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ORIGINAL ARTICLE

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Networks of hospital discharge planning teams and readmissions

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ABSTRACT

Improving the hospital discharge process to prevent readmission requires a focus on the coordination and communication between interprofessional team members in and outside of the hospital as well as with patients and their caregivers. Yet little is known about how these actors currently communicate and coordinate during the discharge process. Network analysis allows for a direct look at this communication and coordination. This network analysis study utilized retrospective chart review to identify the individuals involved in the discharge planning and their communication with each other for 205 patients. Using this abstracted data, a network was created for each patient wherein a node was any individual involved in the patient's discharge planning process and a tie was any communication documented in the chart related to discharge planning between individuals. Graphical and structural network analyses were used to compare the networks of readmitted patients and non-readmitted patients. Networks of patients not readmitted were more hierarchical, unidirectional, streamlined compared to those readmitted. These findings demonstrate the feasibility and usefulness of conceptualizing discharge planning as a network. Future efforts to understand discharge planning and create interventions to improve the process may benefit by considering network patterns of communication.

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Introduction

Hospital readmission is a key quality metric tied to Medicare penalties, higher costs, and increased medical complications for patients (Emerson et al., 2012; Hines, Barrett, Jiang, & Steiner, 2006; McIlvennan, Eapen, & Allen, 2015; Robert Wood Johnson Foundation, 2012; Scott, Shohag, & Ahmed, 2014). Nearly one in five Medicare patients is readmitted to the hospital within 30 days of discharge (Jencks, Williams, & Coleman, 2009) and among older adult patients, those with dementia are 20% more likely to be readmitted after hospitalization than those without dementia (Phelan, Borson, Grothaus, Balch, & Larson, 2012).

Poor communication at the time of hospital discharge within the interprofessional team of providers in the hospital and outside of the hospital and between the team and patients and their caregivers has been linked to readmission (Auerbach et al., 2016). Both providers and patients/caregivers consider good communication as indicative of a high quality hospital discharge (Bull, Hansen, & Gross, 2000; Kripalani et al., 2007). As a result, interventions to improve hospital discharge often encourage interprofessional teamwork and include a component focused on communication (Burke, Kripalani, Vasilevskis, & Schnipper, 2013; Coleman & Berenson, 2004; Kripalani, Theobald, Anctil, & Vasilevskis, 2014; Shepperd et al., 2013).

However, there is currently a poor understanding of how interprofessional discharge planning teams communicate and what effect this has on discharge quality and outcomes. Discharge planning teams often involve health care professionals (HCPs) in the hospital (e.g., physicians, nurses, social workers) and outside the hospital (e.g., primary care physicians, home health care, skilled nursing, assisted living, and rehabilitation facility staff, pharmacists), as well as patients and their caregivers. Specifically, for patients with dementia these teams often include providers at the patients' discharge facilities including skilled nursing, assisted living, rehabilitation, and other short- or long-term healthcare facilities because dementia patients are more likely to be discharged to these locations than back home, even when controlling for where they were admitted from (Lin, Scanlan, Liao, & Nguyen, 2015). Examining the relationships among these actors, including how they communicate with each other, is critical. For example, it is not sufficient to simply know that a social worker and a registered nurse were involved in discharge planning for a patient. It is valuable to know how they worked together, and with the patient, to understand the impact on the patient's outcomes after discharge. A deeper understanding of the dynamic relational patterns of these actors during the discharge process could guide future intervention development and quality improvement efforts.

Network analysis, in which the structure of relationships, characteristics of the actors in relation to each other, and subgroups are examined, is a method through which unique insights can be gained to achieve this deeper understanding (Luke, 2015; Scott, 2017). This method has been used to study

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the communication networks within primary care practices and emergency departments as well as the emergency department-to-inpatient and nursing day-to-night shift handoff processes (Benham-Hutchins & Effken, 2010; Effken, Gephart, Brewer, & Carley, 2013; Patterson et al., 2013; Scott et al., 2005).

However, to our knowledge, this method has not been applied to communication among the interprofessional actors involved in hospital discharge planning. Therefore, the objectives of our study were to describe the communication networks of discharge planning teams for a cohort of older adults, and to examine the association of network characteristics with 30-day readmission.

