# Seeking to Learn versus Seeking to Teach: Network Position and Timely Electronic Documentation in Healthcare Practice

*Completed Research Paper*

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## Abstract

*Timely documentation of administered medications is enabled by electronic medical records (EMR) systems, but also made more difficult due to increased task interdependencies in EMR-enabled medication administration practice. We investigate how clinicians can use their advice networks to accomplish timely EMR documentation. We consider the novel social structures through which nurses actively solicit advice ("seeking-to-learn" network) versus actively contribute unsolicited insights ("seeking-to-teach" network) in the course of patient-care work. Results from 2-level hierarchical linear modeling showed that while clinicians are better off "seeking-to-learn" from positions of brokerage/gatekeeping over requests for advice (betweenness centrality), they are better off "seeking-to-teach" from positions where their indirect contacts are within relatively close reach (closeness centrality) and their direct contacts are highly influential or popular (Bonacich Power centrality). Our study contributes by providing a more nuanced conceptualization of advice networks as a novel way of addressing a major information systems issue in healthcare.*

**Keywords:** Social network analysis, healthcare information systems, survey research, advice networks, seeking to learn networks, seeking to teach networks, knowledge management, medication administration

## Introduction

In hospitals, medication administration is a core patient-care practice (Acheampong et al. 2014). Timely documentation of administered medications, enabled by time-stamping functionalities afforded by electronic medical records (EMR), is an important performance metric for which nurses are individually held accountable (Appari et al. 2012; Raman and Bharadwaj 2012). However, EMR-enabled medication administration is also a complex interdependent practice involving tightly coupled actions of multiple providers, and the frequent need to ask for and provide help (Brady et al. 2009). This creates a dichotomy between accountability versus control for individual nurses who, on the one hand, are held responsible for timely EMR documentation of administered medications, but on the other hand, find themselves not in complete control of this activity. From an organizational standpoint, lack of timely documentation aggravates patient safety concerns and could jeopardize hospital accreditation (Hughes and Ortiz 2005).

Timely documentation of administered medications, and the challenges that clinicians experience in realizing timely documentation, is a healthcare information technology (HIT) issue (Davidson et al. 2007; Lapointe et al. 2007; Raman et al., 2012). First, timely documentation is measurable, trackable, and able to be monitored specifically due to the time-stamping functionality made possible by the electronic medication administration records that are a part of most EMRs (Davenport and Glaser 2002). The EMR system also affords standardization of patient-care practices across all instantiations and all care providers (Raman et al. 2012). As a result, while prior to technology enablement, many different versions of a particular patient care practice may have co-existed within the same hospital, EMR implementation calls for everyone in the hospital to comply with a single hospital-approved version of each patient-care practice (Polites and Karahanna 2013). Standardized EMR-enabled practices typically involve technology-enabled communications and hand-offs of work across providers and divisions within the hospital, which aggravates the interdependencies and tight couplings of work among providers and across related patient-care practices (Orlikowski 2002; Raman et al. 2012). Thus, while on the one hand, HIT enables timely documentation of administered medications, it also contributes to many of the challenges that come in the way of nurses realizing this important performance metric.

In this study, we investigate how clinicians can use their informal social networks in the workplace to accomplish 'timely EMR documentation of administered medications' in a work environment where their own tasks are increasingly interdependent and tightly coupled with the tasks of others, causing delays in their tasks to not be entirely within their control (Howard-Grenville 2005). We focus specifically on the role of advice networks due to the likely importance of advice in the successful completion of individual tasks when these tasks must be performed within the broader context of interdependent and complex work practices. Advice networks have also been well recognized as drivers of employees' individual performance in other organizational contexts (Sykes et al. 2009, 2014). We take a novel agency-based perspective of advice networks to consider the differentiated social structures through which nurses actively solicit advice ("seeking to learn") versus actively contribute unsolicited insights ("seeking to teach") in the course of patient-care work to facilitate timely EMR documentation of administered medications. Specifically, we address the following research question: *What social positions in "seeking to learn" versus "seeking to teach" network structures are likely associated with more timely EMR documentation of administered medications for providers located in these positions?*

The study was conducted within the inpatient division of a large urban hospital system; patient-care providers employed within a set of 27 patient-care units, representing the entire inpatient division of this hospital system, were included as the sampling frame. We used a combination of survey data (to collect data on social network variables and controls) and organizational records (to obtain objective data on the dependent variable, 'timely EMR documentation of administered medications'). The separation of data sources for independent versus dependent variables is a particular strength of this research design.

## The EMR-enabled Medication Administration Practice in Hospitals: Background

In hospitals, the work of providing patient care is organized into a complex set of interrelated patient-care practices, of which medication administration is a significant one (Appari et al. 2012; Brady et al. 2009; Hughes et al. 2005; Metules et al. 2007). The medication administration practice refers to the sequence of interdependent tasks through which medications are provided to all the patients admitted in the hospital – multiple times, around the clock, and throughout their stay in the hospital. The practice is triggered every time a physician writes a medication order for a patient and concludes once the nurse documents administration of the medication to the patient. Documentation of medication administration is an important task for nurses (Hurley et al. 2007; Metules et al. 2007). Although this end task itself is simple, its timely execution is complicated by delays and challenges arising in tightly coupled tasks occurring earlier in this practice and by interdependence with tasks in other crosscutting patient-care practices (Brady et al. 2009; Hughes et al. 2005; Leape et al. 1995).

