Collaboration and entanglement: An actor-network theory analysis of team-based intraprofessional care for patients with advanced heart failure

A. McDougall^{a,c,*}, M. Goldszmidt^{c,f}, E.A. Kinsella^{b,c}, S. Smith^e, and L. Lingard^{c,d}

^aHealth & Rehabilitation Sciences–Health Professional Education, Western University, London, ON, Canada

^bHealth & Rehabilitation Sciences–Occupational Therapy/Health Professional Education, Western University, London, ON, Canada

^cCentre for Education Research & Innovation, Schulich School of Medicine & Dentistry, Western University, London, ON, Canada

^dDept. of Medicine, Schulich School of Medicine & Dentistry, Western University, London, ON, Canada

^eDept. of Medicine, Division of Cardiology, Schulich School of Medicine & Dentistry, Western University, London, ON, Canada

^fDept. of Medicine, Division of Internal Medicine, Schulich School of Medicine & Dentistry, Western University, London, ON, Canada

Abstract

Despite calls for more interprofessional and intraprofessional team-based approaches in healthcare, we lack sufficient understanding of how this happens in the context of patient care teams. This multi-perspective, team-based interview study examined how medical teams negotiated collaborative tensions. From 2011 to 2013, 50 patients across five sites in three Canadian provinces were interviewed about their care experiences and were asked to identify members of their health care teams. Patient-identified team members were subsequently interviewed to form 50 “Team Sampling Units” (TSUs), consisting of 209 interviews with patients, caregivers and healthcare providers. Results are gathered from a focused analysis of 13 TSUs where intraprofessional collaborative tensions involved treating fluid overload, or edema, a common HF symptom. Drawing on actor-network theory (ANT), the analysis focused on intraprofessional collaboration between specialty care teams in cardiology and nephrology. The study found that despite a shared narrative of common purpose between cardiology teams and nephrology teams, fluid management tools and techniques formed sites of collaborative tension. In particular, care activities involved asynchronous clinical interpretations, geographically distributed specialist care, fragmented forms of communication, and uncertainty due to clinical complexity. Teams ‘disentangled’ fluid in order to focus on its physiological function and mobilisation. Teams

*Corresponding author. Health & Rehabilitation Sciences, Western University, c/o Centre for Education Research Innovation, Health Sciences Addition, Suite 110, 1151 Richmond St., N6A 5C1, Canada. amcdougall@royalcollege.ca (A. McDougall).

also used distinct ‘framings’ of fluid management that created perceived collaborative tensions. This study advances *collaborative entanglement* as a conceptual framework for understanding, teaching, and potentially ameliorating some of the tensions that manifest during intraprofessional care for patients with complex, chronic disease.

Keywords

Canada; Actor-network theory; Intraprofessional collaboration; Entanglement; Heart failure; Palliative care; Fluid management

1. Background

The discourse of inter-/intraprofessional collaboration (IPC) evokes authority for those who wield it in contemporary discussions of clinical professionalism. Professional practice guidelines and codes of ethics leverage IPC as a symbol of workplace equity, patient safety and effective communication. Policymakers and administrators convey IPC's central role in workplace equity, effective communication and safe care (Service, 2001; Herbert, 2005). It stands as a matter of fact in healthcare, and proponents advocate its importance for improved patient access to health services, better use of clinical resources, and less stress with higher retention among health care providers (HFO, 2010; WHO, 2010).

Extensive critical reflection in healthcare sociology has focused on interprofessionalism, the study of professional interaction between professionals from medicine, nursing or other health professions. Much of this work began with the sociology of professions, particularly work theorizing how disciplines establish jurisdictions that are frequently put in conflict when existing boundaries must be defended or when new boundaries must be advanced (Abbott, 1988, 2001). Interprofessionalism researchers have described the influence of jurisdictional conflict at varying levels of analysis. At a macro-level, culture (Hall, 2005) and discourse (Haddara and Lingard, 2013) have been shown to be in conflict with how IPC is understood and enacted through health policy, or where professional hierarchies and values find ways to subsist despite professional interaction (Paradis and Whitehead, 2015). At an organisational level, studies have illustrated the tensions inherent in interprofessional practice, such as when institutional rules conflict with public legislation (Lahey, 2012) or when scope of practice guidelines are unsuited for institutional systems (Khalili et al., 2014; Manias, 2015). At the individual level, studies have shown how role confusion in interprofessional collaboration leads to interpersonal and professional misunderstandings (Khalili et al., 2013; Rodriquez, 2015) and “incivilities” (Boateng and Adams, 2016). Stronger critiques posit that interprofessionalism masks a managerialist discourse pervading contemporary healthcare that co-opts the hierarchical divisions between healthcare professionals that it is purported to dispel (Finn et al., 2010; Learmonth, 2003). Other work aims to reconceptualise the term altogether, claiming that interprofessional collaboration does not necessarily reflect the complex realities of clinical practice and should not be idealised as a central goal (Lingard et al., 2012a, 2014).

Researchers have paid such extensive, recent attention to interprofessionalism in order to fill gaps left by early social science that focused narrowly on medicine over nursing and other

health professions. These studies include canonical work on professional development in medical education (Becker, 1961) and early theories on the practice of medical expertise and authority (Freidson, 1960, 1970). This early work in the sociology of professions mapped the same medical hegemony responsible for an overall lack of scholarly attention offered to nursing and other health professions (Barr et al., 2005). Furthermore, this shift toward inter-professionalism is also regarded as the historical by-product of public calls for medical reform following several damaging reports published at the turn of the 21st century (Green, 2014). White papers such as the Institute of Medicine damning *To Err is Human* (Kohn et al., 2000) and the UK's horrific *Shipman Inquiry* (Smith, 2002) exposed the dangers of unilateral models of clinical decision-making and authority. Leaders and practitioners from across the health professions embraced the discourse of inter-professionalism as a way to improve professional equity and patient safety in medicine (Reeves et al., 2010).

The NHS' *Five Year Forward View* stands as a contemporary example of interprofessionalism's place in health policy discourse. This government report describes a significant investment in interprofessional primary healthcare teams that will facilitate networks of integrated care, multi-specialty group practices and an expansion to in-reach support for patients at home (NHS, 2014). Another example is Canada's *Unleashing Innovation* report, which recommends healthcare that engages and empowers patients and families in healthcare decision-making and leverages digital health technologies to streamline the integration of care across the specialty health workforce (Health Canada, 2015). With support through public perception, policy reform and outcomes-based research funding, interprofessionalism ascended to the sine qua non of the patient safety and medical professionalism movements.

Interestingly, much less scholarly attention has been paid to medical *intra*-professionalism, which captures. Relations between subdisciplines of a given discipline and traces how that discipline internally invents, maintains, and invests in its "intellectual turf" (Abbott, 2001, p. 139). While medical specialisation dates back to the 19th century, its heterogeneity continues as medical education and research drive the development of new specialties, sub-specialties, and advanced practice certifications every few years (Weisz, 2006). Studies of medical intraprofessionalism include explorations of dynamic, overlapping scopes of practice among medical specialties (Martin et al., 2009; Lingard et al., 2012a), challenges accessing resources and equipment (Currie et al., 2008; McIntosh et al., 2014), professional legitimacy claims (Sanders and Harrison, 2008; Currie et al., 2014), and working through institutional or departmental authority (Powell and Davies, 2012). Notwithstanding this work, researchers have made recent, high-profile calls for research exploring how intraprofessional HF care delivery is accomplished in increasingly complex and distributed healthcare environments (Clark and Thompson, 2010; Clark, 2013; Selman et al., 2009).