Methods

Methodology/research design

This was an observational retrospective study in which the medical charts of patients at an urban teaching hospital were reviewed. The network analysis was part of a larger case-control study on the transitional care delivered to patients with dementia, therefore the sample for this study included older adults with and without dementia.

The sample consisted of hospitalized adults ≥ 70 years old, discharged alive between 1st January 2015 and 31st December 2015. Four strata of patients were of interest for the larger study: surgical patients with dementia, non-surgical patients with dementia, surgical patients without dementia, and non-surgical patients without dementia. A hospital administrative database was queried to identify eligible patients within the strata and then a random sample of charts was reviewed within each stratum. Patients with dementia (identified by ICD-9 diagnosis) were over-sampled to achieve the aims of the larger study. Charts were reviewed until topical saturation was reached (i.e., no new patterns or themes of transitional care were revealed). Brief, semi-structured interviews were conducted with hospital providers after analysis to assess the face validity of the results of the chart review. Whether or not the patient was subsequently readmitted was not a criterion in sampling charts. A more detailed description of the larger study's methodology can be found elsewhere (Prusaczyk, Fabbre, Carpenter, & Proctor, 2018).

Data collection

Readmission was defined as readmission to the index hospital within 30 days of index discharge. Discharge planning was defined as "planning ahead for hospital discharge while the patient is still being treated in the hospital and includes collaborating with the outpatient provider and taking the patient and caregiver's preferences for appointment scheduling into account," (Burke et al., 2013).

For the purposes of our study, we categorized all non-home disposition locations as "facility". These non-home locations included a skilled nursing facility, rehabilitation facility, assisted living facility, or any other short- or long-term facility.

The data were represented as a directed network consisting of nodes and ties. A node was any individual involved in the discharge planning process for a patient. A tie was any communication or coordination documented in the chart between two individuals related to the discharge planning. A sending node was the person who initiated the activity and the receiving node was the recipient of the communication. For example, if the case manager called the social worker to discuss a patient's discharge, the case manager was the sending node, the social worker was the receiving node, and the call was the tie.

Once a connection between two nodes was established, repeat connections in the same direction between those two nodes were not recorded. This was because we were interested in which individuals were working together and not the frequency or intensity of those interactions. However, data reporting a connection in the opposite direction between those two nodes were recorded. In our previous example, the case manager called the social worker, creating a directional tie from the case manager to the social worker. If the case manager contacted the social worker again related to discharge planning, this was not recorded. However, if the social worker called the case manager to discuss discharge planning, a new directional tie was recorded, this time with the social worker as the sending node and the case manager as the receiving node.

We included health care professionals (HCPs) as well as patients and family members in the network. It was necessary to combine patients and family members as a single actor because it was not possible to determine for every case if the HCPs were interacting with the patient and/or their caregiver.

This method resulted in a network for each patient that included the distinct actors involved in that patient's discharge planning and the connections between those actors.

Data analysis

These networks were analyzed visually through graphic representation and statistically through network typology analysis, including dyad and triad analyses. Graphical representation included determining the width, or strength, of the tie by the number of patients out of the 205 for whom this tie was present in their individual patient network. In other words, the thicker the tie, the more common that interaction between actors was across the 205 patient networks. Analysis of the networks' size, density, diameter, and Index of Qualitative Variation (IQV) was conducted. Density is a ratio of the number of ties in the network to the number of all possible ties, providing a metric of interconnectedness. Diameter is a measure of the shortest distance between the two most distant nodes in a network. The IQV is the difference in the types of actors involved in the discharge planning between readmitted and non-readmitted patients. Dyad analysis included an analysis of asymmetric dyads – when the tie between two nodes is unidirectional as opposed to bidirectional. The proportion of asymmetric dyads to total dyads for each network was calculated to control for each patient's network size (Wasserman & Faust, 1994).