The medication administration practice is complex, comprising a well-defined sequence of tightly coupled and interdependent tasks (Brady et al. 2009; Hughes et al. 2004). The physician's handwritten medication order is filled by pharmacy and shows up on the nurses' and respiratory therapists' (RT) view of the EMR system (Fitzhenry et al. 2007). The patient's nurse/RT must then perform a 'new medication verification' step for each new medication order, by comparing the electronically entered order with the original physician order, and providing an electronic sign-stamp indicating successful verification. Additionally, at each dosage time, a separate verification of the EMR information against the medication vial is needed right before administering the medication to the patient (Paoletti et al. 2007). Then, the patient's nurse or RT would physically administer the medication, sometimes with the assistance of patient care technicians, and would complete digitally time-stamped documentation of successful administration on the EMR system (Hurley et al. 2007).

For controlled substance medications, such as morphine for pain relief, this entire sequence of steps would need to be conducted in the presence of a witness nurse, with the patient's primary nurse and the witness nurse jointly signing off all time-stamping activities. A few additional steps for safeguards in proper use would also be warranted, such as retrieval from special protected automated machines in pre-allocated quantities and secure disposal of medication and vials, all in the presence of a witness nurse (Mandrack et al. 2012; Rodriguez-Gonzalez et al. 2012; Thomas et al. 2012; Van den Bemt et al. 2009).

A medication reconciliation step also needs to occur as part of this practice at every change of shift at the hospital (Liu et al. 2015; Poornima et al. 2015; Vogenberg et al. 2013). During shift change, the outgoing nurse/RT from the previous shift explains to the incoming nurse/RT all the medications that the patient in question has been taking, mentioning any exceptional situations, like a change in dosage called in by the doctor, or any discontinuation of medication, or if they were waiting to receive test results from a prescribed laboratory test for the patient. This work is done with the EMR screen up in front of the nurses, and with them checking the current status of each medication off of this EMR screen. Both nurses must electronically check-off successful reconciliation for each patient on the EMR screen.

Tasks in other patient-care practices also intersect with these medication administration tasks. Examples include the processing of physicians' procedure orders, such as laboratory tests, X-rays, and other diagnostic tests; the documenting of patient vital signs by patient-care technicians; the completion of patient's admissions database information for new and transferring patients.

Tight coupling in medication administration tasks is caused by two related factors – task interdependence and hand-offs of work – both of which cause delays in an earlier task to send ripple effects on later tasks in the sequence (Davidson et al. 2007; Lapointe et al. 2007). For example, an incomplete or delayed 'new medication verification' task, aggravated by the shift-based nature of hospital work (Hughes et al. 2004) or the use of inconsistent medication names in writing prescription orders (Fitzhenry et al. 2007), can cause unavoidable delays in the 'EMR documentation of administered medication' task, which comes later in the sequence (Brady et al. 2009). As another example, during medication reconciliation, errors in any patient-care task detected by the outgoing nurse could potentially end up delaying timely 'EMR documentation of administered medication' for the nurse in the next shift as transfer of care gets put on hold while the outgoing nurse fixes these errors (Teunissen et al. 2013). As another example, sometimes a nurse may need to wait to receive test results of an ordered blood test, to see if any adjustments in medication dosage would be necessary before the next dose could be administered. The resulting delays in the 'EMR documentation of administered medication' task were not caused by direct delays in the performance of the EMR documentation task itself but by delays in previous tightly coupled tasks in the EMR-enabled medication administration practice and in related patient-care practices.

Agency plays a significant role in actual performance of medication administration and other patient-care practices (Howard-Grenville 2005). Agency-based choices of people involved in these practices can create alternative ways of conducting specific tasks. This could trigger parallel workflows or sub-practices as spin-offs from the core EMR-enabled medication administration practice. For example, physician call-ins of new/changed medication orders would trigger a whole other subset of tasks on the nurses' end to verify and document the order before it could be further processed. Additionally, as the EMR-enabled medication administration practice is performed repeatedly under varied patient-care scenarios, agency-based choices allow people involved in the practice to figure out various timesaving ways of performing the tasks involved in this practice. As just one example, while some nurses may prefer to handle 'EMR documentation of administered medication' in real time, as they go, other nurses may find it timesaving to batch documentation for the end of their shift. Due to the tightly coupled nature of the EMR-enabled medication administration practice, time savings gained in earlier tasks, through agency-driven choices, can translate to timeliness in the later 'EMR documentation of administered medication' task. For individual clinicians, therefore, being able to follow one's preferred timesaving approaches to conducting any of the tasks in the EMR-enabled medication administration practice allows improvements in timely performance of the specific 'EMR documentation of administered medication' task as well. Each person's ability to follow preferred approaches depends not only on their own agency-driven choices but also on the agency-driven choices of others.

Within this context, there is ample opportunity for seeking to learn, through actively soliciting advice from others when faced with a problem as well as seeking to teach, through unsolicited advice giving in the form of personal tips, tricks, and insights in the course of performing the medication administration practice (Sykes et al. 2014; Tucker et al. 2007).

When problems or unexpected patient-care scenarios arise, nurses would need to request advice from their colleagues regarding how to resolve the issue (seeking to learn). The complex nature of the patient-care work environment, wherein the medication administration practice is intertwined with other patient-care practices, makes it so that it is impossible for any single nurse or RT to know everything that is needed to perform his/her job or to resolve challenges (Tucker et al. 2007; Sykes et al. 2009).

Unsolicited advice giving by sharing one's personal tips, tricks, and insights (seeking to teach) is also common among clinicians. This gives clinicians an opportunity to further spread awareness of their preferred approaches and insights, developed from their personal experiences with patient-care practices in different patient-care contexts (Gray et al. 2004; Howard-Grenville 2005). Due to tight coupling of sequential tasks, seeking to learn as well as seeking to teach on any of the tasks involved in or related to the EMR-enabled medication administration practice could benefit timely performance of the last task in this practice, namely 'EMR documentation of administered medication.'

