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KNOWLEDGE SHARING AND HEALTHCARE COORDINATION: THE ROLE OF CREATION AND USE BROKERS

(Accepted manuscript)

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KNOWLEDGE SHARING AND HEALTHCARE COORDINATION: THE ROLE OF CREATION AND USE BROKERS

(Marco Marabelli, Sue Newell, Chantal Krantz, and Jacky Swan)

Abstract - *The paper arises from research that examined a healthcare coordination improvement initiative that was focused on increasing knowledge sharing among a network of healthcare workers involved in the care of children with complex medical needs. Part of this initiative involved a summary medical note (the SPOC) that was paper-based and carried by parents between the specialists involved in their child's care. The SPOC's effectiveness is discussed through a knowledge as practice perspective, which focuses on the role of mediators (both material and human). Our analysis demonstrates that the SPOC's effectiveness can be understood by looking at the combined roles of boundary objects and human brokers. We identify two distinct broker roles: creation brokers and use brokers. In discussing our case, we extend our analysis to suggest how these broker roles may also be useful in thinking about how to improve the effectiveness of (electronic) health record systems more generally – for researchers as well as for practitioners.*

Keywords: Knowledge Management in Healthcare; Knowledge Sharing; Practice Perspective; Boundary Objects; Knowledge Brokers.

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INTRODUCTION

Healthcare costs are escalating in many countries and the hunt is on to find efficiencies while improving patient care and widening access. One major dimension of this problem that has been identified relates to the fragmentation of care, with a lack of communication and coordination between the different specialists involved seen to create inefficiency as well as potentially serious quality breakdowns. For example, Shannon (2012) documents a range of studies that have identified communication deficiencies between physicians as well as the consequences of such deficiencies. She notes that “gaps in communication may lead to patient harm, delays in care, continuation of incorrect treatment, increased length of stay, and increased costs” (p. 16). In another study, Agarwal et al. (2010) estimated that in US hospitals alone (i.e., not considering costs across the multiplex of healthcare providers), over US\$12 billion were wasted due to communication inefficiencies among care providers, equating to about 1.97% of total hospital revenues.

This communication problem arises because many patients need to see a multitude of different specialists and, even though these different specialists may be dealing with different illnesses or symptoms, it is important that overall patient care is coordinated. This means that there needs to be some communication between the specialists so that they can share knowledge and so coordinate treatment. Such coordination can help to ensure that clinicians are not suggesting treatments that are in conflict (e.g., because of side-effects of particular drug interactions) or not duplicating tests (and so increasing costs) and will also help to support overall patient well-being. Problematically, the more specialists that are involved in the care of a particular patient, the more likely is that patient to be fragile, suffering from multiple conditions that make their life difficult anyway, without them having to navigate through a quagmire of different specialists and

their (lack of) coordination.

There are numerous ideas that now exist that are aimed at targeting these healthcare coordination problems. For example, the Patient-Centred Medical Home idea, first presented in 2004 in the ‘Future of Family Medicine’ (Martin et al., 2004), promotes the idea that the Primary Care Physician (PCP) should act as the coordinator proactively managing an individual’s healthcare needs rather than reactively responding when a person presents at the practice and then leaving specialists to deal independently with specific issues that cannot be treated by the PCP. Another example is the creation of Accountable Care Organizations (ACO) in the USA where a group of physicians are collectively responsible for a group of patients and share in any savings achieved because of their improved coordination (Berwick, 2011).

Examples exist in other countries and, in all cases, the overall goal is to enhance care provision by reducing the boundaries between healthcare workers who come from different specializations and work in different organizations. Most discussions about these kinds of initiatives point to the crucial role played by Health-IT (HIT). For example, in relation to the patient-centered medical home idea Cohn et al. (2009) write , that ‘A vital first step is to invest in HIT’ (p. 292). More generally, the adoption of HIT is seen as crucial for improving the coordination of care and reducing costs (Hillestad et al., 2005).

In this paper we take a knowledge management approach to coordination and look at the role of information systems (not exclusively IT-based and including human actors as a fundamental part of any system) in attempts to improve the coordination of care (and so healthcare outcomes) through the flow (or, better, the translation) of knowledge among different players of a healthcare network. In looking at knowledge translation processes we take a practice perspective (Cook and Brown, 1999) and identify the role of mediators (brokers and boundary objects) that

can promote knowledge sharing and, ultimately, healthcare coordination. We apply this perspective in a case study of an initiative that aimed at improving coordination across the different specialists involved in the treatment of children with complex care needs.

Our case analysis highlights the role of a specific boundary object – the SPOC (Single Point of Care) medical sheet. The SPOC is a paper-based record (albeit created with computers); it incorporates a number of details about patients; and in its knowledge translation role, was able to radically improve the coordination of care. However, our findings indicate that the SPOC was useful only in so far as there were knowledge brokers who were involved in its creation and use. We thus highlight the importance of looking at the relationships between boundary objects and brokers (i.e., the material and the human) as knowledge mediators in the coordination process. More importantly, we argue that the focus on mediation as a fundamental aspect in the sharing of knowledge can help to identify relatively simple solutions to healthcare coordination problems – solutions that are relatively easily put in place and inexpensive but yet can have dramatic consequences. In doing this we articulate what it is about the characteristics of this particular information system that made it effective in relation to healthcare coordination. This also allows us to discuss what might help to improve effectiveness of HIT more generally.

The paper is structured as follows: next, we define and unpack knowledge processes in healthcare and concentrate on the role of mediators therein. Then we document our method and present our findings. The following section discusses these findings and integrates the insights of our fieldwork with the existing literature. The final section highlights contributions, draws some conclusions, and shows implications.