Existing knowledge of medical intraprofessionalism is also constrained by a strong inclination in social theory to view collaboration as a human endeavour. One prominent definition states IPC is "an active relationship between two or more health or social care professions who work together to solve problems or provide services" (Zwarenstein and Reeves, 2006, p. 48). Scholars taking up this definition tend to essentialise people as the crux of the relationships, interactions, negotiations and forces that lead to intraprofessional

collaborative tensions. Few studies explore the intermingling of human and nonhuman elements in intraprofessional collaboration, though there are notable exceptions (Fenwick and Nerland, 2014; McIntosh et al., 2014; Timmermans, 2006; Timmermans and Buchbinder, 2012).

This study used actor-network theory (ANT), an approach to social theory and research presupposing that all human and nonhuman entities, or *actants*, are entitled semiotic space in descriptions of the social. ANT posits that not only do people play a role in intraprofessional collaboration, so do laws, guidelines, technologies, and clinical spaces. From this standpoint, human actants are both part of and defined by broader networks of human and nonhuman actants. Importantly, the sociologist Michel Callon's term *entanglement* features in this analysis first to describe the heterogeneous, relational milieu of people, things and ideas that compose our world, and second to describe the dynamic interactions, patterns and assemblies through which these human and nonhuman *actants* form practices, knowledges and technologies (Callon, 1999).

1.1. Actor-network theory and IPC

Though its descriptions have varied over the past 35 years, ANT, alongside Science, Technology and Society (STS) and the Sociology of Scientific Knowledge (SSK), originated as a relational-materialist framework for exploring knowledge producing environments and data transmission (Law and Singleton, 2013). The philosopher and anthropologist Bruno Latour stands as one of the major contributors to its intellectual foundations and methodological considerations (*esp.* Latour and Woolgar, 1979; Latour, 1987, 1988, 1993, 1996, 2004, 2005, 2013). ANT represents a departure from structuralist approaches to sociology; social scientists have described it as application of post-structuralist perspectives (Fenwick and Nerland, 2014; Law, 2004). Latour (2005) calls structuralist sociology the “sociology of the social” (Latour, 2005, p. 9), claiming social science overly relies on hidden social forces at work influencing human actants. ANT, or the “sociology of associations” (Latour, 2005, p. 9), posits that local collectives of people, things and researchers form their own relational ‘sociologies’. While ‘sociologists of the social’ describe society in terms of an organisational ether that pervades all human experience, ‘sociologists of association’ describes the social as a heterogeneous entanglement of constantly shifting relations between human and nonhuman actants (Latour, 2005; Callon, 1999).

ANT-informed social research heralds new perspectives on and solutions to well-entrenched ways of viewing the world. It posits that technical fields like science and medicine ground daily practice in *matters of fact*. For Latour (2004) these matters of fact are reproducible framings about our world that operate as filtrated, simplified byproduct of more complex *matters of concern* (n.b. Latour, 2004). To unpack matters of fact and lay bare matters of concern, ANT research aims to disrupt taken for granted understandings through rich description (Latour, 1987, 1993; Callon and Law, 1997; Callon, 1999; Latour, 2004, 2005). It has been called a process of “heterogeneous engineering” in which the social is punctuated and complicated with considerations of technical, conceptual, and textual semiotics (Law, 1987; Mol and Law, 1994; Callon and Law, 1997).

Michel Callon borrows the term *entanglement* from quantum physics to define the social (Callon, 1998, 1999). Like the unpredictable, paradoxical interactions between entangled quantum particles (Steward, 2008), Callon notes how entangled interactions characterise the natural state of complex social phenomena such as economies (Callon, 1999; Callon et al., 2002; Callon and Muniesa, 2005; Callon, 2007b). For Callon, human, nonhuman and conceptual actants operate within an infinitely complex, overlapping, sociomaterial “proliferation of relations” (Callon, 2007a, p. 277). Within this complexus, neither an actant nor a relation have an inherent state; instead Callon defines *framing* as the operations through which actants define themselves, define others, and distinguish each other. To illustrate framing, Callon (1999) asks readers to imagine the social interaction of buying a new car. Prior to the purchase, a number of complexities around the car must be ignored in order for the vehicle to be sold. The sales transaction is an activity requiring three parts: the customer, the vendor, and the car. The customer's previous vehicle, the car dealership's payroll operations and the car's electrical systems are relationally connected to the sale of the car but they are not a part of the sale. The sales exchange requires framing—in this case, through financial arrangements, legal documentation and the like. The vehicle mediates this framing of relations and then, after the purchase, it will mediate an entirely new set of social relations such as a new owner and a new transportation regime. Although the vehicle has not physically changed, through framing it now stands in a new set of heterogeneous relations.

While Latour's work has primarily focused on the area of science studies, ANT has also been applied in healthcare sociology (*esp.* Mol and Law, 1994; Mol and Berg, 1994; Berg and Mol, 1998; De Laet and Mol, 2000; Mol, 2000, 2002; Law and Mol, 2004; Law and Singleton, 2005; Mol, 2008, 2009, 2010; Law and Mol, 2011). This past work has highlighted the dynamic nature of generating knowledge and information among heterogeneous communities of medical specialties, health professions and patients and families. Further, this work advances the relational indeterminacy of objects, technologies, techniques and social roles in medicine. Building on this foundational work viewing healthcare through ANT's lens, a growing body of research has accounted for the inherent challenge and complexity of intraprofessionalism in healthcare (Bleakley, 2012; Fenwick and Nerland, 2014; MacLeod et al., 2015). This research arose in response to recent calls for rich, descriptive research that illustrates the complexity of medical intra-professionalism (Cristancho, 2014; Lingard et al., 2012b; Fenwick, 2012). Specifically, this research was conducted with Canadian healthcare teams involving patients with advanced heart failure (HF).

2. Methods

This paper originated from a larger, multi-site study of IPC on complex, distributed Canadian HF care teams (Lingard et al., 2013; Tait et al., 2015; LaDonna et al., 2016). Using grounded theory (Charmaz, 2014), this larger study aimed to provide descriptive evidence and inductive theorisation to inform calls for better palliative care access for patients with advanced HF. The study recruited participants with advanced HF who were identified by healthcare providers as likely to require more complex/palliative team-based care within the next 12–18 months. All patients were recruited through either a HF clinic or through their family doctor. Recruitment information provided to patients by a healthcare provider

indicated that they were being asked to consider participating in an interview to talk about their HF care experiences and the members of their care team. Patient care teams, not just patients, were the focal point of this work. These methods used team-based, multi-perspective interviewing (Pinnock et al., 2011; Murray et al., 2009; Kendall et al., 2009) to gain a range of insights on team-based patient care. Patients were asked for permission for researchers to request interviews with people they identified as members of their healthcare team. These multi-perspective, patient-initiated interview sets were called *team sampling units* (TSUs), defined as a set of at least 3 interviews: a patient interview, an interview with at least one of the patient's lay caregivers (e.g., a spouse), and an interview with at least one of the patient's health care professionals (e.g., a cardiologist).

Using this approach, the study took place in heart function clinics and family medicine practices in four cities in three Canadian provinces, where researchers conducted 205 interviews with 62 patients with advanced HF, 58 caregivers and 72 health care providers. This study was approved by separate research ethics boards in all four cities and all participants provided two-stage informed consent, first prior to enrollment and second prior to the interview. From this dataset, 50 patient interviews led to complete TSUs (see Table 1). The TSUs were heterogeneous in their composition and included an average of 5 interviews (LaDonna et al., 2016). The TSUs also frequently involved health care providers from different specialties and disciplines collaborating remotely.