Our data showed that clinicians regularly engaged in 'seeking to learn' and 'seeking to teach' advice networks in the course of performing medication administration work. In our sample, the average frequency with which an individual clinician engaged in 'seeking to learn' interactions with another clinician was 4.44 on a 7-point Likert scale, anchored as 1 (Rarely)… 4 (Sometimes)… 7 (Often). This suggests that, on average, when faced with a problem, a clinician in our sample would seek advice from another clinician a little more often than "sometimes." Moreover, on average, clinicians in our sample identified about 2 other people with whom they would engage in these 'seeking to learn' interactions, with some respondents indicating up to 10 or 11 candidates for such interactions. The corresponding numbers for the 'seeking to teach' networks were comparable. The average frequency of 'seeking to teach' interactions between two clinicians in our sample was 4.55. Also, on average, clinicians in our sample reported receiving unsolicited tips, tricks, and insights from about 2 other people on their unit, with some respondents receiving unsolicited insights from upto 11 people. These initial frequency measures provided empirical support to back up our theoretical expectation of the importance of 'seeking to learn' and 'seeking to teach' advice networks in timely EMR documentation of administered medication.

## Theory Development

In this study, we investigate the social positions, in their respective networks, occupied by those who seek to learn versus those who seek to teach, which relate to more timely EMR documentation of administered medication for that clinician. The overall research model in shown in Figure 1.

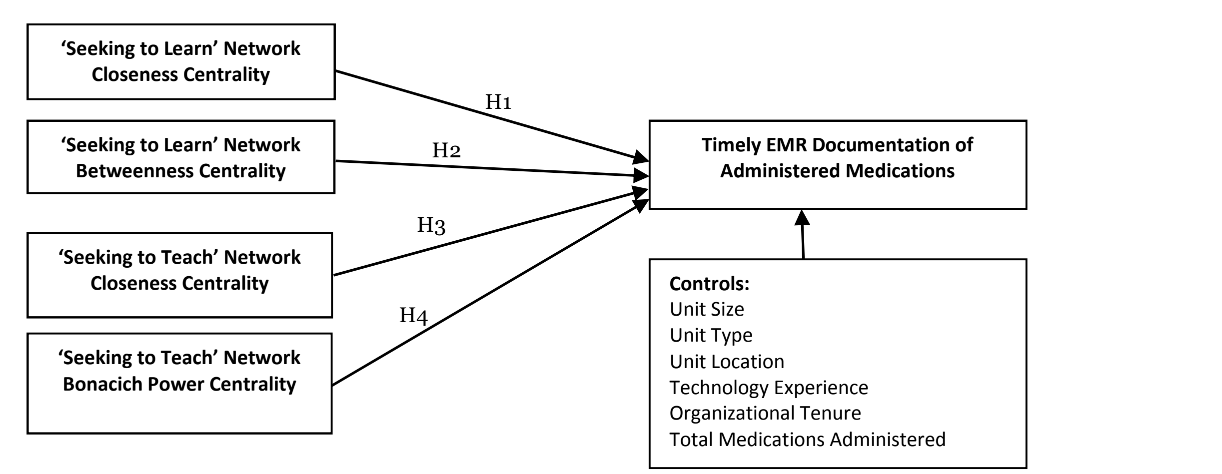


**Figure 1. Research Model: Relationships between Location in 'Seeking to Learn' and 'Seeking to Teach' Networks and Timely EMR Documentation of Administered Medications**

## *Location in 'Seeking to Learn' (STL) Networks*

'Seeking to Learn' networks are conceptualized as social structures through which people actively place requests for advice from others when faced with problems in their performance of tasks associated with EMR-enabled patient care work (Gray et al. 2004; Kendall et al. 1999). Centrally located individuals are expected to more likely engage the entire network for problem-specific advice in seeking to learn from far and near to help resolve the problem at hand (Scott 2000).

In social network theory, closeness centrality and betweenness centrality positions offer complementary ways of engaging the whole network (Barthelemy 2004; Gong et al. 2009; Hanneman et al. 2005). The closeness centrality position captures the reach of the focal node (i.e., person seeking advice) to all other nodes in the network (Scott 2000). It provides an indication of how quickly information, such as requests for advice, from the focal node can percolate through the network to reach other nodes. The betweenness centrality position captures the extent to which the focal node falls between pairs of otherwise-disconnected nodes within the network (Hanneman et al. 2005; Perry-Smith 2006). It indicates the local dependency of these other nodes on the focal node for connecting with others in the network (Scott 2000). This structural position captures the ability of the focal node to mobilize his/her own requests for advice as well as to monitor and control the requests made by others in ways that end up benefiting the focal node. Intuitively, closeness centrality considers the configuration of all possible connections in a whole network with a view to emphasizing the *connectedness* of the network. Betweenness centrality considers the configuration of all possible connections in the whole network with a view to emphasizing the *disconnectedness* (structural holes) of the network (Scott 2000).

Our theorizing relating these network positions to timely EMR documentation of administered medication melds social network theory with practical examples realistic to our empirical context. We take this approach to establish the face validity of our hypotheses from an abstract/theoretical as well as a concrete/practical perspective. The practical examples draw support from Figure 2, which provides an illustration of a 'seeking to learn' network (Scott 2000). The nodes in Figure 2 represent nurses in a hospital working on tasks associated with medication administration and other patient-care practices. The links represent requests for advice made in response to difficulties faced in the performance of these tasks.