KNOWLEDGE MANAGEMENT PROCESSES IN HEALTHCARE

Barriers to Knowledge Sharing

Several scholars have considered the challenges of managing knowledge in healthcare settings and barriers have been identified that represent hindrances to this (see Nicolini et al. 2008 for a comprehensive review). In particular, sharing knowledge in order to coordinate treatment in healthcare has been identified as a problem for several reasons. For example, Hall (2005) notes how physicians are trained to take responsibilities and make quick decisions; therefore, learning to share expertise can be hard for them. Similarly, Reese and Sontag (2002) note that the way physicians are trained is focused on individual actions and outcomes rather than on relationships. The result is that there are a number of barriers such as power/political issues, clinical management conflicts, lack of trust, and lack of leadership that make knowledge sharing difficult in healthcare (Nicolini et al., 2007).

HIT is often presented as at least part of the solution to this problem (Fichman et al., 2011; Hillestad et al., 2005). One of the main applications of HIT is to patient records, commonly referred to as Electronic Medical Record systems (EMRs) promoted on the premise that they can help to reduce mistakes and cut costs by improving knowledge sharing (Davidson, 2000). However, recent data show that the adoption of EMRs is often difficult (Jha et al., 2009). For example, in the UK, the implementation of the NHS (National Health Service) National Program for IT (NPfIT) has been fraught with difficulties, finally being deemed ‘unworkable’ in August 2011 after 2.7 billion pounds had been spent (National Audit Office, 2011, <http://www.nao.ac.uk>). The reasons for these problems with adoption and implementation are many and numerous, and are linked to the unique nature of healthcare settings (Fichman et al.,

2011). On the one hand, many primary care practices are very small, making the costs of adopting prohibitively high (Simon et al., 2007). Moreover Miller and Sin (2004) indicate that financial benefits are uncertain and while appreciable in the long-term, in the short-term additional costs (in the form of decreased revenues) might occur from seeing fewer patients during the ‘migration’ process. On the other hand, introducing an EMR across a large national healthcare system is also problematic because of the diverse needs and interests that must be accommodated (Aanstad and Jensen, 2011). In this paper, we consider a case where a rather simple, partly paper-based record system was introduced to facilitate knowledge sharing across medical professionals and organizations, with a view to improving the coordination of care for a particular patient group. We examine the effectiveness of this tool in the light of our understanding of how knowledge is shared, which is articulated next.

Knowledge Translation and the Practice Perspective

In addressing issues of knowledge sharing it is important to be clear about the perspective of knowledge that is adopted. In this paper, we adopt a practice perspective, which implies an immanent relationship between knowing and practice (Nicolini, 2011), whereby knowledge is constituted in practice (Bourdieu, 1977). From this perspective, knowledge is not seen as a tangible asset that can be easily moved within or across organizations, communities or individuals (Gherardi, 2006). Instead, knowledge is constituted as actors engage in practices with other human and non-human actors (Feldman and Orlikowski, 2011; Sandberg and Tsoukas, 2011). This perspective brings to the fore the idea of mediators (Latour, 2005; Nicolini, 2011; Rycroft-Malone, 2007). Nicolini (2011), for example, suggests that knowledge cannot be directly transferred between actors but, rather, must be translated through mediators so that it is “tentatively reproduced in time and space” (p. 14). Such mediation is especially important in the

context of sharing knowledge *between* communities, because knowledge is embedded in the practices, for example, of different medical specializations in a hospital context.

Mediators, then, are actors that can promote knowledge sharing. In particular, following Nicolini (2011) mediators *translate* knowledge “into the scene” (Nicolini, 2011, p. 9), and can be human and/or material. The concept of knowledge translation is relevant in that, as we will further show throughout the paper, it provides an explanation for how knowledge sharing is possible when this occurs, for example, across contexts (Suchman, 2000). Such a concept is needed because, from the practice perspective, knowledge is not just sticky (Szulanski, 1996) but belongs to specific groups of people and their situated practices (see the literature on COP, Lave and Wenger, 1991). Indeed, the literature on sociomateriality would suggest that all mediators and mediation processes involve both human and non-human actors in a dynamic and emergent interplay (Orlikowski, 2007). Nevertheless, for analytic purposes it can be helpful to separate out the agency involved in the human actors vis a vis material objects (Leonardi and Barley, 2010) as they mediate (and so translate) knowledge sharing activities. In this light, below we can consider the literature that has discussed the roles of (human) brokers and (material) boundary objects.

Knowledge Brokers: Brown and Duguid (1998) propose two different roles for human actors who work to encourage the sharing of knowledge between communities – translators and knowledge brokers. They define translators as ‘individuals who can frame the interests of one community in terms of another community’s perspective’ (p. 103). This requires that the translator is knowledgeable about the practices of both communities and so is able to mediate between the communities, with the two communities staying separated and the translator being independent of both. They define knowledge brokers as those individuals who participate in one community but have weak links to another community, with these weak links encouraging

knowledge flow between communities (as in Granovetter's 1976 idea of 'the strength of weak ties'). Interestingly, other definitions of knowledge brokers, suggest that knowledge brokers are those individuals who broker knowledge across structural holes (Burt, 1992), more in line with Brown and Duguid's idea of translators. From our practice perspective, however, we assume that human actors translate knowledge in order that the shared knowledge provides meaning and legitimacy for a particular community (Carlile, 2004), whether or not they are independently mediating across separate communities or working themselves in overlapping communities. We thus use the generic term of knowledge broker to describe this knowledge translation work of human actors as they bridge the practice worlds of different communities. Research indicates that these knowledge translation efforts are not always effective, because for example, the knowledge broker does not remain neutral in their translation efforts, giving more credence to the practice (and so knowledge) of one community (Brown and Duguid, 1998). Research has therefore identified how effective knowledge brokers must be respected by the different communities and recognize different meanings and pragmatic interests (Fleming and Waguespack, 2007).