2.1. Exploring the cardiology/nephrology interface with ANT

Early in the analysis a cohort of 13 HF patients was noted because they were seeing both a heart specialist and a kidney specialist. As a result, these patients were being seen by both cardiology (heart specialty) teams and nephrology (kidney specialty) teams. Intraprofessional collaboration between these care teams appeared particularly complicated, often involving negotiations and disputes involving medical devices, medications and decision-making authority. ANT offered a productive orientation for exploring collaboration between these specialty teams. During their interviews, these 13 patients identified 116 team members 47 of whom were interviewed (see Table 2). While the analysis reviewed all of these 13 TSUs, descriptions below are taken from the four TSUs that featured one patient, at least one lay caregiver, at least one cardiologist and at least one nephrologist (See Fig. 1).

ANT research outputs, called *accounts*, are focused and descriptive. While ANT is a methodologically diverse approach, there are two truisms across most ANT-informed accounts. First, an account aims to evoke insights through thick description. Second, study are always the impressions of researchers or research teams (e.g., Latour, 1987, 1996; Mol, 2002; Law, 2004). Two researchers (AM, LL) began a focused analysis of TSUs featuring both cardiology and nephrology care teams. These researchers wrote frequent research memos and sought guidance from clinical collaborators during research meetings and drafting discussions (SS, MG, AK).

Within the context of the larger study, fluid acted as a central entity in the collaboration between cardiology care teams and nephrology care teams. Fluid's role on these teams revolves around how advanced HF destabilises a patient's bodily fluid equilibrium. Fluid fluctuates between periods of relative equilibrium (euvolemia), fluid overload (edema), and

fluid deficit (hypovolemia). Fluid bloats patients' bodies, induces fatigue, creates discomfort, and causes shortness of breath. As patients' bodies grow and distend, the fluid also overloads their cardiovascular systems. It dilutes internal serums and forces already weak hearts to work harder. Whereas fluid was a tacit actant in patients' lives before HF, this account describes fluid on the advanced HF care teams as a component of new, overlapping framings. In particular, we use the construct of heterogeneous entanglement to view fluid's active role in causing and influencing intraprofessional collaboration and collaborative tensions.

3. Results

We present these findings grouped within three headings. The results first describe fluid as an actant on cardiology and nephrology teams. Next, disentanglements were observed reducing fluid from actant to a passive bodily function. The results then outline how teams *framed* fluid according to practices associated with its mobilisation. Framings differed between specialty teams, sometimes creating situations where fluid led to of perceived collaborative tension. Finally, instead of the term collaboration, the results describe how these shifting disentanglements and framings characterise a process that we label *collaborative entanglement*. Collaborative entanglement stood out as a useful conceptual framework for exploring how nonhuman actants operate through medical intraprofessionalism.

3.1. Disentangling fluid mobilisation

In descriptions of intraprofessional collaboration for fluid overload, cardiology and nephrology team members described fluid in terms of physiological functions and techniques for mobilising fluid. Consider the list of actants this cardiologist uses to describe treating fluid overload:

Fluid management issues include the clinical scenario of someone on high-dose diuretics, fully treated with beta blockers, ACE inhibitors ... with salt and fluid restrictions so those sort of lifestyle changes. As a patients' HF progress, they may become candidates for aldosterone antagonists, other advanced medical therapies and then become candidates for mechanical support devices. (Dr. Edwards).

Fluid introduces a litany of actants and activities. It spreads beyond the patient's body to act on relational networks of physiological functions: ACE-inhibitors to relax blood vessels swollen by fluid, beta-blockers to slow adrenal production to reduce the rate of fluid production, diuretics to promote the production of urine to output fluid, aldosterone therapy to inhibit salt absorption to reduce fluid retention, and mechanical therapeutic interventions to externally extract fluid. The teams mobilise fluid; however so too does fluid relationally mobilise an extensive network of other actants and activities.

For the patients in this account, fluid necessitated dialysis, a technology involving a sophisticated network of other actants served as a notable nonhuman actant for the four patients in this account (see Fig. 1). Although fluid stood out as a powerful nonhuman actant, physicians often framed it in terms of an actant that could be manipulated and

controlled. One nephrologist situated dialysis as an activity used in a scenario where relative equilibrium is achieved through structured feedback loops and ‘tinkering’:

Once we established Mr. Charlebois on dialysis and established what his weights are and his mode of therapy, dialysis is just more tinkering over time. Does his weight go up or down a few pounds? Is that fluid? Is that actual body mass that he's gaining or losing? And then adjusting his prescriptions on that basis. (Dr. Chavez, Nephrologist).

In a similar description of fluid mobilisation, a nurse practitioner from a different clinic explained “we phone often to check on [Mr. Thompson's] weight and symptom management ... making sure he has enough [dialysis] bags and other equipment” (Jasmine). These descriptions of fluid's physiology and mobilisation disentangle intraprofessional care for fluid overload into stable descriptions like ‘management’ and ‘tinkering’.

Notwithstanding these stabilised descriptions, cardiology and nephrology team members frequently relayed how they grappled with fluid and its management. Fluid measurements and categorisations were as much a composite of a patient's body when they were seen as they were a set of relations between the present and a past clinic visit. Not only would cardiology team members such as Dr. Edwards play a role in adjusting treatment for fluid overload, so too would nephrology team members. Several healthcare providers expressed that fluid management decisions were communicated over long periods of time, if at all, making fluid management difficult and time consuming in practice:

Sometimes I don't know who is following [Mr. Singh] ... which sometimes looks bad in front of the patient and makes it look like we don't know what we are doing. (Jasmine).

Fluid became entangled with broader networks of prescription medication and dialysis technologies. Fluid also required asynchronous clinical appointments between specialists, complicated intraprofessional relationships, unique scheduling arrangements, detached electronic medical records and variations in techniques and medical expertise. Far from something health care teams could straightforwardly disentangle, manipulate and control, fluid emerged as a substantive actant influencing intraprofessional collaboration between cardiology and nephrology teams.

3.2. Framing fluid as matter of fact/concern

Fluid's ability to create tensions in collaborative HF care was further illustrated in the frequent negotiations over competing framings for fluid observed as cardiology teams and nephrology teams collaborated. Take this nephrologist's example:

Often cardiologists give patients a lot of diuretics, and we have to make sure we speak the same language as the cardiologists because the kidney doesn't necessarily like the diuretics and the heart needs the diuretics. (Dr. Timmins).

Cardiologists prescribe diuretics for fluid management as a matter of fact, but this framing constitutes a matter of concern for nephrologists focused on caring for the kidney. Some health professionals used battle analogies to characterise how fluid is entangled with issues of clinical authority and collaborative practice. According to one cardiologist:

Diuretics are bad for your kidneys. Well yes, they're bad for your kidneys, but you've heard me say this before, the heart wins the battle, the kidney wins the war. So in order to keep [Mr. Thompson] dry, we have to give him diuretics. We fully know they're bad for his kidneys, but he won't be able to breathe or do anything if he's wet [fluid overloaded] and he'll end up back in the hospital. So that's been one of our sort of push and pull. (Dr. Sanders).