Triad census analysis, which looks at all of the 16 different combinations of ties between any three given nodes, starting with no ties between any of the nodes (A, B, C) through ties between every possible node (A↔B↔C, A↔C), was conducted (Wasserman & Faust, 1994). Examples of triad patterns included in this analysis are the in-star (A→B←C), out-star (A←B→C), and directed line (A→B→C).

The Chi-Square tests, Student's t-Test, and Wilcoxon Rank Sum tests were used according to the distribution of the data. Logistic regression analyses were used to examine findings significant at the bivariate level. All analyses were conducted with R Version 3.4.0 using the igraph package. Visualizations were done with Gephi Version 0.9.1 and OmniGraffle Version 7.4.2.

Ethical considerations

This study was approved by the Institutional Review Board at Washington University in St. Louis.

Results

The discharge planning networks were constructed and reviewed for 205 patients (Table 1), including 39 (19.0%) patients readmitted within 30 days and 166 (81.0%) who were not readmitted within 30 days. Owing to the nature of the parent study, 59.5% (n = 122) of patients had dementia. There were no significant differences between readmitted patients and non-readmitted patients on age, number of hospital admissions or emergency department visits in the past 12 months, sex, race, marital status, living arrangement prior to hospitalization, presence of a dementia diagnosis, mobility status, receiving surgery during hospitalization, disposition, or discharging to a higher level of care than pre-admission. The only significant difference between readmitted patients and non-readmitted patients was average length of stay (7 days vs. 5 days, respectively, $p = 0.03$).

There were 14 unique actor roles (nodes) involved in the discharge planning of the 205 patients. Figure 1 graphically represents a summary of their communication across the full sample. Not all nodes were involved in the discharge planning for every patient. The median number of actors involved in patients' discharge planning networks was three with a range of 1–6.

Case managers and social workers were involved in a majority of patients' discharge planning (93% [n = 191] and 66% [n = 135], respectively) and were highly engaged with other actors, as indicated in Figure 1 by the numerous ties between them and other nodes as well as the width of many of these ties. Social workers were engaged in more bidirectional communication than any other type of actor, with social workers initiating and receiving communication with case managers, physical therapists, occupational therapists, registered nurses, nurse practitioners, and physicians. Only two nodes – primary care physicians, and ambulance providers – did not initiate any documented interaction related to the discharge planning process for any patient and were only engaged in the discharge planning process when others initiated communication with them.

There was no difference in the overall network structure of patients who were subsequently readmitted or not. The average number of nodes for readmitted patients was 2.69 (SD = 1.00) and 2.51 (SD = 1.09) for non-readmitted patients ($p = 0.44$). Average density did not differ between the networks of readmitted versus non-readmitted patients (0.29 [SD = 0.14] vs. 0.26[SD = 0.15], $p = 0.16$). There was also no difference between the average network diameter of the readmitted and non-readmitted patients (0.97[SD = 0.54] vs. 0.88[SD = 0.68], $p = 0.40$). The average IQV did not differ between readmitted and non-readmitted patients (0.60 [SD = 0.27] vs. 0.54[SD = 0.31], $p = 0.70$).

Table 1. Differences in demographic and clinical characteristics between patients readmitted and those not readmitted within 30 days (N = 205).