Boundary Objects: Second, boundary objects play a more indirect role acting as mediation devices that facilitate knowledge sharing across communities. Star and Griesemer (1989) define a boundary object as "an object that lives in multiple social worlds and which has different identities in each" (p. 409). Boundary objects can be physical or conceptual and can be used by people in different communities. While each group can interpret the boundary object somewhat differently (so all boundary objects have some degree of flexibility in terms of the meanings that they give rise to), they nevertheless allow for communication that can provide some temporary agreements, albeit these can be constantly renegotiated as the boundary object generates new ideas. In this sense, they allow local understandings to be reframed in the context of some kind

of collective activity (Bechky, 2003). Levina and Vaast (2005) note that it is not some inherent property that makes an artifact a boundary object but rather the way the object is used in “collective-reflection-in-action” and so comes to acquire a common identity. In this sense, boundary objects do not simply play a role in creating common understanding that allows coordinated actions; they also play a symbolic role, legitimating certain practices for those involved (Swan et al., 2007).

While Nicolini (2011), in his study of telemedicine, did not differentiate between brokers and boundary objects, he did identify how healthcare mediators can translate knowledge “by contact” and “at distance”, depending on whether the process of knowledge sharing involves physical proximity. It may be presumed that boundary objects are useful as mediators that can work “at distance” since they can be shared (sometimes virtually) and do not require co-presence. Crucial mediators “at distance” in Nicolini’s study were various types of HIT, which provided physicians with information about a patient even when the patient was not physically present. Conversely, mediation “by contact” involves brokers who can communicate and translate between two communities. For example, Nicolini describes the nurse who interfaces between the doctor(s) and the patient. However, because Nicolini considered mediators “by contact” and “at distance” separately, he did not look specifically at the interactions between brokers and boundary objects. Yet, Kimble et al., (2010) show how brokers will often use boundary objects selectively, mobilizing them for different purposes; for example, to facilitate (or even impede) information sharing or to control the flow of information. This suggests that it is important to look at the relationships *between* brokers and boundary objects (i.e., between the social and the material) to fully understand how they mediate the sharing of knowledge across communities. Table 1 provides a summary definition of these two core concepts of knowledge broker and boundary

object and identifies some of the relevant supporting literature.

Table 1. Knowledge Brokers and Boundary Objects

	Knowledge brokers	Boundary objects
Definition	Human agents connecting different communities and promoting knowledge translation by helping to give meaning and legitimacy to the knowledge that is shared	Physical and conceptual objects that ‘make things happen’, being plastic enough to adapt to local needs yet robust enough to maintain a common identity across sites
Supporting literature	Carlile, 2004; Brown and Duguid, 1998; Fleming and Waguespack, 2007; Verona et al. 2006	Nicolini, 2011; Lavina and Vaast, 2005; Star and Griesemer, 1989; Swan et al. 2007

In summary, one of the major challenges in managing knowledge in healthcare settings exists because knowledge does not flow “from one end to another”. Instead, knowledge sharing involves, as we said, translation (rather than transfer) across different groups of practitioners (Lees and Meyer, 2011; Nicolini et al., 2008), and relies on the work done by human and material mediators (brokers and boundary objects). Examining the role of brokers and boundary objects as mediators in this context can, therefore, help us to understand how knowledge can be effectively shared in such settings in order to improve the coordination of care. Our research question is therefore: *What roles do boundary objects and knowledge brokers play in knowledge translation processes that help to improve healthcare coordination?*

METHOD

The fieldwork was undertaken in a project that was set up at the Children’s Hospital of Eastern Ontario (CHEO) in Ottawa, Canada. The Coordination of Care Pilot Project (hereafter, the Pilot Project) was focused explicitly on improving the coordination of care for children with complex health problems. Excellent access to the participants was negotiated (including with the parents), allowing us to look at knowledge sharing in-depth – a requirement for undertaking a practice perspective study (Feldman and Orlikowski, 2011). An interpretive methodology was followed

(Walsham, 1993; Klein and Myers, 1999) in that we sought out multiple interpretations of events and outcomes from the various participants.

Data Collection: Timelines, Participants in the Study, and Interviews Technique

Our study commenced in September 2010 and ended in September 2011. We took a qualitative approach and conducted 27 interviews with all those directly involved in the pilot project: the Project Manager; the Most Responsible Physician (MRP); the Nurse Coordinator from CHEO; the managers and care workers of the partner organizations; and parents of the children involved in the Pilot Project. We included several repeat interviews in order to collect longitudinal data to capture emergent dynamics. Each interview was conducted in the narrative interview style (Bauer, 1996), allowing for uninterrupted storytelling. Most interviews, however, developed with the following breakdown: in the first part (about 10 minutes), the participant provided general knowledge about her/his background (education and past jobs, at CHEO or elsewhere); in the second (and central) part of the interview (30-40 minutes) the participant provided details about her/his role in the Pilot Project chronologically. The details and richness provided in this part varied depending on the participant's involvement in the project: some people started with a marginal role and then became more involved; some were involved in the project from the beginning while others became involved later. However, all interviewees were involved in the project at the time of their interviews; therefore, along with retrospective data (what they remembered about events occurring in the past), we were able to capture real time events, feelings and perceptions and, with repeat interviews, a longitudinal component (during the second interview we asked what had changed from the first meeting). The last part of the interview (5-15 minutes) was more led by us (the researchers): we asked specific questions about events and details which, based on our notes, were not fully covered by the participant's

storytelling. We also conducted 8 non-participant, direct observations of advisory committee meetings.

Interviews (27 in total) and most meetings were recorded and transcribed. Moreover, a number of informal meetings, phone calls (not recorded), and emails helped us develop an in-depth understanding of the Pilot Project and the dynamics of its development. In order to add “official” sources, we also gathered a variety of documents (e.g., committee meeting presentations and documents obtained from the CHEO-Pilot Project) that had been circulated between actors in the initiative and/or shared with the families of the children involved.