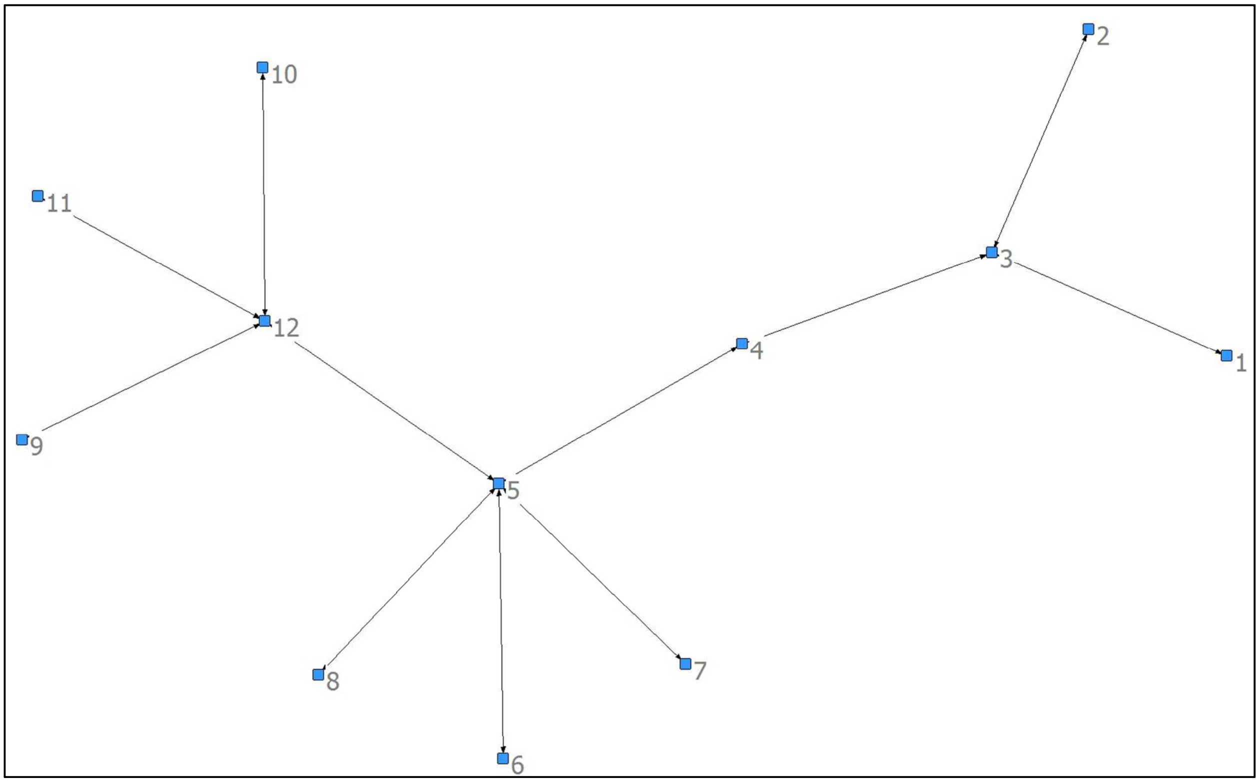


**Figure 2. 'Seeking to Learn' Network – An Illustration**
**Closeness Centrality Examples: High – Node 5, Low – Node 1**
**Betweenness Centrality Examples: High – Node 5, Low – Node 2**

### Closeness Centrality in 'Seeking to Learn' Networks

Positions of high closeness centrality in any social network are located at short distances from most other points in the network (Scott 2000; p. 85-86). This implies that, when faced with problems in performing practice-related tasks, requests for advice put forth by people in such positions in STL networks would require only a small number of intermediaries, if at all, in order to reach all other nodes in these networks (Hanneman et al. 2005; Scott 2000). In Figure 2, Nurse 5, in high closeness centrality position, is able to reach all other nurses in the advice-soliciting network via relatively few (only 1-3) links. In contrast, Nurse 1 is "close" to only a few nodes in the network. Requests for advice put forth by Nurse 1, in the low closeness centrality position, would have to go through many intermediary nodes in order to reach most other nodes in the network.

Requests for advice sent out from positions of high closeness centrality reach others in the network more quickly due to the shorter distances that these requests need to travel in order to spread through the network and find their way to people who can help (Durmusoglu 2013; Scott 2000). This is likely to facilitate quicker access to problem-specific advice, and in turn, quicker resolution of the problem that had triggered the request for advice (Borgatti et al. 2003; Sykes et al. 2014). As problems are resolved more quickly, the corresponding practice-related tasks are conducted in a timelier manner.

Requests for advice from high closeness centrality positions are also more effectively transmitted through the network without much distortion or miscommunication (Hansen 2002; Soh et al. 2004). The transmittal of requests for advice from one node to others in the network depends on the agency-based choices of each individual involved in the transmittal. The more intermediaries that are involved in transmitting a message, the more likely it is for crucial parts of this message to be dropped or to be misunderstood, and therefore, lost in transmission. Intermediaries are also less likely to convey the urgency or earnestness of tone that the original request may have carried; the more intermediaries that are involved the more likely it is that the request that reaches distal contacts are stripped of these important non-verbal cues (Adler et al. 2002; Ahuja 2000; Powell et al. 1996). As a result, distal contacts either do not receive the request for advice at all, or may receive a watered-down or even incorrect version of the request made from a low closeness centrality position. This increases the likelihood of delayed problem resolution, and ultimately delayed completion of practice-related tasks, for people in low closeness centrality positions.