Variable	Readmitted (N = 39) M (SD) Range	Not Readmitted (N = 166) M (SD) Range	p-value
Age (in years)[a]	82 (6.67) 70–93	82 (6.792) 70–101	1.00
Length of stay (in days)[a]	7 (5.14) 2–27	5 (4.93) 1–33	0.03
# of past admissions in 12m[b]	0.8 (1.19) 0–5	0.6 (1.02) 0–5	0.61
# of past ED visits in 12m[b]	0.6 (1.21) 0–5	0.6 (1.25) 0–10	0.63
	n (%)	**n (%)**	
Male[c]	17 (43.6)	75 (45.2)	0.85
Black (vs. White)[c]	18 (46.2)	60 (36.1)	0.25
Married (vs. Not Married)[c]	17 (43.6)	74 (44.6)	0.91
Living arrangement before hospitalization[c]			0.52
Alone	8 (20.5)	28 (16.9)	
With a caregiver (spouse, child, other family member, friend)	26 (66.7)	104 (62.7)	
In a facility	5 (12.8)	34 (20.5)	
Dementia[c]	21 (53.8)	101 (60.8)	0.42
Mobility Status[c]			0.14
Unassisted	9 (23.1)	46 (27.7)	
Cane/Walker	26 (66.7)	79 (47.6)	
Wheelchair	2 (5.1)	24 (14.5)	
Unknown	2 (5.1)	17 (10.2)	
Admitted for surgery[c]	14 (35.9)	54 (32.5)	0.69
Disposition[c]			0.85
Home Alone	1 (2.6)	9 (5.4)	
Home with Home Health	10 (25.6)	32 (19.3)	
With a caregiver	9 (23.1)	48 (28.9)	
Rehab Facility	4 (10.3)	12 (7.2)	
Skilled Nursing Facility	14 (35.9)	62 (37.3)	
Short Term Hospital	1 (2.6)	3 (1.8)	
Discharged to higher level of care than pre-admission[c]	24 (61.5)	79 (47.6)	0.12

[a] Two-sample t-test; [b] Wilcoxen Rank Sum test; [c] Chi-square test

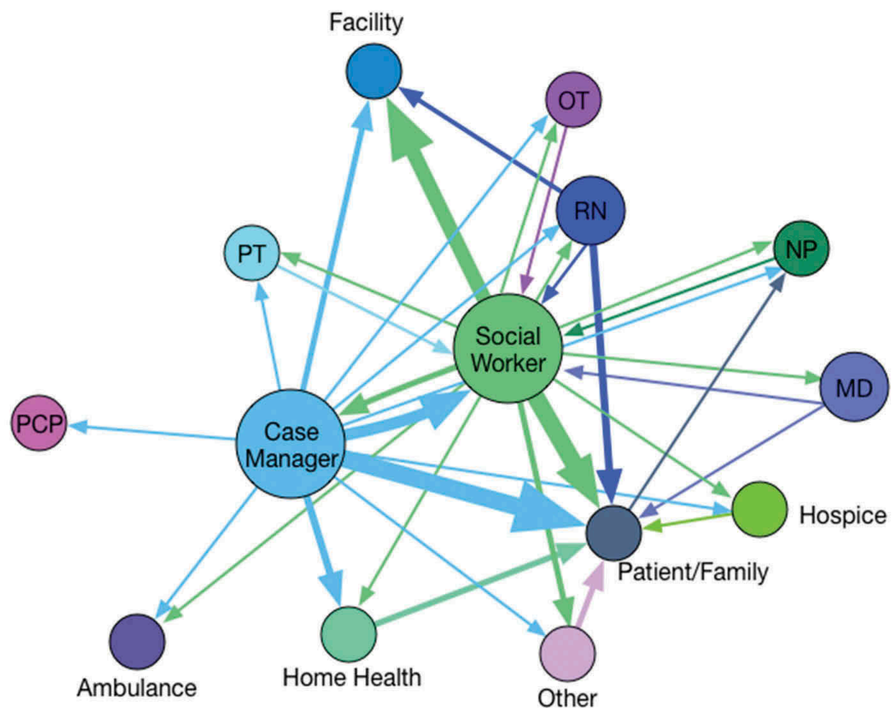

Figure 1. The summary discharge planning network for older adults discharged from the hospital.

For the dyad and triad analyses, there were significant network differences between patients who were subsequently readmitted or not (Figure 2). The dyad analysis revealed that the proportion of asymmetric dyads to total dyads was lower in the readmitted versus non-readmitted patient networks (mean of 0.72[SD = 0.22] vs. 0.65[SD = 0.20], p = 0.04) (Table 2). This indicates less unidirectional or streamlined communication was present in the readmitted patient networks. The triad census analysis examines 16 different combinations of ties between any three given nodes (a triad). This analysis found there was no difference between the readmitted patient networks and non-readmitted patient networks except for the "out-star" triad combination (A←B→C). Out-star triads were significantly less common in the networks of readmitted patient networks compared to the non-readmitted patient networks (mean of 0.82[SD = 1.0] vs. 1.20[SD = 1.85], p = 0.04).