The war metaphor relates to a central matter of concern pertaining to how cardiology team members framed fluid management. They related that patients die when their kidneys fail, not their hearts. "The heart wins the battle" by making patients feel better when it functions well, allowing patients to "breathe [and] do [things]". By extension, the heart loses the battle when patients are "wet" and "end up back in hospital". Why then does "the kidney win the war"? Through this framing, the cardiologist indicates that fluid management is a series of "battles" and that a patient's mortality is the "war". Authority for regular symptom management "battles" shifts away from the cardiologists and on to the nephrologists as the "war" for kidney function intensifies.

These perceived shifts in authority were described in other interviews as well. Nephrology team members' descriptions also revealed perceived tensions in how fluid management was framed through dialysis. One nephrologist described dialysis as "consistent day by day extra fluid removal [which] does a better job of keeping patients out of hospital." (Dr. Chavez) As a matter of concern, however, it is perceived as both "an underused resource" (Dr. Chavez) and a naively quick fix: "the cardiologists got wedded to the idea of 'a quick spin of dialysis changes the career of the patients' and I think that that's a little flawed." (Dr. Chavez) Further complicating the picture, one nephrologist described a clinical trial of dialysis for HF that was "undervalued" by cardiologists asked to refer HF patients in need of fluid management:

A couple of years ago there was a trial put out by our dialysis provider ... in a program where we think we work pretty cooperatively, there were mutterings that cardiologists weren't going to probably want to have their patients on 'dialysis.' We think that the therapy is undervalued by some of the cardiologists. (Dr. Chavez).

From another perspective, one cardiologist explained how some HF patients have a type of kidney failure that does not meet the minimum guidelines for dialysis, even though their fluid overload is unmanageable with HF drug therapies:

There are patients who it's difficult to impossible to manage their HF because they have such a severe degree of renal impairment that it's altering their response to diuretics ... I must convince the nephrologist that this person needs to be dialysed for fluid management, not because of 'kidney failure symptoms' (Dr. Edwards).

Each of these descriptions illustrates fluid being framed as a matter of fact in one specialty while being a matter of concern in the other.

This intraprofessional negotiation took the form of asserting authority over the framing of fluid and its disentanglement. Both parties contended with the other's distinctive definitions

of 'fluid' because, according to one nephrology, her role "somewhat overlaps with the cardiologist's role, in the sense that both look at a patient's weights, fluid status and blood pressure," (Dr. Kahn, Nephrologist). Some participants recognised that this debate looks like disagreement:

Patients sometimes get mixed messages from their nephrology team and their cardiac team, so we need to make sure we're all on the same page. I often hear and see patients feeling quite frustrated that someone is telling them to take less fluids and someone else is telling them to take more. (Dr. Kahn, Nephrologist).

While this nephrologist acknowledges that patients can feel frustrated at the apparent contradictions in fluid management directions, another explained how these distinctive approaches to fluid set up complex intraprofessional relations of authority:

Nephrologists are probably obliged to follow the cardiologist directions about HF patients, although I might tend to whisper in a patient's ear and tell them to lie to the cardiologist about how much liquid they drink. I think it's a problem ... I don't believe that it's necessary to restrict fluid water intake. (Dr. Olaf).

While the cardiologist described in this scenario treats fluid restrictions as a matter of fact, fluid is such a matter of concern for this nephrologist that she overtly encourages her patients to disregard their cardiologist's fluid restriction advice.

The cardiologists in this study expressed as a matter of fact the need to mobilise fluid with standard drug therapies. Conversely, the nephrologists in the study treated the need to mobilise fluid with dialysis as a matter of fact. While both matters were self-evident in their own disciplines, this ANT analysis reveals how framing fluid restricted its active presence impacting complicated negotiations around the pathophysiology of each patient's HF, management decisions around adverse events and decision-making authority between specialties. Collaboration occurred alongside competing intraprofessional framings of fluid. While these framings were viewed as matters of fact meant to build a more cohesive understanding of an actant perceived by team members to be passive, descriptions often served to minimise, or disentangle, fluid's active role in team-based care.

3.3. Collaborative entanglement

Many of the descriptions of intraprofessional collaboration for fluid and its management were disentangled from dozens of other possible relations. For example, intraprofessional fluid management became increasingly complex as a patient's heart function and kidney function deteriorated. However, the role of fluid in palliative care and end-of-life issues were seldom discussed between cardiology and nephrology team members—although exceptions did occur, as in the case of Mr. Thompson (see Fig. 1). Further, none of the health care professionals discussed fluid and its relation to pharmaceutical manufacturing companies, or the different types of ACE inhibitors or brands of mechanical devices. Fluid's measurement and subsequent presence in the form of data storage and archiving was also not discussed, nor was the composition of patient health record systems for recording fluid metrics. Left out of most conversations were topics like transportation networks for clinical materials,

clinical scheduling arrangements and procedures, and arrangements for patients to pick up or have medication and equipment delivered. While these other relational networks were observed as entangled in relational networks of fluid and its mobilisation, participants disentangled fluid into more simplified constructs.

During data analysis, we began using the term *collaborative entanglement* to describe how daily operations of intraprofessional HF care were enmeshed in issues and practices that were far broader than just physiology and decision-making around how best to “tinker” with fluid. Collaborative entanglement was defined as the state of human and nonhuman actants coordinating healthcare in the context of multiple, overlapping framings. Collaboration across cardiology and nephrology teams is one site of collaborative entanglement. At first glance, it appears that healthcare professionals from cardiology and nephrology teams struggled to agree on fluid and its management. In fact, some of the activities appeared to be poor examples of intraprofessional collaboration. The nephrologist who told patients to ignore the fluid restriction advice from cardiologists: “[I] tell them to lie to the cardiologist about how much liquid they drink” (Dr. Olaf). Similarly, a cardiologist's statement that cardiovascular care trumps renal care at a certain point in fluid management would appear to be an intra-professional culture clash: “you've heard me say this before, the heart wins the battle, the kidney wins the war” (Dr. Sanders). And repeatedly, intraprofessional collaboration would appear to be rife with tensions over competing assessments of the best course of action for fluid management: “I must convince the nephrologist that this person needs to be dialysed for fluid management, not because of ‘kidney failure symptoms’... sometimes fluid management issues alone may dictate the need for dialysis” (Dr. Edwards). Such examples beg the question of how these cardiology teams and nephrology teams found ways to successfully collaborate in the face of clinical uncertainty, shifting authority, overlapping matters of fact/concern and asynchronous communication. In these examples, entanglement seemed to be causing collaboration problems, not offering resources or solutions.

On the contrary, the analysis displays the inherent problems in lines of reasoning that emphasize simplicity and clarity. Simplicity does not reflect the realities of daily intraprofessional practice. One strong example comes from theorizing how stabilised framings of fluid appeared to contradict intraprofessional practice. Across the dataset, healthcare professionals frequently discussed how using diuretics to treat persistent fluid overload eventually cause kidney injury—sometimes quite seriously. Intraprofessional collaboration for patients with advanced HF was intricately complicated by this seemingly simple matter of fact. Across the TSUs, intraprofessional collaboration between cardiology and nephrology teams exhibited competing framings on the impact of HF diuretic drugs on patients' kidneys. Taking a human-centred view on the actants described in these data, we might have labeled these activities *collaborative tensions*, *poor teamwork* or *cultures clashes*. But ANT, however, uses a different lens, one that aims as much as possible to include the relational constitution of human and nonhuman actants in intra-professional collaboration. The label *collaborative entanglement* fit with ANT thinking.

