "My perspective can be shaped … by contacts I am working with." As Adler et al. note, aligning contacts evidently lends strength and resilience to an

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[6] The CDN role differed somewhat from that of a COP in that, from the very beginning, its intent was to withdraw from the community once the initiatives it spearheaded were self-sustaining.

innovation. The Project Manager further noted that the CDN "made the contact across the region by coordinating the activities of a lot of different people where before there was an extremely complex and very diverse context." In fact, the strong leadership of two individuals went far in promoting the initial adoption of the stroke protocol.

> *Those two believed in [the stroke protocol] and were prepared to put their professional weight behind it and so when … the protocol was implemented … the other members … came around to it.* [CDN Project Manager]

This lends support to another of Adler et al.'s propositions which states: "When acknowledged experts play an active role in promoting innovations, diffusion will be more effective" (proposition 4 in Table 1).

LEARNING BY DOING—UTILIZING BEST PRACTICES

"Learning-by-doing" plays a central role in the adoption of new practices and technologies in a healthcare setting [Pisano, Bohmer, and Edmondson, 2001], Pisano et al. also speak of the importance of experience in the learning curve, but caution that not all organizations build on and exploit their accumulated experience both effectively and efficiently. In the context of the CDN, organizers ascertained regional strengths (identifying best practices in organizations across the region) and then built on these strengths to improve overall patient care. Where stroke treatment could be accomplished most effectively at a central location, centralization of services occurred despite the anticipated reluctance of other organizations whose stroke treatment programs would no longer be used (proposition 11 in Table 1). In cases where the primary caregivers and community health workers could get the message about prevention out most effectively, the CDN used this strength (proposition 12 in Table 1).

MEDIA—AWARENESS RAISING

One of the important elements in increasing the number of patients eligible for rtPA administration was early identification of stroke symptoms by the patient, the patient's family, and other primary caregivers. An extensive public awareness campaign was launched in conjunction with the Heart and Stroke Foundation of Ontario[7] to educate people about stroke symptoms, and to encourage people believed to be suffering a stroke to seek help immediately. CDN members stayed in close touch with stakeholders and offered flexible professional education as needed (proposition 16 in Table 1).

> *In terms of feedback on education … often they will tell us what they need.* [CDN staff member]

Paramedic and other regional ambulance service employees were also educated on the identification of stroke symptoms since they were key players needed to invoke the transportation 'bypass' rules and enable patients to be sent directly to the tertiary centre for rtPA administration. Thus they frequently bypassed the hospital nearest to the patient.[8]

Emergency room personnel in the tertiary facility were educated also because they were significantly affected. Not surprisingly, the opportunity to provide some modicum of support and

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[7] The Heart and Stroke Foundation of Ontario (HSFO) partnered with the CDN and three other provincial stroke care pilot sites.

[8] The willingness of hospitals to agree to this practice speaks volumes about the support for, and success of, the CDN initiative. Hospital funding from the Ontario government was tied to patient count. Hospitals were agreeing to work cooperatively, for the good of the patient, even if this could lead to reduced organizational funding.

assistance to many stroke victims provided substantial relief to the nursing staff and paramedics. They subsequently became strong advocates for the overall protocol once it was invoked.

SETTING EXPECTATIONS

> *They are very supportive and believe wholeheartedly in this because what we were told is, before this happened, those folks, the emergency room nurses and paramedics, felt incredibly helpless if they had a patient with a stroke. Now they feel there is hope. [CDN staff member]*

Emergency room physicians and the attending neurologists were more cautious in their support of the protocol. They bore the greatest risks. On the one hand, they witnessed the tremendous effort exerted by the various parts of the healthcare system responsible for getting the patient to the tertiary facility within the time window. On the other hand, they were required to assess the risk to each patient associated with administration of the rtPA, since one of the potential negative effects is catastrophic hemorrhaging. One effect of this risk is that a subset of stroke patients arriving at the tertiary facility actually receive rtPA, although outcomes of the rtPA recipients are generally seen as quite positive.

CONTINUOUS IMPROVEMENT

In general, the method of involving as many professionals and organizations as possible was seen as one of the successful strategies of the CDN project (proposition 13 in Table 1). Participation led to improved understanding and outcomes:

> *If we went in front of a group like paramedics for example we used that opportunity to hear from them how things are working in the field. And used that as an opportunity to give them feedback or to get feedback from them so we could use that as part of the continuous improvement.* [CDN staff member]

LONGER-TERM KNOWLEDGE INITIATIVES

In the development of the stroke protocol, it became apparent that there was a need for and an interest in enhanced, long-term stroke care skills to follow up on the emergency treatments the patients received at the tertiary care facility. Thus, programs were developed to aid community health centre and local hospital staff in post-stroke care and rehabilitation. This effort was linked in part to the need to improve overall quality of care, and in part to the need to enable every part of the regional healthcare system to fulfill its appropriate role. The tertiary care facility was best suited to be the destination to enable rapid treatment of the stroke, but it was not an appropriate location for ongoing and rehabilitative care. Thus, repatriation of patients to an institution closer to their home was important early on in the recovery period. The community services available close to home go far to fill the needs of stroke patients as they go through the rehabilitative process:

> *The tendency is to think linear, like a linear continuum. But it is not the best way to think about it. You start at either a person or the community and then interspersed within the community there are some services of primary care to be used within the community. Some of the support systems – volunteer agencies, a lot of that it varies to different degrees but there is generally a local presence within a community, might be a support group, might be volunteers, and might be something like that. Community care access centres, they exist as an institution but they broker services that are delivered in the community.* [CDN Project Manager]

The CDN tried to show stroke patient care as a continuum, leading from the community to the tertiary care facility, and back to the community where primary care could lead, ideally, to unsupported full health and independent living.

VI. IMPLICATIONS FOR RESEARCHERS AND PRACTITIONERS

The propositions developed by Adler et al. provided a helpful lens through which the CDN experience could be examined. Testing these propositions was an important contribution made by our study. We refer readers to Table 1 for a summary of the case study findings. Adler et al.'s research suggested that the CDN generally positioned itself well and developed helpful strategies to accomplish its goals. It set the stage for further innovations to improve patient care. CDN demonstrated the importance of community champions, trust, inter-organizational communication, education, and the role of boundary-spanning professionals. Regional leaders were given evidence that knowledge and voluntary healthcare innovations could be successfully disseminated across independent health service agencies spread throughout the large geographical area.

The CDN experience provides several valuable lessons. Strong leadership, clear vision, clearly articulated goals, and dedicated resources were essential for project success. Also important was the structured approach to spanning boundaries that was undertaken by the interdisciplinary team of academics and practitioners who were seen as not beholden to any single profession or organization [Adler et al., 2001; Morone and Taylor, 2004]. Encouraging stakeholders to rally around shared beliefs (e.g., "we should do what is best for the patient") permitted cooperation even when that involved the reduction of personal and institutional power and freedoms. Similar approaches could be helpful in other challenging situations involving the diffusion of professional knowledge.

With the CDN, formal and informal interactions were vital for successful innovation [Brazelton and Gorry, 2003]. Once one or more influential people were 'on board,' it was easier to accumulate a critical mass. Supportive, influential professionals helped to legitimate, and hence diffuse, the innovation. Such was the case with the emergency room nursing staff and regional paramedics.

Organizations were encouraged to exploit, as far as possible, existing strengths and systems. In the case of the CDN, the newly created regional stroke centre was housed in a well-respected hospital with an existing reputation for innovation (which Adler et al. suggest is key). Furthermore, rather than forging new lines of communication, education and knowledge diffusion followed existing avenues and paths for information transfer. This outcome is in keeping with previous research showing the importance of infrastructure and culture in the diffusion of knowledge [Selamat and Choudrie, 2004]. The necessity of taking advantage of existing organizational assets, such as knowledge, lines of communication, and existing technology, also supported Adler et al.'s proposition 17 (Table 1), which states that "When information systems make it easy for professionals to access information, diffusion will be more effective." As we pointed out at the beginning of Section V, although CDN participants did not create and configure a system specifically for the diffusion of information and knowledge, they were confident in their ability to interact among themselves using technology such as fax, telephone, e-mail, and the web since these media were readily available and familiar to most participants.

For the CDN, homecare was already well established. Therefore, working with professionals responsible for this care permitted the knowledge about stroke care innovations to diffuse quickly within the community. The CDN personnel strengthened networks for communicating when they traveled throughout the southeastern Ontario region conducting educational seminars and making presentations. By building these networks at the project's beginning, they made their job easier when the time came to communicate protocols and establish best practices. As is seen in propositions 11 and 12 in Table 1, the horizontal and vertical flow of information among organizations and individuals was particularly important. By establishing patterns for information flow and knowledge transfers, and encouraging existing avenues for communication, CDN was better able to achieve its goals. Turning over the initiatives to existing organizations represented, paradoxically, both a strength and a weakness of the CDN plan. CDN accomplished what it set out to do and disbanded. Before doing so, it embedded its key initiatives into the operations of influential, ongoing organizations that unfortunately were, as a result of their very strength and dominance, viewed by some stakeholders as being partisan.

The CDN Project Manager believes that the stroke protocol initiative provided an excellent learning experience for all stakeholders involved because it taught them how to:

> *work out some of the wrinkles in the inter-organizational activities. How do you make sense of a group of independent organizations attempting to work together, attempting to achieve productive outcomes? There was a lot that we can learn from stroke, there is a lot that we did learn from stroke … We used stroke as a way of demonstrating what could be done.* [CDN Project Manager]

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