Thus, in Figure 2, Nurse 5's requests for advice are in the unique position of being able to travel the fastest through the network and reach someone who may have a solution to offer. For example, Nurse 5 could have identified a discrepancy between the medication name appearing on a physician's handwritten medication order versus on the eMAR entry made by Pharmacy; this discrepancy would be holding her back from proceeding with the 'new medication verification' task. As she looks to others on her patient-care unit for advice, her network location allows her to send out requests for advice, either directly or through only 1-2 intermediaries, to cover every single person on her unit. Such short paths connecting her to everyone in her patient-care unit are likely to allow her requests to travel much faster through the entire network, than say, the requests for advice made by Nurse 1 in Figure 2, faced with the same problem. Nurse 1's peripheral location in the advice-soliciting network allows her requests for advice to quickly reach only three-four other nodes in the network, while the request has to travel through a larger number of intermediaries, to reach the vast majority of other people on her unit. So, Nurse 1 is less likely to reach quick resolution for her problems. Moreover, the greater number of intermediaries on whom Nurse 1 has to depend for the transmittal of her requests for advice creates greater uncertainty that her requests would ever even make their way, in right content and tone, to most of the people in Nurse 1's network. These uncertainties are a lot lower for Nurse 5 due to the fewer intermediaries needed for her to reach everyone on her patient-care unit. Due to tight coupling of all tasks in the medication administration practice, delays in the 'new medication verification' task are likely to trickle down to cause delays in the final task of this practice, namely 'EMR documentation of administered medication.'

*H1: Clinicians seeking to learn from positions of higher closeness centrality in STL networks would be likely to accomplish more timely EMR documentation of administered medication.*

### Betweenness Centrality in 'Seeking to Learn' Networks

In STL networks, people in high betweenness centrality positions are located on the shortest paths connecting most pairs of advice solicitors (Scott 2000; Wasserman et al. 1994). As such, people in such positions are better able to monitor and control the requests for advice that are flowing in this network (Dolev et al. 2010; Scott 2000). For this reason, high betweenness centrality positions are known as brokers or gatekeepers of information flow in social networks (Scott 2000). We theorize that, due to the capabilities of monitoring and control afforded by their position, those who actively seek to learn from positions of high betweenness centrality are better able to mobilize *relevant* problem-specific advice and bring it to bear on the problems they face (Burt 1992). They can also restrict the flow of requests for advice on other unrelated topics that they do not perceive as problematic, causing these requests to consume fewer available resources in STL networks (Buechel et al. 2013; Burt 1992). In doing so, location in high betweenness centrality positions in this network would allow active seekers to better exercise their agency-based preferences in the requests for advice that are allowed to circulate through the network.

In Figure 2, at any given point in time there are likely many competing and complementary requests for advice initiated by the various nurses in a patient-care unit. Requests for advice are costly on the time and effort of the people to whom the requests are placed. They, therefore, compete with each other for attention. Nurse 5 occupies a high betweenness centrality position in this network. From this position, Nurse 5 can essentially control and monitor the flow of these requests for advice through the network by intercepting requests and deciding whether or not to pass them along to others. When faced with a problem in medication administration work – for example, "the patient is throwing up the medication" – Nurse 5 can choose to pass along requests that she perceives as relevant to her specific problem in the hopes of getting more people in the network to be thinking about and responding to this issue. Nurse 5 may also choose to block the flow of requests for advice on other non-related issues that she may not perceive as problematic, like "how to enter patients' vital signs on the electronic system," so that these non-related issues do not take time and attention away from the problems that Nurse 5 is facing. As more of the requests for advice flowing through the network are brokered by Nurse 5 in this manner, these requests center around the problem of patients being unable to keep their medications down.

Consequently, more of the nurses in the network are exposed to and likely thinking about this problem. The specific problem faced by Nurse 5 is, therefore, likely to find quicker resolution, affording more timely task performance for this nurse in high betweenness centrality position.

People in high betweenness centrality positions are also able to channel their own requests for advice in more fruitful ways. These positions bridge across otherwise disconnected neighbors on either sides of the structural holes that they are known to occupy (Scott 2000; p. 87). This is easily visible in Figure 2. Were it not for Nurse 5, Nurses 1-4, Nurses 9-12, Nurse 6, Nurse 7, and Nurse 8 would never have been connected to anyone else in the network. Such contacts, who are otherwise disconnected from each other, are better able to provide non-overlapping insights in response to the requests for advice made by nodes in high betweenness centrality positions (Burt 1992; Perry-Smith 2006). For people in these positions, therefore, requests for advice are likely to result in more useful responses, leading to quicker resolution of problems, and in turn, timelier task performance.

*H2: Clinicians who actively seek to learn from positions of higher betweenness centrality in STL networks would be likely to accomplish more timely EMR documentation of administered medication.*

## *Location in 'Seeking to Teach' (STT) Networks*

In the spirit of teaching others what they consider to be productive ways of engaging with EMR-enabled patient care work, 'seeking to teach' networks capture the pattern of social interactions through which people voluntarily share with others tips, tricks, and insights relating to such work. To be of value, such efforts of seeking to teach must also be perceived as useful by recipients; this is accounted for in our data collection approach.

In the interdependent work context of EMR-enabled patient care work, unsolicited attempts to teach others is likely to benefit the teacher as long as it can increase the visibility of the teacher's shared insights (Wasko et al. 2005). With increased visibility, those who seek to teach are likely to be better able to themselves follow their preferred approaches at work by allowing more of their colleagues to be aware of, and therefore, likely accommodating of, these approaches (Faraj et al. 2015; Olivera et al. 2008). Increased awareness also creates an opportunity for others to join-in on advice-givers' preferred approaches, which garners legitimacy and, in turn, organizational support for these approaches (Faraj et al. 2015; Washington et al. 2004). As we theorize, therefore, it is not simply the act of voluntarily offering unsolicited insights, but the ability to do so from such locations that increases the visibility of shared insights, that is related to timely EMR documentation for those who seek to teach in STT networks.