Specialty care teams particularly demonstrated collaborative entanglement when negotiating possible interactions between medical therapies. In this analysis, exploring negotiations

around diuretics and dialysis took us beyond intraprofessional collaboration on the TSUs. During observations and discussions with cardiology and nephrology team members we learned that the practice of using dialysis for HF has been debated since the 1960s (Lemmon et al., 1960). A recent clinical trial comparing dialysis techniques with diuretics—and other medications—for advanced HF concluded that medication management was more effective and safer (the CARRESS-HF trial, see Bart et al., 2012a). However, a flurry of critical letters to the publishing journal's editor led the CARRESS-HF authors to admit that there remains “uncertainty in clinical practice for patients with acute decompensated HF and kidney disease ...:

Ideal rate of fluid removal, supportive medical therapy, monitoring measures, and the conditions used to determine the best time for discontinuing acute decongestive therapies ... are *unknown* ... Data are lacking to answer these and many other questions that directly affect the outcomes of patients with volume overload and renal dysfunction (Bart et al., 2012b).

The debate continues on whether, where, when and how diuretics trump dialysis for patients with HF, or vice versa. And intraprofessional collaboration occurs alongside both fluctuations in individual each patient's fluid and shifting best practice guidelines.

When the next conclusive trial on fluid management is released, another debate will ensue on another clinical practice. The cardiology teams and nephrology teams conduct their work as it occurs over time, featuring intraprofessional debates between each other and broader scientific debates in their field. More than simply differences training and culture, these framings deeply involve multiple, overlapping relations between human and nonhuman actants. This is collaborative entanglement.

4. Discussion

It may be tempting to read the above scenarios as dysfunctional collaboration, and other research has treated the tensions they reveal as a threat to both quality patient care and appropriate trainee socialisation (Reeves et al., 2011; Reeves, 2012). This account is distinct from these conversations in that it considers intraprofessional collaboration as it occurs not only between people, groups and cultures, but also as entangled networks and disentangling/framing activities.

To provide equipment with which others can move forward, this discussion offers two insights for further consideration. First, that initiatives around intraprofessional collaboration should reframe the “common purpose” narrative to include the entanglement of human and nonhuman actants. And second, that the notion of collaborative entanglement is a theory for grappling with not only researching intraprofessionalism, but also teaching and learning authentic collaboration competencies.

4.1. Entangling the common purpose narrative

The results suggest that the object of intraprofessional collaboration is more granular, and less stable, than the idea of ‘the patient.’ The object of collaboration in HF care is often not

even, interestingly, the heart. Instead, the object of collaboration prominently features a relational network of actants involved in mobilising and being mobilised by fluid. It is with fluid and its attendant relations that team members are interacting and reacting in their work. And while fluid influences, and is influenced by, collaboration for patients with advanced HF, it is also disentangled and framed in diverse, sometimes contrasting ways.

Fluid as patients experience it, cardiovascular fluid management as cardiology teams approach it, and renal fluid management as nephrology teams conceptualise it are distinct framings. Sometimes the framings are commensurate, but sometimes they are in tension depending on descriptions, definitions and activities involving fluid. For a nephrology team, too little fluid may be the cause of a patient's complaints; while for a cardiologist the same patient's complaint may be from too much fluid. The same patient's fluid is framed with different mechanisms, definitions and, subsequently, clinical advice. Following the work of Mol, fluid is “multiple”: it varies depending on a cardiology or nephrology perspective and it features different, sometimes overlapping networks of equipment, diagnostics, imaging techniques, schedules, spaces and organ systems (Mol, 2002). In a sense, this account describes cardiology teams and nephrology teams that are, therefore, not only collaborating around a/the/our patient, but are also collaborating around the multiple framings of the same patient.

This critical insight calls into question the standard popular solution to collaborative tensions: the ‘common purpose’ narrative. Consider the following example from a study of HF intraprofessional collaboration between cardiology teams and palliative care (PC) teams:

Integrating PC into the model of HF care means a rethinking for both PC clinicians and HF practitioners alike. This type of culture change can be a slow process. The key to establishing a collaborative relationship is to identify a PC champion within the cardiology group at one's own institution ... Numerous excellent reviews have been published on the potential benefits of PC for patients with HF. (Gelfman et al., 2014, p. 757).

Illustrated here, the common purpose narrative, centres on people working together to achieve collective goals. In this case, the common purpose is “culture change”, and it can be achieved when local “champions” help to “ensure buy-in from HF clinicians” in order to benefit patients. Guidelines, research papers and reports using the common purpose narrative claim that intraprofessional collaboration succeeds only when healthcare providers act with the patient's best interests in mind in an environment of information sharing, role clarity and shared understanding.

Informed by ANT, this study calls the common purpose narrative into question by considering how physiological actants, like fluid, play a role in framing activities that occur in multiple, competing ways across disciplines. Despite shared narratives of a common purpose between cardiology teams and nephrology teams, fluid overload composed and was composed by many relations that complicated intraprofessional team collaboration. We observed asynchronous clinical interpretations of patients and their fluid, geographically distributed cardiology and nephrology team members, fragmented communication formats and modalities, and clinical uncertainty in the face of patient complexity. Overall,

contrasting framings continued to emerge despite effective information sharing, role clarity and shared conceptual definitions. In fact, toward our final point, collaboration in fluid management for HF appears, at its core, less a matter of sharing a common purpose and more a matter of embracing collaborative entanglement.

4.2. Teaching collaborative entanglement

Recent calls for medical education reform argue that current medical competency frameworks are too focused on teaching physicians to become experts in one-to-one patient encounters. Training focuses exclusively on skills such as taking histories, examining bodies, obtaining test results, diagnosing diseases and performing treatments and procedures. Care providers are individually expert but struggle to identify who is on the team and how to leverage other forms of expertise to improve patient care (Lucian Leape Institute, 2010). The reform arguments posit that medical education has failed to accept that, while necessary, individual expertise no longer sufficient in an era requiring “collaboratively effective systems physician[s]” (Lucey, 2013, p. 1640) who can successfully integrate distributed, intraprofessional “microsystems” (Donaldson and Mohr, 2001; Cooke et al., 2010). From this standpoint, successfully shifting medical education pedagogy toward collaborating on complex, intraprofessional systems will require focused emphasis on the entangled epistemologies of clinical practice and the multiple ontologies of human and nonhuman actants (Fenwick, 2014). This paper argues that teaching collaborative entanglement will be at the core of this shift.

Heterogeneous collaboration of humans and nonhumans across medical specialties has received little attention—exceptions include recent work on boundary objects in oncology rounds (Heldal, 2010) and liver transplantation teams (Lingard et al., 2012a, 2014). This inattention may perpetuate the assumption that physicians frame all patients' bodies the same way, and therefore that physicians' collaborative practices are unified and representative of a shared lens of ‘biomedicalisation’ (Clarke, 2010). The results suggest this position is enriched by considering the complexity, artistry, and uncertainty of medical practice. Collaborative entanglement is marked by team members' recognition that other disciplines frame materials differently, through multiple ontologies of actants like symptoms, technologies and patients. Despite the many ways entanglement disrupts stabilised knowledge about patients and symptoms, such recognition underpins the possibility of collaboration evident in our data.

Collaborative entanglement is a conceptual framework that is additive to, not dismissive of, the ongoing sociological understanding of intraprofessionalism: that collaboration is a cognitive process occurring between people working together to achieve the goal of patient care. One of the benefits of incorporating the notion of collaborative entanglement into medical training is that it begins to attune trainees to the complexities they will face in practice. How dialysis was framed in this account is a good example. While we know there is conflicting evidence for the efficacy of these treatments, especially when patients' kidney function is still reasonably good (Tang, 2012; Chung and Meyer, 2015), coming to a decision around dialysis requires cardiology teams to frame fluid the way nephrology teams do and nephrology teams to frame fluid the way cardiology teams do. However, fluid itself

demands this negotiation through its refusal to respond straightforwardly to either discipline's desire to have their framing take priority. In effect, while each discipline tries to view fluid as both passive (something they control) and singular (something their specialty understands in a distinct manner from other specialties), fluid forces collaborative entanglement.