Data Analysis: Narrative, Coding Process, and Reliability Test

We used our interviews, observations, and documents collected about the Pilot Project to write a narrative of the case and to analyze issues/dynamics associated with knowledge sharing and the role of mediators. In so doing, we used the concepts of boundary objects and brokers as sensitizing devices (Patton, 2002). The analysis process was iterative (Eisenhardt, 1989), taking us back-and-forth between our data and the existing literature on the role of mediators in knowledge sharing and included a coding phase supported by Nvivo® 10. For instance, at first we used an open-coding procedure (Miles and Huberman, 1994) that allowed us to capture a number of dynamics that occurred prior to the start of our fieldwork (so, retrospectively) as well as ongoing dynamics covering the period March 2010 - September 2010 and the period September 2010 - September 2011 (longitudinal). This first phase of data analysis helped us develop a broad, open-ended view of the Pilot Project and lead to the identification of a number of main ‘themes’ of the project. During the second phase of data analysis we focused more specifically on themes associated with collaboration, communication, and knowledge sharing processes and more specifically we looked for the actors (human and material) that played a key

role in these processes. Once an actor was identified, we examined the specific role they had played in knowledge translation and the characteristics of the actor that seemed to provide the leverage explaining their success in this process. Alternating data analysis and fieldwork helped to provide additional details on these key themes (Eisenhardt, 1989; Myers and Newman, 2007; Strauss and Cobin, 1999).

We adopted a variety of different approaches to ensure that our analysis followed the main criteria considered important for interpretive research – trustworthiness, credibility, confirmability and transferability (Denzin and Lincoln, 2002). First, while, one author was responsible for conducting the initial analysis and writing the initial rich case narrative, fieldwork was conducted by two authors so the second could help to verify the account and coding structure. Second, a third author acted as ‘peer debriefer’ (Gioa et al, 2010), pointing to ‘gaps’ in the data set and positing alternative explanations for findings so that these could be ruled out (or embraced). Finally, we presented the individual case narratives to project members who were able to verify our interpretations.

The next section is focused on a) providing an overview of the Pilot Project (narrative) and b) looking at the data with respect to key episodes where the relevance of mediators is highlighted.

FINDINGS

The Coordination of Care Pilot Project (Narrative)

The Pilot Project is housed at CHEO and involves the Hospital itself (a world class tertiary pediatric center), and several other pediatric organizations and agencies in the Ottawa community, including for example, the Champlain Community Care Access Centre, a community health provider that organizes home, school, and hospital care, developing customized “care plans” and providing support from healthcare professionals (nurses,

physiotherapists, social workers, registered dieticians, occupational therapists, speech therapists, and personal support workers) and the Ottawa Children's Treatment Centre that provides specialized care for children and youth in Ontario, with multiple physical, developmental and associated behavioral needs.

The Pilot Project started in March 2010 and was funded by the Champlain Community Care Access Centre. The Pilot Project focuses on 23 medically complex and fragile children and aims to: a) provide family-centered comprehensive care coordination across the system, and b) facilitate communication and collaboration among care providers while relieving the burden of care coordination on families, to ultimately improve the health status of patients. In order to pursue the aims of the Pilot Project, three key roles were introduced: 1) a Project Manager (Lara), 2) the Most Responsible Physician (Kathy), and 3) the Nurse Coordinator (Beth). Lara supervises the Pilot Project: ensures that processes, communication pathways, and flow maps have been developed; conducts staff training sessions; coordinates the meetings and presentations for the advisory committees, and prepares reports. Kathy, the Most Responsible Physician (MRP), reviews the overall complex medical needs of each child and coordinates communication with all the specialists at CHEO, other tertiary pediatric centers specialists, and the community physicians. Beth, the Nurse Coordinator, works very closely with Kathy, interfacing between the doctors, the nurses, and managers at CHEO, and the other agencies; she is the go-to person for all the families of the children in the project. In addition to these new roles, an advisory committee for the project was also set up, including the key project members identified above, some other hospital administrators and some nominated family members.

The SPOC and its Creation

Prior to the Pilot Project, access to timely and comprehensive medical summaries for these

children was extremely problematic. The information to guide decision-making and treatment was often buried in various sections of large volumes of medical charts that were distributed across the specialists involved – in some sites in electronic form, in others in paper files. Many specialists were involved in each child's care, but no one person took the lead. This gap in care coordination was left to the parents to fill by default; a daunting job given most had no medical training even if they had become, of necessity, experts on their child's needs. Parents expressed great concern with this assumed role of medical care coordinator: they regularly had to advocate for their child in the Emergency Room (ER) with a physician who did not know their child and, sometimes at least, were not taken seriously. More concerning was that when parents would present to the ER with their child in a crisis the ER staff often did not have instant access to the list of medical issues, medications, previous tests that had been done, and protocols that worked best for that individual child. They could search for the child's record on the hospital EMR but this would take time and be difficult to use because of the sheer amount of, but also partiality of, the information that it would contain. In fact some hospital departments kept their records separately and information from specialists seeing the child outside the hospital was totally absent. This issue was particularly important in urgent cases where a clear picture of the clinical situation of a child could be determinant to providing emergency care. Kathy (MRP), provides an example:

"You have this child who has these cyclical vomiting episodes. So each time this child gets a cyclical event gets quite dehydrated, hypotonic, quite unwell, and needs intravenous access for hydration, medication to reduce the episodes of vomiting. And this is a child that's been looked after by neurology, metabolic; neurosurgery is also involved for other reasons. This patient needs hospitalization usually and then the

Emergency, well, you'll have whoever is on for that day. So they don't have the knowledge base of this patient. They have to go through a chart that is quite complex because of the other complexities of this child. Then they can call the specialist but it's not always the specialist on call that knows this patient".

As a result, the families were struggling to act as coordinators. This led to the idea of designing a medical sheet that incorporates a number of valuable and up-to-date pieces of information regarding a child's condition, thus providing easy access to information for health professionals who may not be familiar with the child. In fact, the SPOC (Single Point of Care) medical sheet as it came to be known, was inspired by one of the parents who had developed a one page "cheat-sheet" to facilitate sharing information about their child with the ER staff. The SPOC was created with input from the ER staff; specialists within CHEO; parents; community pediatricians in Ottawa; and community partners. All these different parties were encouraged to provide feedback on the initial prototype developed by the Pilot Project advisory committee and this feedback and adjustment to the SPOC draft was continued until a design was created that all were satisfied with. The family members, in particular were crucial in terms of the design of the SPOC. As we have noted, the SPOC was based on an idea from a parent, but more generally it was the parents on the advisory committee who were able to identify problems and suggest how a paper record could help to overcome these.