Social network theory suggests that unsolicited advice contributed by more central positions in a network would, in general, be more visible (Borgatti et al. 2003; Scott 2000). As theorized next, two types of central positions are specifically likely to offer theoretically distinct and complementary ways of enhancing the visibility of unsolicited contributed insights: closeness centrality and Bonacich power centrality (Hanneman et al. 2005; Scott 2000). The practical examples used to contextualize our theorizing in this section draw on Figure 3, which illustrates an STT network. The nodes in Figure 3 represent nurses working in a hospital patient-care unit. The links represent voluntary contributions of unsolicited tips, tricks and insights, driven by what the nurses that sought to teach found to be useful/productive in their work; only those 'seeking to teach' contributions that were corroborated as useful by recipients were included in this network.

### Closeness Centrality in 'Seeking to Teach' Networks

Seeking to teach from positions of high closeness centrality in STT networks is likely to increase visibility of taught insights. People in positions of high closeness centrality are able to reach out to most others in their network via short paths, i.e., requiring only few intermediaries (Hanneman et al. 2005; Scott 2000). This allows their unsolicited insights to reach most others in the network more quickly and with less distortion (Hansen 2002; Soh et al. 2004). Social network theory suggests that when the insights of the advice-giver have to travel through multiple intermediaries, the control and responsibility for transmittal of these insights shifts from the advice-giver to the intermediaries (Scott 2000). Intermediary nodes, guided by their own agency-driven needs and preferences, have their own competing interests, time constraints, and even their own preferred insights that may clash with the insight provided by the unsolicited advice-giver (Hanneman et al. 2005). All of this may impede the willingness or promptness by which intermediaries pass along the advice-giver's unsolicited insights to the latter's more distal contacts (Borgatti et al. 2003; Durmusoglu 2013). At the very least, just the fact that the unsolicited insight needs to be relayed from one person to the next causes it to take progressively longer (Hansen 2002). It also introduces greater risk that someone in these multiple links will drop the ball and either fail to pass forward the advice-giver's insight or will pass it along in a form that is significantly distorted (Adler et al. 2002; Ahuja 2000; Powell et al. 1996).

Greater visibility for their preferred insights offers several benefits to those seeking to teach from high closeness centrality positions, allowing them to perform practice-related tasks in a timelier manner. First, greater visibility simply increases others' awareness of the teacher's preferred insights. When others are aware of someone's preferences, they are more likely to accommodate these preferences whenever feasible, compared to when they are not aware of these preferences (assuming that healthcare is a generally cooperative, rather than a competitive, workplace, where people are not out to bring each other down). This allows those seeking to teach from high closeness centrality positions in STT networks to more smoothly follow the approaches with which they have found success (Faraj et al. 2015; Olivera et al. 2008). Increased visibility also allows errors/pitfalls as well as improvement opportunities in the teacher's preferred insights to more quickly come to the attention of the teacher, enabling him/her to learn and improve their ways of working (Cabrera et al. 2002; Hansen et al. 2002). Finally, the more people that know about the preferred approaches of the teacher, the more opportunities there are for others to choose to follow these approaches in their own work (Faraj et al. 2005). As more people gravitate towards the preferred approaches of those seeking to teach from high closeness centrality positions in STT networks, these approaches are more likely to become the unwritten norm in the teacher's department or unit, allowing the deployment of managerial and organizational support around these approaches. As their preferred approaches are better supported on their unit by colleagues and superiors, due to the unsolicited insights that they choose to share with others, those seeking to teach from high closeness centrality positions are likely to be able to get through her practice-related tasks in a more efficient, i.e., timelier, manner.

In Figure 3, Nurse K is in a position of high closeness centrality in the STT network, needing only 1-2 intermediaries to reach out with her unsolicited insights to all other nurses on her unit; Nurse B is in the opposite situation, being located in a peripheral position in the same network. Suppose Nurse K figured out a convenient way to keep track of patient-specific idiosyncrasies relating to medication intake: for example, patient Henry may need to take the medication crushed in pudding, patient Julie may need to take it mixed with orange juice, while patient Miranda may be choking on larger sized pills. Instead of committing this kind of specific information to memory, Nurse K devised an approach of entering a patient-specific note in the EMR system each time an idiosyncrasy was resolved, which she personally found to be time-saving. Nurse K's network location allowed her to quickly spread this preferred insight about the EMR notes to everyone on the unit, since Nurse K could reach 5 of the nurses on her unit directly, and the other nurses through no more than two intermediaries. Furthermore, since only two intermediaries (e.g., Nurses T and P) were required for Nurse K to reach even her most distal contact (e.g., Nurse N) in the network, the chances that these two intermediaries would drop the ball by withholding or distorting the message is a lot less than, let's say, for Nurse B who requires 5 intermediaries (Nurses E, J, K, T, and P) to reach the same node. Nurse K's network position, therefore, afforded greater visibility to her unsolicited preferred insight.