5. Limitations

Our decision to focus on health care providers leaves room for an elaborated description of how intraprofessional collaboration impacts the lived experience of patients and caregivers. Although patients and caregivers were an important part of the overarching study, and the focus of separate analyses (Tait et al., 2015; LaDonna et al., 2016), we encourage more research to tackle collaborative care from a sociomaterial standpoint. Similarly, though the focus on the interface between cardiology care and nephrology care illustrated a number of key tensions, it also silenced the voices of other allied health professionals. As future work emerges using this lens, it will be important to further consider the notion of 'collaborative entanglement' in relation to other health professionals. For example, other research could address how nurses conceptualise and enact fluid or other materialities of care for patients with advanced HF.

6. Conclusion

Leveraging collaborative entanglement offers an opportunity for addressing future challenges facing practice and learning in intra-professional medical care. Our aim is not to essentialise fluid, but to highlight how in advanced HF care it stands as one of the many actants that play a significant role in intraprofessional collaboration. In this account, fluid shapes such collaboration. In other accounts, other networks will emerge. Rather than a prescription for the future, this account aims to inspire ideas for future investigations into understanding entanglement in health care and health professional education.

Acknowledgments

Foremost, the authors wish to thank the patients, family members, and health professionals across Canada who shared their insights with us. The authors received financial support for the research of this article from the g51:Canadian Institutes of Health Research (CIHR) and the Academic Medical Association of Southwestern Ontario (AMOSO).

References

- Abbott, AD. *The System of Professions: An Essay on the Division of Expert Labor*. University of Chicago Press; Chicago: 1988.
- Abbott, AD. *Chaos of Disciplines*. University of Chicago Press; Chicago: 2001.
- Barr, H., Koppel, I., Reeves, S., Hammick, M., Freeth, D. *Effective Interprofessional Education: Assumptions, Argument and Evidence*. Blackwell; 2005.
- Bart BA, Goldsmith SR, Lee KL, Givertz MM, O'Connor CM, et al. Ultrafiltration in decompensated heart failure with cardiorenal syndrome. *N Engl J Med*. Dec; 2012a 367(1533–4406):2296–2304. [PubMed: 23131078]
- Bart BA, Goldsmith SR, Lee KL, Redfield MM, Felker GM, et al. Cardiorenal rescue study in acute decompensated heart failure: rationale and design of CARRESS-HF. *J Card Fail*. Mar; 2012b 18(1532–8414):176–182. [PubMed: 22385937]

- Becker, HS. *Boys in White: Student Culture in Medical School*. University of Chicago Press; Chicago: 1961.
- Berg, M., Mol, A. *Differences in Medicine : Unraveling Practices, Techniques, and Bodies*. Duke University Press; Durham, N.C: 1998.
- Bleakley A. The proof is in the pudding: putting actor-network-theory to work in medical education. *Med Teach*. 2012; 34(6):462–467. [PubMed: 22489979]
- Boateng GO, Adams TL. “Drop dead I need your job”: an exploratory study of intra-professional conflict amongst nurses in two Ontario cities. *Soc Sci Med*. 2016; 155:35–42. [PubMed: 26986240]
- Callon, M. *The Laws of the Markets*. Blackwell Publishers/Sociological Review; Oxford: 1998.
- Callon M. Actor-network theory: the market test. *Sociol Rev*. 1999; 47(S1):181–195.
- Callon, M. *Technoscience: The Politics of Interventions*. Oslo Academic Press; Oslo: 2007a. Actor-network theory: the market test; p. 273–286.
- Callon M. An essay on the growing contribution of economic markets to the proliferation of the social. *Theory, Cult Soc*. 2007b; 24(7–8):139–163.
- Callon M, Law J. After the individual in society. *Can J Sociol*. 1997; 22(2):165–182.
- Callon M, Méadel C, Rabeharisoa V. The economy of qualities. *Econ Soc*. 2002; 31(2):194–217.
- Callon M, Muniesa F. Economic markets as calculative collective devices. *Organ Stud*. 2005; 26(8):1229.
- Charmaz, K. *Constructing Grounded Theory*. 2. Sage Publications; Thousand Oaks, CA: 2014.
- Chung ES, Meyer TE. Cardiorenal syndrome: misgivings about treatment options, clarity on prognosis. *J Card Fail*. 2015; 21(2):116–118. [PubMed: 25481432]
- Clark AM. What are the components of complex interventions in healthcare? theorizing approaches to parts, powers and the whole intervention. *Soc Sci Med*. 2013; 93:185–193. [PubMed: 22580076]
- Clark AM, Thompson DR. What heart failure programme works best? wrong question, wrong assumptions. *Eur J Heart Fail*. 2010; 12(12):1271–1273. [PubMed: 20870673]
- Clarke, A. *Biomedicalization: Technoscience, Health, and Illness in the US*. Duke University Press; Durham: 2010.
- Cooke, M., Irby, DM., O’Brien, BC. *Educating Physicians: a Call for Reform of Medical School and Residency*. John Wiley & Sons; 2010.
- Cristancho S. Fewer themes, more stories: shall we consider alternative ways for representing complexity well? *Perspect Med Educ*. 2014; 3(3):159–162. [PubMed: 24895105]
- Currie G, El Enany N, Lockett A. Intra-professional dynamics in translational health research: the perspective of social scientists. *Soc Sci Med*. 2014; 114:81–88. [PubMed: 24911511]
- Currie G, Finn R, Martin G. Accounting for the ‘dark side’ of new organizational forms: the case of healthcare professionals. *Hum Relat*. 2008; 61(4):539.
- De Laet M, Mol A. The Zimbabwe bush pump: mechanics of a fluid technology. *Soc Stud Sci*. 2000; 30(2):225–263.
- Donaldson, MS., Mohr, JJ. *Exploring Innovation and Quality Improvement in Health Care Micro-systems: A Cross-case Analysis*. National Academies Press; 2001.
- Fenwick T. Complexity science and professional learning for collaboration. *J Educ work*. 2012; 25(1):141–162.
- Fenwick T. Sociomateriality in medical practice and learning: attuning to what matters. *Med Educ*. 2014; 48(1):44–52. [PubMed: 24330116]
- Fenwick, T., Nerland, M. *Reconceptualising Professional Learning*. Routledge; London: 2014.
- Finn R, Learmonth M, Reedy P. Some unintended effects of teamwork in healthcare. *Soc Sci Med*. 2010; 70(8):1148–1154. [PubMed: 20137845]
- Freidson E. Client control and medical practice. *AJS*. 1960; 65(5):374.
- Freidson, E. *Profession of Medicine: A Study of the Sociology of Applied Knowledge*. Chicago: 1970.
- Green C. The making of the interprofessional arena in the United Kingdom: a social and political history. *J Interprof Care*. 2014; 28(2):116–122. [PubMed: 24354499]