The document thus designed houses the most current information about the complex nature of a child's medical condition and needs. This information is summarized into 2-3 pages and is drawn from multiple, large 'phone-book size volumes' of medical charts. The SPOC is divided into three sections: the first contains a high level medical history, lists all medical issues, allergy information, and advanced directives; the second includes the key people involved in the child's

care and a current list of medications and dosages; while the third focuses on tests/results; surgeries; treatment protocols, and lists of technology used at home. Figure 1 shows the first page of the SPOC. The Nurse Coordinator, Beth, updates the SPOC manually, pulling from various sources into a single document on her computer: she keeps an eye out for changes by looking at any encounter the child has had at CHEO; a parent will let her know if changes have occurred in the community; or one of the specialists treating a child may contact Kathy (MRP), to consult about a change in treatment they are thinking about and then Kathy will pass on this information to Beth. Updates are thus done periodically, depending on changes to the child's health and treatment. Given that the children involved in the Pilot Project are very sick, recording changes can be frequent. Importantly, updating the SPOC includes deleting information that is no longer relevant (e.g., because a medication is no longer taken) as well as adding information (e.g., because a new medication has been started). This is different to other medical records where information is never deleted even if it is no longer relevant simply because, for legal reasons, the record needs to be a full account of all encounters with a medical professional. Once a SPOC is updated, Beth passes it to Kathy (MRP) to sign; then, she issues a new SPOC (via fax and/or by hand) to the parents, the ER, and the community agencies.

We have described the SPOC and its development in some detail because the interview analysis indicated its importance for all parties – everyone involved believed it was central in improving coordination. This was the case even though the initial Pilot Project proposal had not specifically set out to create such a document; indeed the initial proposal had suggested that the project would investigate the implementation of an EMR. However, project participants early on had identified that they did not have sufficient funds for this. Importantly, our empirical analysis not only identified the centrality of the SPOC, it also revealed that there were associated practices

that supported its implementation and use, as we describe next.

Figure 1. The SPOC

Implementation of the SPOC

During the initial implementation of the SPOC, the Pilot Project team encountered challenges with some of the physicians – generally, those doctors who were not directly involved in the Pilot Project. For instance, some of the ER doctors were skeptical regarding the adoption of a paper-based medical sheet that was held by the families. However, Kathy (MRP), providing detailed information about the initiative, soon overcame this barrier. Interviews and observations suggested that one of the issues that made this possible was her professionalism and leadership ability, as a CCAC Manager states:

“You have to be a very good communicator, you have to have the ability to work well with physicians, right? – understand their world. And [Kathy] does that, she’s an internal physician here, she’s highly respected. So she has the ability to be able to speak to a gastro specialist on the same level versus a nurse that might be in the community. An [agency] person calling [might get a response] I don’t have time to speak to this, right? I’m busy. But [Kathy], they’ll make time for [Kathy]. Right? They’ll make time for her because it’s just the way it works. ... And so that information continues to be fed back. And she also hears their perspective”.

Some parents were worried that their own role as advocate for their child’s healthcare needs would be undermined by the SPOC. However, giving parents the document and making them *owners* of it allayed these worries. Nevertheless, a few families were not very happy with the inclusion of some personal information and the Coordinator Nurse (Beth) played an important role in making sure that this information was excluded and the families were comfortable with the SPOC. She put a lot effort into creating relationships with the families, even if it was very time consuming during the first year (“When we first started it was way more, it was ten hours a

day”, as Beth stated during an interview) and now is trusted by the families as a “single access to care” who will update their SPOC.

Another important issue for the project team was to manage the relationships with those physicians who are external to CHEO. In particular, it was important that the community pediatricians were willing to adopt the SPOC since they actively contribute to the care of children with complex needs. Project team members were able to effectively introduce the SPOC to the community pediatricians, as Lara explains:

“So I presented to the community pediatricians, I mean the pediatricians that have had patients that are in the project they really, really appreciate, I mean, it has worked out well for them. And where they felt this was useful was, the summary, the SPOC for them was very, very helpful because they had all detailed information about their patients, so the availability of the information was a huge piece. They’re starting to work with Beth because ... one piece I wanted to make sure was they connected the nurse coordinator directly, so they can feed us back what they’re seeing, what they’re doing, what are the reports, and vice versa if they’re missing anything.... So slowly - but I think they’ve heard the message”.

Our analysis, then, revealed the different actors who acted as mediators, helping to translate knowledge between the different specialist communities involved in the care of these children with complex care needs. We identify the mediators in Table 2 below, summarizing the type (human or material), the role that played in knowledge translation, quotes which epitomize this role and finally the characteristics of each mediator which were found to be important in relation to their knowledge translation. In the final section of this analysis, we consider how the SPOC was actually used in practice and the perceptions of this new tool by those involved.

Table 2: Mediators in the Pilot Project

Mediator	Type	Role in Translation	Example quotes	Leverage
MPR (Kathy)	Human	Coordination between specialists	<i>Putting together different experts at the table</i>	Professionalism, leadership
Family members	Human	Identify and overcome barriers	<i>What are the needs that they're seeing, what gaps exist?</i>	Direct involvement with the children
PM (Laura)	Human	Communication across the agencies	<i>Reach out to all of the community providers to say here's what's going on with this patient</i>	Out-reach, engagement
NC (Beth)	Human	Building relationships with the families	<i>A single access to care</i>	Trust, flexibility
SPOC	Material	Coordination across the agencies and specialists	<i>It's good because it's written by a doctor</i>	Official character of the document

Outcomes of the SPOC for Knowledge Sharing

Impressively, the SPOC only took around 12 months to be implemented from initial inception; a significantly reduced timeframe compared to the adoption of an EMR and was also considerably cheaper. Indeed, the initial idea had been to create an integrated EMR for these patients but the costs had proved prohibitive. Most importantly, the SPOC is considered to be useful by all the parties. For the families it is “something visual that they could follow and make sure that nothing is missing”, according to the Nurse Coordinator. It was also an effective support for further visits/medications. As highlighted by a physician “So they could look and say, ‘Oh yeah, he’s due for blood work in the next month, let me remember that’”. Also, it is an official document that can be shown if an emergency occurs (at CHEO as well as in other hospitals) and (quote from a family member): “it comes from a doctor, it’s not just the mum”. Lastly, the SPOC represents a “hub” where CHEO and the other agencies involved can input relevant information.