Two logistic regression analyses were conducted modeling readmission and asymmetric dyads and out-star triads controlling for length of stay and race (both of which were significant or approaching significance with readmission at the bivariate level). Due to the skewness of the out-star triad and asymmetric dyads distributions, the square root of these terms were entered into the models. Results showed there was a significant, negative relationship between the number of out-star triads in a network and subsequent readmission (b = −0.73, p = 0.02). A separate model was analyzed and the proportion of asymmetric dyads was also significantly associated with readmission status but the direction of the relationship changed (b = 4.42, p = 0.03). Given the small number of readmitted patients, we do not believe these models to be robust and therefore do not interpret their results. However, we present these models as evidence that the bivariate results warrant further modeling with a larger sample and more covariates.

Discussion

In this network analysis, 14 unique types of actors were involved in the discharge planning process. Social workers and case managers were the most common providers involved in discharge planning. Social workers communicated with others more than any other actor, and case managers were the only documented link to primary care physicians.

A key finding is that the out-star triad pattern (A←B→C), which suggests efficient, streamlined communication among actors, was less common in the networks of readmitted patients. In the out-star triad, one actor initiates the communication and the other actors do not initiate with the sender or each other. At first, this pattern may seem undesirable because one might hope that all actors involved in discharge planning were reaching out and initiating communication with each other. However, this pattern could also represent an efficient and hierarchical pattern, where one actor (B) acts as the hub of the discharge planning process and coordinates information between all the other actors. The lack of communication initiation from both actors (A and C) could indicate that there is no need for actors to re-engage once the interaction has already taken place because the first interaction was sufficient and effective. If both actors are initiating communication, this could be because the initial communication was not effective or adequate because an issue required back-and-forth problem solving.

We recognize, however, that alternatively this pattern may reflect the presence of more straightforward issues among a group of patients that were less medically and socially