Improved visibility of Nurse K's unsolicited insights allowed her to document her own administered medications on the EMR system in a timelier manner. As everyone on her patient-care unit learned of Nurse K's EMR notes, many thought it was a good idea and decided to enter similar EMR notes for their own patients. This circled back to improve the timeliness of Nurse K's medication documentation tasks, when she was able to locate similar time-saving notes left by her colleagues for patients that Nurse K took over from them. As entering such notes became popular knowledge on Nurse K's patient-care unit, managers as well as other nurses on the unit knew to spontaneously look for these notes, all of which streamlined Nurse K's burden of reporting and communicating detailed idiosyncratic patient information to colleagues and superiors on her patient-care unit and hastened transfer of care procedures for Nurse K. Finally, if Nurse K was violating any hospital rules in the way she was recording these EMR notes – for example, maybe she was recording them in a location within the EMR system that could pose a regulatory liability for the hospital – then, because other nurses were aware of her approach, they could quickly bring this issue to her attention. The issue could then be corrected before Nurse K had invested too much time and work into this approach.

*H3: Clinicians who seek to teach from positions of higher closeness centrality in STT networks are likely to accomplish more timely EMR documentation of administered medications.*

**Bonacich Power Centrality in 'Seeking to Teach' Networks**

An alternative way of increasing the visibility of one's preferred insights is when those seeking to teach these insights selectively target the insights to people who, because of their positions in the network, are themselves important or visible in the network. According to social network theory, this can be accomplished by seeking to teach from positions of higher Bonacich power centrality in STT networks (Scott 2000). Well-connected people tend to be highly visible, and also more influential, in their network (Hahneman 2005; Ibarra et al. 1993; Scott 2000). They can exert more direct influence, just due to the sheer number of people with whom they are directly connected (Scott 2000). In addition, their popularity in the network also creates an indirect source of influence, where other people – regardless of whether they are directly connected to these nodes – tend to watch and emulate what they do, sort of like a celebrity effect (Basil 1996; Kahle et al. 1985; Shalley et al. 2008).

When people seek to teach from higher Bonacich Power Centrality positions in their STT networks, people who are more popular and influential in these networks are made aware of their preferred insights, which can benefit the timeliness of the teacher's own work in many ways (Hanneman et al. 2005; Scott 2000). First, influential contacts may try to accommodate the preferred insights that they learn from those seeking to teach from high Bonacich Power centrality positions (Feldman et al. 2003; Freed et al. 1994; Howard-Grenville 2005; Mossholder et al. 2011). Since these contacts are well-connected in the network, they can mobilize greater resources in their attempts to accommodate these preferences (Perry-Smith et al. 2003; Scott 2000). Influential contacts may also end up liking the unsolicited insight shared by those seeking to teach from high Bonacich Power centrality positions in STT networks and choose to incorporate it into their own workflow (Argote et al. 2000; Bock et al. 2005). Because of their ability to directly and indirectly influence others in the network, any attempt by influential contacts to either facilitate or adopt the preferred insights shared by the advice-giver is likely to be magnified due to others in the network following suit (Basil 1996; Kahle et al. 1985). So, now, just by passing along their preferred insight to a select few well-connected individuals in the network, those seeking to teach from positions of high Bonacich Power centrality can find many more people in the network making adjustments in their workflows to accommodate or incorporate these preferences. Therefore, with relatively low cost of time and effort, the teacher is able to find it disproportionately easier to follow his/her own preferred approaches that were personally more productive for him/her. He/she is also going to find more departmental/managerial support rallying around his/her preferences, as a disproportionately larger number of people (in comparison to the number of people with whom he/she directly shared the insight) adopt his/her insight (Washington et al. 2004). Finally, the influential contacts are more keenly watched by everyone else in the network (Scott 2000). So, when they propagate, facilitate, or incorporate the unsolicited insights shared by those seeking to teach from positions of high Bonacich Power centrality, it creates an opportunity to even more quickly bring to the forefront any errors, loopholes, pitfalls, or any other areas for improvement that may be present in these insights. This can free up those seeking to teach from these positions in the STT network to be even more productive and timely in the performance of their work.

In Figure 3, Nurses J and P are both directly connected to 3 individuals, but all of Nurse J's 3 contacts are themselves well-connected, and therefore, more influential and visible in the network, while Nurse P's contacts are mostly peripherally located in the network. By definition, Nurse J occupies a higher Bonacich power centrality position while Nurse P occupies a lower Bonacich power centrality position.

Let us consider the unsolicited insight discussed in our theorizing leading up to hypothesis 3: the writing of EMR notes regarding patient-specific preferences for medication intake. A nurse in Figure 3 could either choose to pass this insight along to as many people as she possibly could throughout the entire network, as was theorized in Hypothesis 3. Or, someone like Nurse J, located in a high Bonacich power centrality position, can significantly economize on her efforts by selectively seeding her unsolicited preferred insight to her three well-connected, and therefore, more popular direct contacts, Nurses E, M, and K. Whatever Nurses E, M, or K do is very visible to others in the network, either through direct connection (13 out of the total 20 nodes in Figure 3 are directly connected to either one of these nodes) or because of their general popularity in the network. So, when these nurses receive insights from Nurse J, then how so ever they respond to these insights garners attention from the rest of the network.

Interestingly, according to our theorizing, Nurses E, M, or K do not necessarily need to directly *adopt* the insight provided by Nurse J in order for Nurse J to be benefited. Even if Nurses E, M, or K play only a facilitating/supportive role towards the insight shared by Nurse J, this is likely to benefit Nurse J because others in the unit will tend to now be more accepting and accommodating of Nurse J's insight just due to the affirming actions or words of the popular nurses. Popular nurses E, M, and K are also likely to more quickly identify flaws or improvement opportunities in Nurse J's preferred insight due to their higher direct access to the insights of other nurses, namely of Nurses A, B, C, D, F, G, H, I, Q, R, T, and S, because of their well-connectedness in the network. Nurse J is, therefore, able to become timelier in the performance of her medication administration tasks, including the specific 'EMR documentation of administered medication' end task, due to her ability to strategically offer her unsolicited preferred insight to her three well-connected direct contacts, Nurses E, M, and K.