- Gelfman LP, Kalman J, Goldstein NE. Engaging heart failure clinicians to increase palliative care referrals: overcoming barriers, improving techniques. *J Palliat Med.* 2014; 17:753–760. <http://dx.doi.org/10.1089/jpm.2013.0675>. [PubMed: 24901674]
- Haddara W, Lingard L. Are we all on the same page? a discourse analysis of interprofessional collaboration. *Acad Med.* 2013; 88(10):1509–1515. [PubMed: 23969354]
- Hall P. Interprofessional teamwork: professional cultures as barriers. *J Interprof Care.* 2005; 19(Suppl 1):188–196. [PubMed: 16096155]
- Health Canada. Unleashing Innovation: Excellent Healthcare for Canada. Health Canada; Ottawa: 2015.
- Heldal F. Multidisciplinary collaboration as a loosely coupled system. *J Interprof Care.* 2010; 24(1):19–30. [PubMed: 20001545]
- Herbert CP. Changing the culture: interprofessional education for collaborative patient-centred practice in Canada. *J Interprof Care.* 2005; 19(Suppl 1):1–4. [PubMed: 16096140]
- HFO. Implementing Interprofessional Care in Ontario. Government of Ontario; Toronto: 2010.
- Kendall SA, Carduff E, Worth A, Harris F, Lloyd A, et al. Use of multi-perspective qualitative interviews to understand patients' and carers' beliefs, experiences, and needs. *Br Med J.* 2009; 339:b4122. [PubMed: 19828645]
- Khalili H, Hall J, DeLuca S. Historical analysis of professionalism in western societies. *J Interprof Care.* 2014; 28(2):92–97. [PubMed: 24383410]
- Khalili H, Orchard C, Laschinger HK, Farah R. An interprofessional socialization framework for developing an interprofessional identity among health professions students. *J Interprof Care.* Nov; 2013 27(1469–9567):448–453. [PubMed: 23777592]
- Kohn, L., Corrigan, J., Donaldson, M. To Err Is Human: Building a Safer Health System. Institute of Medicine; Washington DC: 2000.
- LaDonna KA, Bates J, Tait GR, McDougall A, Schulz V, Lingard L. Who Is on Your Health-care Team? *Health Expect.* 2016:1–13. Epub ahead of print.
- Lahey, W. Interprofessionalism and collaborative self-regulation in the health professions. In: Short, SD., McDonald, F., editors. *Health Workforce Governance: Improved Access, Good Regulatory Practice, Safer Patients.* Ashgate Publishing; Surrey: 2012. p. 113-143.
- Latour, B. *Science in Action : How to Follow Scientists and Engineers through Society.* Harvard University Press; Cambridge, Mass: 1987.
- Latour B. A relativistic account of Einstein's relativity. *Soc Stud Sci.* 1988; 18(1):3–44.
- Latour, B. *We Have Never Been Modern.* Harvard University Press; Cambridge, Mass: 1993.
- Latour, B. *Aramis, or, The Love of Technology.* Harvard University Press; Cambridge, Mass: 1996.
- Latour B. Why has critique run out of steam? from matters of fact to matters of concern. *Crit Inq.* 2004; 30(2):225–248.
- Latour, B. *Reassembling the Social : An Introduction to Actor-network Theory.* Oxford University Press; Oxford ; New York: 2005.
- Latour, B. *An Inquiry into Modes of Existence : An Anthropology of the Moderns.* Harvard University Press; 2013.
- Latour, B., Woolgar, S. *Laboratory Life : The Social Construction of Scientific Facts.* Sage; Thousand Oaks: 1979.
- Law, J. Technology and heterogeneous engineering: the case of Portuguese expansion. In: Bijker, WE., Hughes, TP., Pinch, T., editors. *The Social Construction of Technology.* The MIT Press; Cambridge, MA: 1987. p. 111-134.
- Law, J. *After Method : Mess in Social Science Research.* Routledge; New York: 2004.
- Law J, Mol A. Embodied action, enacted bodies: the example of hypo-glycaemia. *Body Soc.* 2004; 10(2–3):43–62.
- Law J, Mol A. Veterinary realities: what is foot and mouth disease? *Sociol Rural.* 2011; 51(1):1–16.
- Law J, Singleton V. Object lessons. *Organization.* 2005; 12(3):331–355.
- Law J, Singleton V. Ant and politics: working in and on the world. *Qual Sociol.* 2013; 36(4):485–502.

- Learmonth M. Making health services management research critical. *Sociol Health Illn.* 2003; 25(1): 93–119. [PubMed: 14498946]
- Lemmon WM, Hironse T, O'Connor RA, Bailey CP. Congestive heart failure—relief by renal dialysis. *JAMA.* 1960; 174(17):2124–2128. [PubMed: 13760752]
- Lingard L, McDougall A, Levstik M, Chandok N, Spafford MM, Schryer C. Representing complexity well: a story about teamwork, with implications for how we teach collaboration. *Med Educ.* 2012a; 46(9):869–877. [PubMed: 22891907]
- Lingard L, McDougall A, Levstik M, Chandok N, Spafford MM, Schryer C. Using loose coupling theory to understand interprofessional collaborative practice on a transplantation team. *JRIPE.* 2014; 3(3):1–17.
- Lingard L, Vanstone M, Durrant M, Fleming-Carroll B, Lowe M, et al. Conflicting messages: examining the dynamics of leadership on interprofessional teams. *Acad Med.* 2012b; 87(12): 1762–1767. [PubMed: 23095927]
- Lingard LA, McDougall A, Schulz V, Shadd J, Marshall D, Strachan PH, Tait GR, Arnold JM, Kimel G. Understanding palliative care on the heart failure care team: an innovative research methodology. *J Pain Symptom Manage.* 2013; 45(5):901–911. [PubMed: 23017607]
- Lucey CR. Medical education: part of the problem and part of the solution. *JAMA Intern Med.* 2013; 173(17):1639–1643. [PubMed: 23857567]
- Lucian Leape Institute. Report of the Lucian Leape Institute Roundtable on Reforming Medical Education. National Patient Safety Foundation; Boston: 2010. Unmet Needs: Teaching Physicians to Provide Safe Patient Care.
- MacLeod A, Kits O, Whelan E, Fournier C, Wilson K, et al. Socio-materiality: a theoretical framework for studying distributed medical education. *Acad Med.* 2015; 90(11):1451–1456. [PubMed: 25830536]
- Manias E. The concept of teamwork does not fully explain how interprofessional work occurs in intensive care. *Aust Crit Care.* 2015; 28(4):235–237. [PubMed: 26239212]
- Martin GP, Currie G, Finn R. Reconfiguring or reproducing intra-professional boundaries? specialist expertise, generalist knowledge and the 'modernization' of the medical workforce. *Soc Sci Med.* 2009; 68(7):1191–1198. [PubMed: 19201073]
- McIntosh N, Meterko M, Burgess JFJ, Restuccia JD, Kartha A, Kaboli P, Charns M. Organizational predictors of coordination in inpatient medicine. *Health Care Manage Rev.* 2014; 39(4):279–292. [PubMed: 24378402]
- Mol, A. Pathology and the clinic: an ethnographic presentation of two atheroscleroses. In: Lock, MM, Young, A., Cambrosio, A., editors. *Living and Working with the New Medical Technologies: Intersections of Inquiry.* Cambridge University Press; Cambridge, UK: 2000. p. 82–102.
- Mol, A. *The Body Multiple : Ontology in Medical Practice.* Duke University Press; Durham: 2002.
- Mol, A. *The Logic of Care : Health and the Problem of Patient Choice.* Routledge; London ; New York: 2008.
- Mol A. The art of medicine: living with diabetes: care beyond choice and control. *Lancet.* 2009; 373(9677):1756–1757. [PubMed: 19480076]
- Mol, A. Kolner Z Fur Soziol Sozialpsychologie. 2010. Actor-network theory: sensitive terms and enduring tensions; p. 253
- Mol A, Berg M. Principles and practices of medicine. The co-existence of various anemias. *Cult Med Psychiatry.* 1994; 18(2):247–265. [PubMed: 7924402]
- Mol A, Law J. Regions, networks and fluids: anaemia and social topology. *Soc Stud Sci.* 1994; 24(4): 641–671. [PubMed: 11639423]
- Murray SA, Kendall M, Carduff E, Worth A, Harris FM, et al. Use of serial qualitative interviews to understand patients' evolving experiences and needs. *BMJ.* 2009;339.
- NHS. *Five Year Forward View.* NHS England; London, UK: 2014.
- Paradis E, Whitehead CR. Louder than words: power and conflict in interprofessional education articles, 1954–2013. *Med Educ.* Apr; 2015 49(1365–2923):399–407. [PubMed: 25800300]
- Pinnock H, Kendall M, Murray SA, Worth A, Levack P, et al. Living and dying with severe chronic obstructive pulmonary disease. *BMJ.* 2011; 342:d142. [PubMed: 21262897]