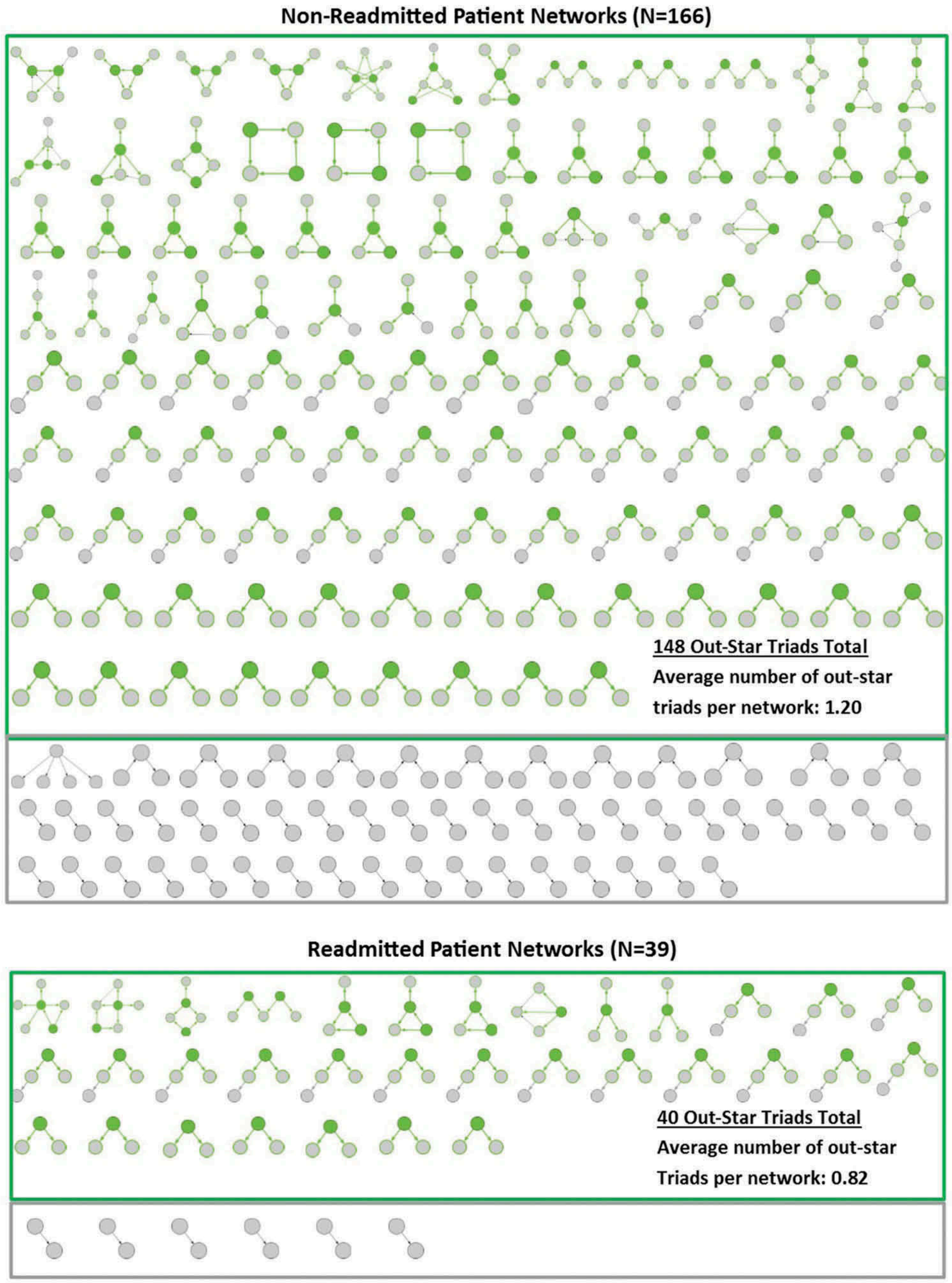

Figure 2. The individual discharge planning networks for 205 older adult hospital patients.

complex and therefore could be addressed by a single communication.

The concept of too much communication being associated with negative outcomes is supported by the literature. Research from the fields of business and engineering have suggested that there is a curvilinear relationship between team performance and communication frequency, where increased communication within a team working on a complex task leads to information overload and decreased productivity (Goris, Vaught, & Pettit, 2000; Patrashkova-Volzdoska, McComb, Green, & Compton, 2003). The idea of a communication "threshold" is also found in the network literature, where too much communication in a network decreases the network's efficiency (Choi & Lee, 2014; Chwe, 2000). To our knowledge, however, this concept has not been studied or shown in interprofessional healthcare teams. Therefore, because the out-star triad patterns were more common in the networks of non-readmitted patients, we posit that this pattern is actually desirable and indicates efficient and effective discharge planning.

This finding has important implications for future work on interprofessional discharge planning teams and readmissions. Many existing transitional care interventions emphasize communication and coordination between providers (Burke et al., 2013; Hansen, Young, Hinami, Leung, & Williams, 2011; Hesselink et al., 2012; Kripalani, Jackson, Schnipper, & Coleman, 2007; Kripalani et al., 2007). We recommend, however, that future evaluations of these interventions and of discharge planning in general measure communication as a network construct as opposed to dichotomous (presence/absence of communication). Furthermore, we recommend

Table 2. Differences in readmitted patients' discharge planning networks compared to patients not readmitted.