In turn, all partners involved in the Pilot Project are “on the same page” for each patient. The mother of a child provides a broad description of the benefits of the SPOC:

“It’s good because it’s [SPOC] written by a doctor, right? So then the doctor can read it and go ‘boom, boom, okay, we understand what the basic interventions are’ and that sort of thing. Which is great. And it’s signed by a doctor... like ‘here you go, this is [basically] what you need to know, except for whatever most recently happened and then I can speak to that, but here you go’. Which is great ... another piece of comfort.... And you meet doctors, even the nicest doctors, there’s a language barrier between primary care giver language and the proper terms the doctors use or how they perceive things. So I think this kind of bridges that a little bit... See like, fibrosis of the right lung [on SPOC]. I wouldn’t have known that; wouldn’t have known whatever the technical term is”.

Beth highlights its success by providing an example of where it is clear that the SPOC represents a boundary object that is used in conjunction with her role as a broker, allowing knowledge sharing and coordination, not just among the pilot project participants but, more generally, in healthcare:

“Well, by the summertime we’d developed such a nice relationship with [the family] that, what happened was they wanted to go camping, but his respiratory issues happened at night so camping in the middle of nowhere was quite a problem...So...I called the hospital. I sent them that SPOC document. I spoke to the 911 responders for that area. We got them all the SPOC documentation, saying this child is going to be here these three days so you know he’s in the area, this is how you treat it, this is what you do. Got fax confirmation from the hospital that they’d received the information,

from 911 operators ... And then called the family and said, 'You know what, it's done, you don't have to worry, you can just go', and they trusted that they didn't have to call all those people and say, 'Did you get this, did you get that?'"

The families of the children with complex care needs are happy with the SPOC and acknowledge that its introduction has improved the coordination between the professionals involved in the Pilot Project, and therefore the efficiency and quality of healthcare for their children. Many parents have reported that it is thanks to the clarity of the SPOC that they often are treated much more quickly in the ER and often can go home rather than be admitted as inpatients since the doctors in the ER could examine the SPOC, which helped them come to a quicker evaluation of the children's conditions, as indicated by a father:

"So we were just at the ER on Tuesday of this week and they knew what the program was about and right away they knew where the files were, we gave them the SPOC sheet that we always carry with us".

Project partner organizations are also happy with the SPOC. For example, now a school therapist is aware of new needs for a child because the social services have received an updated version of the SPOC, as indicated in the two quotes below:

"I've been Bob's case manager in the community now for 4 years and I had no idea he had these other medical issues as well... it's great to receive thorough updates from the hospital; now it helps me to optimize his care at school and home" (community case manager)

"We send them for blood work and request a test and we never hear back the results. Now, with the SPOC, we get that information, I feel like I'm more in the loop about what's going on rather than always asking the parent to give me an update"

(community pediatrician).

Finally, the ER physicians themselves are also very pleased with the SPOC, as it has facilitated access to timely information and knowledge sharing that helps with their decision-making in a very busy ER. Even though the hospital's electronic record is available, the SPOC is updated more frequently, is written in terms that are understandable by the families, is more concise (e.g., only current medications are listed) and yet it provides all the information needed by the ER doctors. In contrast with CHEO's "internal" electronic record, the SPOC can be relatively easily shared with all healthcare community partners. The Chief of Staff in the ER, for example, was really impressed and felt that the SPOC had "helped fill a gap in information" as it relates to this medically complex and fragile population.

DISCUSSION

The description of the SPOC's creation and implementation reveals a number of important insights about the effectiveness of information systems for the coordination of care in healthcare settings. Much recent research and practice focuses on developing integrated EMRs (Poon et al., 2010; Resnick et al., 2004; Wang et al., 2009). Based on principles of inter-operability, such systems allow the sharing of health-related information across geographically distributed healthcare workers and administrators. Recent research has also suggested, however, that EMRs are more useful for administrators than healthcare workers because the medical record has become excessively lengthy, making it difficult for a physician who has not seen a patient before to find the relevant information they need (Newell et al., 2012). This has occurred because the functionality of EMR software (in particular copying-and-pasting and using pre-prepared templates) allows a physician to easily create a long record. Moreover, where an EMR exists, the information is very often limited to just some hospital departments, and almost nowhere is it

integrated with community services (Jha et al., 2009), the costs of developing such integrated systems being prohibitive, as here. The SPOC overcame all three of these problems: it created a short clinically-relevant (rather than administrative) summary; it made this available (via the parents) to the various specialist workers involved in a particular child's care, including community healthcare workers, and it did not involve the huge initial costs of integrated EMRs. However, as our case narrative demonstrated, the SPOC required work on the part of human actors involved in order for it to become an effective boundary object. We discuss this work next in terms of different aspects of knowledge brokering that were apparent from our analysis. Moreover, we also consider how our analysis sheds light on the use of EMRs that are also designed to improve coordination, but do not always achieve this. We identify how the human work of knowledge brokering that we identify in relation to the SPOC may help to provide insight into some of the reasons for this.

Knowledge Translation and Boundary Objects: Creation and Use Brokers

Theoretically, the effectiveness of the SPOC can be viewed using the concept of boundary objects (Star and Griesemer, 1989). The SPOC was useful because it was succinct and so easy to digest – important, given healthcare workers time pressures. It could be interpreted by all the different parties involved in the child's care from their own disciplinary perspective, and yet it also provided a more holistic view of the child than they had had previously. However, while we can see the SPOC as an effective boundary object in its own right, we also suggest that this is not the complete explanation of why it worked so well. Rather, we argue its effectiveness can be attributed to the fact that it worked in conjunction with a number of (human) brokers who were important in its effectiveness. Our findings, considered in the light of existing literature, suggest that it is important to distinguish between two different types of knowledge broker: *creation*

brokers and use brokers.