- Powell AE, Davies HTO. The struggle to improve patient care in the face of professional boundaries. *Soc Sci Med*. 2012; 75(5):807–814. [PubMed: 22633159]
- Reeves S. The rise and rise of interprofessional competence. *J Interprof Care*. 2012; 26(4):253–255. [PubMed: 22676141]
- Reeves S, Goldman J, Gilbert J, Tepper J, Silver I, Suter E, Zwarenstein M. A scoping review to improve conceptual clarity of interprofessional interventions. *J Interprof Care*. 2011; 25(3):167–174. [PubMed: 21182439]
- Reeves S, Macmillan K, Van Soeren M. Leadership of interprofessional health and social care teams: a socio-historical analysis. *J Nurs Manag*. 2010; 18(3):258–264. [PubMed: 20546465]
- Rodriguez J. Who is on the medical team?: shifting the boundaries of belonging on the ICU. *Soc Sci Med*. 2015; 144:112–118. [PubMed: 26409169]
- Sanders T, Harrison S. Professional legitimacy claims in the multidisciplinary workplace: the case of heart failure care. *Sociol Health Illn*. 2008; 30(2):289–308. [PubMed: 18290937]
- Selman LE, Beattie JM, Murtagh FE, Higginson IJ. Palliative care: based on neither diagnosis nor prognosis, but patient and family need. Commentary on Chattoo and Atkin. *Soc Sci Med*. 2009; 69(2):154–159. [PubMed: 19525049]
- Service, N.H. *Working Together, Learning Together: A Framework for Lifelong Learning for the NHS*. NHS; London: 2001.
- Smith, J. *The Shipman Inquiry*. UK Public Inquiry; London, UK: 2002.
- Steward, E. *Quantum Mechanics: Its Early Development and the Road to Entanglement*. Imperial College Press; London: 2008.
- Tait GR, Bates J, LaDonna KA, Schulz VN, Strachan PH, McDougall A, Lingard L. Adaptive practices in heart failure care teams. *J Multidiscip Healthc*. 2015; 8:365. [PubMed: 26316775]
- Tang WH. Reconsidering ultrafiltration in the acute cardiorenal syndrome. *N Engl J Med*. 2012; 367(24):2351–2352. [PubMed: 23131079]
- Timmermans, S. *Postmortem: How Medical Examiners Explain Suspicious Deaths*. University of Chicago Press; Chicago: 2006.
- Timmermans, S., Buchbinder, M. *Saving Babies?: The Consequences of Newborn Genetic Screening*. University of Chicago Press; Chicago: 2012.
- Weisz, G. *Divide and Conquer: a Comparative History of Medical Specialization*. Oxford University Press; Oxford; New York: 2006.
- WHO. *Framework for Action on Interprofessional Education & Collaborative Practice*. World Health Organization; Geneva: 2010.
- Zwarenstein M, Reeves S. Knowledge translation and interprofessional collaboration. *J Contin Educ Health Prof*. 2006; 26(1):46–54. [PubMed: 16557506]

TSUs for primary analysis These 4/50 TSUs met the specific criteria: 1 patient, ≥ 1 lay caregiver, ≥ 1 cardiology healthcare provider, ≥ 1 nephrology healthcare provider	Notable human actants	Notable nonhuman actants
Mr. Charlebois is a 60-70 year old man whose nurse daughter, Cate, provides home support. Cate motivated her father to see specialists when his tendency to ignore his HF symptoms nearly cost his life. Her father, an alcoholic, quit drinking around that time. He has advanced HF managed partly by peritoneal dialysis. He is connected to a home-based dialysis machine for 8 hours every evening. He makes daily phone calls to the dialysis nurses at a local hospital.	Mr. Charlebois Cate Dr. Edwards (C) Dr. Chavez (N)	Fluid Daily calls with nurse Dialysis Supportive family Alcoholism recovery
Mr. Singh is a 70-80 year old man with advanced HF and diabetes. He is on home-based peritoneal dialysis and has highly depleted activity levels. His poor health has led to an inability to drive, which limits his ability to visit his grandchildren. His HF nurse practitioner, Jasmine, describes communication gaps between the cardiology and nephrology teams. She finds that the "kidney clinic" doesn't get back to her when she has questions.	Mr. Singh Nermala Dr. Ohari (C) Jasmine (NP) Dr. Kahn (N)	Fluid Visits with grandkids Dialysis Supportive family Driving
Mr. Thompson is a 60-70 year old man who was recently admitted to palliative care. He has advanced HF and his kidneys are failing. His nephrologist Dr. Timmerson characterizes him as dependent on peritoneal dialysis for symptom management and survival. Tanya, a HF nurse practitioner was disturbed when Mr. Thompson was barred from admitting to hospice with his peritoneal dialysis device because it was considered "life extending therapy".	Mr. Thompson Mrs. Thompson Dr. Sanders (C) Tanya (NP) Dr. Timmins (N)	Fluid Hospice Dialysis Supportive family Hospital visits
Mr. Ivanson is a 70-80 year old man with advanced HF who lives with his wife. His children, Ian and Irene, live nearby. Mr. Ivanson was receiving daily nursing visits to inject IV diuretics as a palliative therapy. According to his palliative care specialist, Dr. Toren, Mr. Ivanson has "outlived" the funding made available for nursing visits. As a result, Ian and Irene have organized their work schedules to administer the injections.	Mr. Ivanson Ian and Irene Dr. Ohari (C) Dr. Toren (PC) Dr. Olaf (N)	Fluid IV diuretics Dialysis Supportive family Home-based nursing

Fig. 1.
Four TSUs featuring interviews with a cardiologist & a nephrologist.

Table 1

TSU cumulative & average size per research site.

Research site	TSUs	Average TSU size
Halifax, NS	20	6
Kitchener, ON	10	4
London, ON	8	4
Vancouver, BC	12	5
Total	50	5

Table 2

Recruitment from HF TSUs featuring nephrology.

Team members	Mentioned by patient	Interviewed
Patients with advanced HF	13	13
Caregiver/supportive person	27	9
Family physician	13	4
Nurses	14	4
Nurse Practitioners	9	4
Specialist physicians	41	13
<i>Cardiologist</i>	<i>24</i>	<i>6</i>
<i>Palliative care</i>	<i>3</i>	<i>1</i>
<i>Nephrologist</i>	<i>14</i>	<i>6</i>
Other	12	NA
Total	129	47