Variable	Readmitted Networks (N = 39) Mean(SD) [10th, 25th, 50th, 75th, 90th percentile]	Not Readmitted Networks (N = 166) Mean(SD) [10th, 25th, 50th, 75th, 90th percentile]	p-value
Structure and Composition			
Size	2.69 (1.0) [1, 2, 3, 3, 4]	2.51 (1.09) [1, 2, 3, 3, 4]	0.44
Density	0.29 (0.14) [0.17, 0.17, 0.25, 0.33, 0.50]	0.26 (0.15) [0.16, 0.17, 0.23, 0.33, 0.50]	0.16
Diameter	0.97 (0.54) [0, 1, 1, 1, 2]	0.88 (0.68) [0, 0, 1, 1, 2]	0.40
Index of Qualitative Variation	0.60 (0.27) [0.0, 0.55, 0.73, 0.73, 0.82]	0.54 (0.31) [0.0, 0.55, 0.73, 0.73, 0.82]	0.70
Dyad and Triad Analysis			
Proportion of Asymmetric Dyads	0.72 (0.22) [0.5, 0.5, 0.67, 1.0, 1.0]	0.65 (0.20) [0.5, 0.5, 0.67, 0.67, 1.0]	0.04
Types of Triads			
A, B, C (no connections)	0.15 (0.37) [0, 0, 0, 0, 1]	0.39 (1.24) [0, 0, 0, 0, 1]	0.75
A→B, C	0.87 (1.40) [0, 0, 0, 2, 2]	1.32 (1.80) [0, 0, 1, 2, 3]	0.12
A←B→C (out-star triads)	0.82 (1.0) [0, 0, 1, 1, 3]	1.20 (1.85) [0, 1, 1, 1, 2]	0.04
A→B←C	0.33 (0.48) [0, 0, 0, 1, 1]	0.59 (0.81) [0, 0, 0, 1, 1]	0.07

There were not enough data on the other triad types to conduct analyses between the groups.

future researchers investigate the possible curvilinear relationship between communication and healthcare interprofessional team performance, as our results have suggested.

Lastly, related to network structure, it is interesting to note that the primary care physician (PCP) appeared relatively disconnected from the network, at least as reflected through documentation of communication related to discharge planning. Hospital case managers were the only providers to have any interaction with the PCP office and the case managers initiated that interaction. Poor communication between hospital providers and PCPs is well documented (Kripalani et al., 2007; Meara, Wood, Wilson, & Hart, 1992) and the most common means of communication between hospital providers and the PCP is the transfer of the patient's discharge summary (Kripalani et al., 2007, 2007). This is consistent with our results. This limited role of the PCP is particularly concerning because evidence shows that poor communication between hospital providers and PCPs is associated with worse patient outcomes and higher readmissions (Hesselink et al., 2012; Kripalani et al., 2007). Future studies and efforts to improve the discharge planning process should look for better ways to engage with PCPs and perhaps begin to leverage the existing connection between PCPs and case managers.

There are limitations to this study. First, we used chart review methodology which has known validity and reliability limitations (Allison et al., 2000; Gearing, Mian, Barber, & Ickowicz, 2006; Hellings, 2004; Krikorian, 1979; Worster & Haines, 2004). Our results only represent communication documented in the chart. We did not collect information on the content of the documented communication or the intensity/frequency of the documented communication, which would have added to the analysis and discussion. We were also unable to identify the role or credentials of the individuals communicating or interacting with hospital providers on behalf of the outside organizations. For example, when the hospital social worker contacted the skilled nursing facility to negotiate discharge plans there was no information in the medical chart about the specific individual at the skilled nursing facility with whom the social worker was speaking. Additionally, there may be other communication that was done in person or informally that was not captured in the chart. However, in the post-analysis qualitative interviews done as part of the larger study, providers validated that the chart review data accurately represented what was done in routine practice. On this basis, we feel our networks are reflective of communication patterns in the discharge planning process. Second, there are limitations to the information we had available on the hospital readmissions. We did not have details on whether a hospital readmission was considered avoidable or unavoidable, nor did we have information on if the patient was readmitted to another hospital within the 30-day period. However, the study's readmission rate was comparable to the literature (Jencks et al., 2009), which suggests an accurate capture of readmissions in our sample. Third, our sample contained more patients with dementia than found in the typical geriatric patient population, which reflected the interests of the parent study. In a more generalizable population, we might expect to see fewer patients discharged to nursing facilities leading to less communication with these facilities in the network. Finally, all patients were from a single hospital, which limits the generalizability.

Concluding comments

This study has demonstrated the value of conceptualizing and examining hospital discharge planning as a network of interprofessionals and patients/caregivers. Results from this study identified the types of actors involved in the process, their role in the network, and the patterns of communication between actors. Network analysis may provide novel insights into healthcare teams, as well as desirable and undesirable communication patterns. By studying discharge planning through a network lens, there is potential to uncover new process mechanisms to improve quality of patient care.

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