Creation brokers were those human mediators who were active in ensuring the SPOC was a useful boundary object for a range of healthcare workers involved in the care of these children with complex care needs. This creation brokerage involved a number of different practices: designing the SPOC (ensuring that input was provided from all the various stakeholders); promoting the SPOC (ensuring that everyone recognized its usefulness); and creating the actual SPOC for each child (ensuring that it was up-to-date and signed-off). In our example, this creation broker role was performed by Kathy (MRP), in her leadership role among the healthcare workers and in her signing the SPOC, giving it legitimacy; by Beth (nurse coordinator), in her vigilance in collating information and building trust with the families; and by Laura, in her engagement work with all the outside agencies. Creation broker roles attest to the idea that how a boundary object is constructed will be important in its subsequent effectiveness (Puri, 2008). However, creation broker roles are under-discussed in relation to EMRs. Individual healthcare workers input information into the EMR but there is typically not a human broker to translate and coordinate it to provide an overview of the patient that will be useful to different healthcare specialists. Rather, it is assumed that the EMR acts as a mediator in its own right, serving as a stand-alone boundary object. Healthcare workers are assumed to be able to actively search and use the information available to coordinate their own treatment plans. However, while healthcare workers using an EMR may now have the *potential* to examine the full medical record to think more holistically about a patient, there is no guarantee that they will do this, especially given the length of patient records today (Newell et al., 2012). Even when an EMR summary page exists, this is pulled automatically from the information that is inputted, and may not provide the most effective portrait for a particular patient. The limitations of this non-human mediated view of

EMRs accounts for why people are promoting the importance of the medical home idea, where a physician (in our case, Kathy – the MRP) effectively acts as the broker between the different specialists (e.g., Martin et al., 2004). This recognizes that having information available to everyone does not necessarily mean that it will be useful for coordination; knowledge brokers are often needed to act on and with the information to make it useful for others, especially for those with complex care needs.

Use brokers were those human mediators who were active in ensuring that the SPOC was actually used in medical encounters. In our case, the parents performed this use brokerage practice. They could bring the SPOC to the attention of the healthcare worker immediately, saving valuable time, especially in an emergency, when looking up the records can take time and can be ineffective, given potential difficulties in surfacing the really important information. Moreover, by having the paper-based SPOC owned by the patients' parents, it gave them legitimacy in their sharing of knowledge with healthcare workers – legitimacy that they had often not previously enjoyed. Thus, while parents had played this broker role previously without the SPOC as a boundary object, they had struggled because the medically trained healthcare workers often did not respect the legitimacy of their knowledge. With the SPOC, they found that they were much more empowered when they communicated with different specialists. This included being able to update the healthcare professional with whom they were interacting about any changes in their child's condition that were not on the SPOC. This testifies to the symbolic role that boundary objects can play (Swan et al., 2007), especially when considered in conjunction with broker practices (Kimble et al., 2010).

Use knowledge broker roles are also not fully discussed in relation to EMRs. Some recent literature promotes the idea of giving patients (or their advocates) access to their full medical

record (e.g., Ralston et al., 2010; Wiljer et al., 2008). The primary rationale for this relates to privacy – it is data about an individual so the individual has the right to know what is written about them. This initiative is often opposed by physicians, for example because the patient will not always understand what is written because of the specialist nature of medical language. In this sense the medical record does not act as a boundary object. In relation to the SPOC, the parents had had to become experts in their own child's medical conditions so that even if specific technical words might have been difficult to remember they had a reasonable understanding of the diagnoses and treatments recorded on the SPOC. More importantly, the SPOC was not so much a boundary object for the patients (or, better, the families of the patients) themselves, as is envisaged in accounts of allowing patients access to their records. Rather, it was a boundary object that they (families) could use in their interactions with all the various specialists, giving them legitimacy in these interactions (which they had not previously enjoyed) because it was "signed by a doctor not a mum". Patients using their own electronic record to advocate are unlikely to gain the same legitimacy unless there is a broker who has explicitly created a record for this symbolic purpose; a point that is not commonly discussed in relation to integrated EMRs. In sum, we can now provide an answer to our research question '*What roles do boundary objects and knowledge brokers play in knowledge translation processes that help to improve healthcare coordination?*' Boundary objects (in our case, the SPOC) help knowledge translation in healthcare settings in that, their material or conceptual nature can be (flexibly) interpreted by different actors (in our case, the families and the different physicians and healthcare workers) and can provide legitimacy to those who make use of the object. More importantly, we also identified how this boundary object was only successful to the extent that human actors performed two types of knowledge brokerage in relation to this object: creation and use. Finally,

we also discussed how these knowledge brokerage roles are often ignored by those advocating for using EMRs to improve coordination across medical specialists, explaining why they may often not produce the outcomes desired (and the outcomes achieved by the SPOC). Table 3 summarizes our findings and contributions.

Table 3. Findings and Contribution

Human and material actors	Main findings	Contributions	
Boundary objects	<ul style="list-style-type: none"> SPOC 	<ul style="list-style-type: none"> The families can use the SPOC in their interactions with all the various specialists, giving them legitimacy in these interactions because it is “signed by a doctor not a mum”; the medical specialists involved learn more about their patient through the circulation of the SPOC. 	<ul style="list-style-type: none"> Boundary objects that can improve healthcare coordination can be simple paper records While more complex EMRs may also act as boundary objects this is likely to depend on the involvement of creation and use brokers; a point often ignored by existing literature on EMRs
Knowledge brokers	<ul style="list-style-type: none"> PM, NC, MRP, families (creation brokers) Families (use brokers) 	<ul style="list-style-type: none"> Creation broker roles need to ensure that concerns of various stakeholders are taken on-board in the design of the SPOC but also in ongoing creation of a summary record that includes only relevant medical information from the huge amount of information about a particular patient Boundary objects can provide symbolic legitimacy for users, here providing families legitimacy in their sharing of knowledge with healthcare workers, but only if this is part of their design 	<ul style="list-style-type: none"> A boundary object requires knowledge creation brokers to ensure various stakeholders feel their needs are taken into consideration during design but also in ensuring the BO is maintained to translate only relevant knowledge A boundary object is effective in conjunction with knowledge use brokers when it provides them with legitimacy

We develop these contributions further as we discuss in more detail relationships between human and material actors in the knowledge translation process.

Human and Material Mediators

Looking at boundary objects and brokers separately while examining their relationships allows us to distinguish between material and human mediators. As we previously noted, Nicolini (2011) is not explicit in distinguishing between these two types of mediators, but his examples suggests that translation by contact happens with human mediators (i.e., an organizational actor who acts as a broker and “deals” with the two ends of a knowledge translation process); while translation at distance happens with material mediators such as, boundary objects that can be carried, or sent, from one end to another of the knowledge translation process – meaning that the boundary object itself does not carry knowledge, it translates knowledge ‘into the scene’ (Nicolini, 2011). In this respect, the SPOC (that is carried by the parents) facilitates a knowledge translation process involving (clinicians) specialists, the MRP, the Coordination Nurse, and other healthcare players (e.g., the social services, the pediatricians who do not work at CHEO, and the ER doctors). However, we would go further and suggest that material boundary objects, because they cannot be as responsive and interactive as human actors, are often not sufficient, on their own, to foster knowledge sharing in healthcare settings involving multiple agencies and professional groups. In order for knowledge to be effectively shared in such settings, human knowledge brokers, acting as mediators (and, following Nicolini, 2011, mediators by contact) are required.

In fact, referring to healthcare and (clinical) information sharing, it is hard to think of an effective artifact that acts as mediator at distance without the emotional support provided by a (human) mediator by contact who gives credibility and legitimacy to the artifact. In other words, we suggest that the material boundary object – the SPOC – played a crucial role once it was entangled (Orlikowski, 2007) with human brokers, in facilitating knowledge sharing. Thus, the fact that family members carried the SPOC was crucial to understanding the effectiveness of this

boundary object. Even though specialists (e.g., in the ER) had been sent the SPOC by fax mail, it was the interaction between the specialist and the family member (facilitated by the physical presence of the SPOC and the legitimacy this gave the family member) that was crucial to its success. Moreover, updating the SPOC required input by a human mediator who had to use human judgment to decide what information to delete and what to include, ensuring in doing this that, even for these patients with very extensive medical notes, the SPOC would provide a comprehensive, up-to-date summary that would be helpful to those providing care. This is why we suggest that the SPOC was a boundary object that relied on the practices of a range of creation and use brokers in the effective sharing of knowledge that helped to improve the coordination of care for these children with complex needs.

CONCLUSIONS AND IMPLICATIONS

A minority of healthcare users account for a majority of healthcare resource usage. This minority includes children like those in CHEO pilot project: patients who have a number of illnesses and so need to see multiple specialists, presenting complex coordination challenges. Many elderly people also fall into this category. Finding ways to coordinate the care of these patients can bring enormous benefits to individual patients, their families, and to healthcare systems more generally. The primary focus in many debates around these issues has been on introducing HIT, especially interoperable EMRs. Introducing interoperable EMRs across a region or nation involves huge costs and takes long periods of time (Aanstad and Jensen, 2011). In addition, recent empirical works shows that while EMRs often lead to departmental efficiency, they are less likely to improve coordination across departments and between different healthcare structures (O’Malley et al., 2010), with the impact of EMRs on costs and quality in the short term showing mixed results (Chaudhry et al., 2006). Given these problems, it is apposite to

reflect that a simple paper-based system could so effectively improve the quality of healthcare coordination for these patients with complex care needs. The SPOC, in conjunction with people playing different brokerage roles, enabled the effective sharing of relevant clinical knowledge across the Pilot Project's healthcare network and achieved both internal and external coordination at CHEO very quickly – moving from initial conception to full implementation within 12 months – and was far cheaper than trying to implement an integrated EMR across all the varied players.

Our findings do not dispute the importance of EMRs for managing knowledge and improving coordination in healthcare settings – indeed the information on the SPOC was typically pulled from electronic records and the current version of the SPOC was kept and updated on a computer. Nevertheless, human brokers, for the purpose of effective knowledge sharing, explicitly created the SPOC from these electronic records and presented it for use in actual medical consultations. We understand why these brokers and the boundary object were *together* so important by adopting our practice perspective that focuses on mediators rather than assuming direct transfer of knowledge. Our analysis thus suggests that, even where interoperable EMRs are introduced, more research is needed to examine where human brokers will still be needed to improve the coordination of care. This account goes beyond the recognition of the importance of getting user buy-in to the system; rather it attests to the on-going need for human brokers to intercede in creating and using a medical record that is going to be effective for mediation purposes in promoting improved knowledge sharing and coordination. These findings, thus, have implications for improving the use of EMRs, but more generally, our analysis pushes us towards reflecting on whether, occasionally at least, a simple (partly) paper-based information system can produce immediate gains at a low cost where an electronic system would be less likely to

produce such short-term benefits.

Of course, it is not to suggest that it would be possible to simply replicate the SPOC initiative elsewhere or for all patients. Our case illustrates very clearly that it was the way the SPOC was created and used as well as the object itself that made it successful. In this sense, the innovative solution identified in this case is not simply transferable to a new context. Moreover, it is unlikely to be scalable for all patients in a particular healthcare setting. However, the lessons from this case can be potentially applied elsewhere, encouraging reinvention of local solutions that identify objects that might help with coordination in conjunction with human actors who can broker the creation and use of such objects. And in terms of scalability, starting with those patients for whom coordination costs are particularly acute given their complex care needs, can be an effective way of approaching the issue of improving efficiency, rather than attempting to address this problem for all patients, the majority of whom may be much less problematic in terms of coordination issues (and associated costs).

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