*H4: Clinicians who seek to teach from positions of higher Bonacich Power centrality in STT networks would be likely to accomplish more timely EMR documentation of administered medication.*

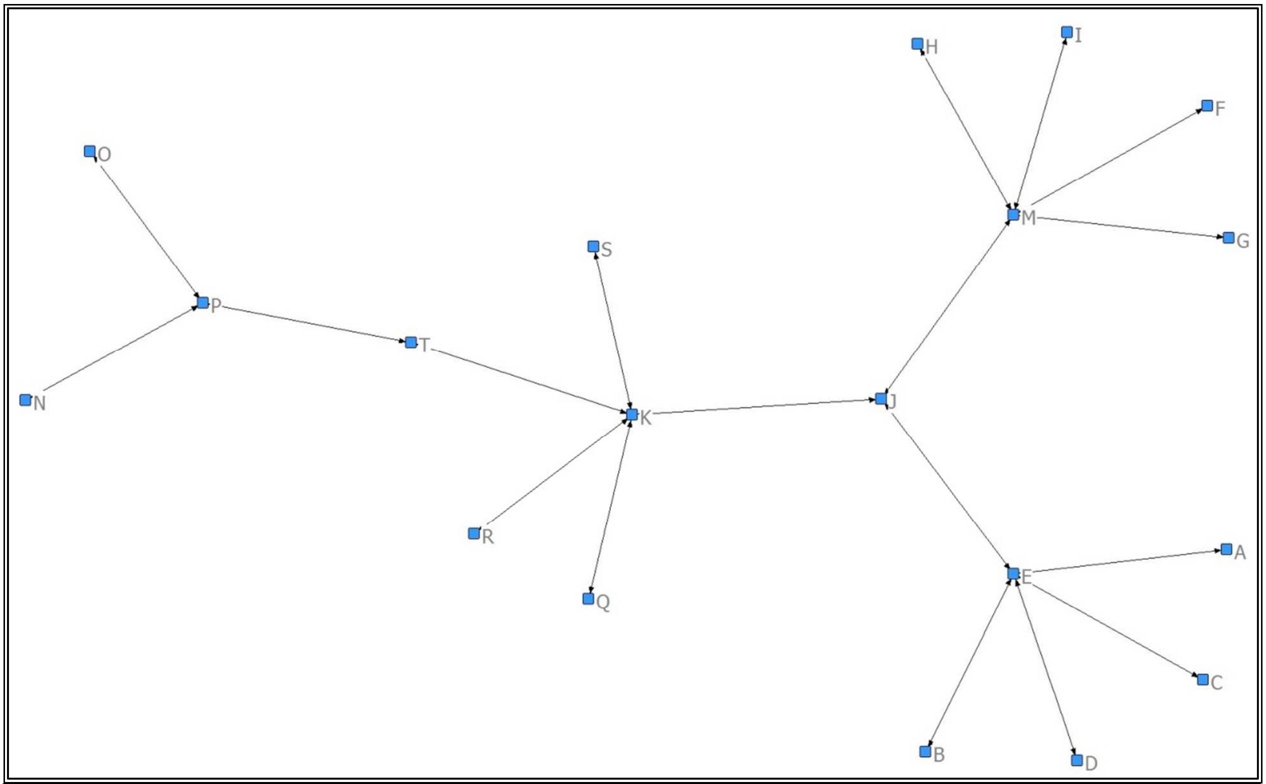


**Figure 3. 'Seeking to Teach' Network – An Illustration**
**Closeness Centrality Examples: High – Node K, Low – Node B**
**Bonacich Power Centrality Examples: High – Node J, Low – Node P**

## Methods

### *Research Setting*

The research setting for this study was the inpatient division of a large urban hospital system, consisting of 27 self-contained and independently-operating patient-care units, representing people from diverse work roles, including nurses, respiratory therapists, patient care technicians, and unit secretaries. The medication administration practice was an important aspect of patient care work here, which affected all inpatient units and intersected with many other patient-care practices, such as processing diagnostic testing orders and results, completing admissions databases, and recording daily vital signs. An EMR system required documentation of all patient-care and medication administration tasks, but beyond being just a database for storing this information, this system was also a communication medium between different providers and a live environment that alerted real-time attention to task completion.

## *Data Collection*

Social network and control variable data were collected, using survey questionnaires, from all the non-physician clinician workforce who were employed within all the inpatient patient care units, for an 83% overall response rate across units. The dependent variable of timely EMR documentation of administered medication for each clinician (nurse or respiratory therapist) was collected from organizational records, representing objective rather than self-reported measures. Discarding responses with missing data, the dataset consisted of 882 responses across 27 patient-care units.

## *Measurement*

### Dependent Variable

For each healthcare provider authorized to administer medications, the EMR system kept track of monthly data on the total number of medications documented as being administered and the number that were documented late, i.e., more than one-hour past due-time. Timely documentation of administered medication was calculated as (total-late) documentation using these EMR records. The actual measure for the dependent variable (DV) was the ratio of timely documentations to total documentations within the same one-month period for each respondent. Since assumptions of normality are not valid in our dataset due to the nested nature of our data, and due to the fact that our DV could only assume positive values, we therefore, used 2-level hierarchical linear modeling with a restricted maximum likelihood analytical approach, which relaxes normality assumptions in the data.

### Independent (Network) Variables

We drew on theoretical conceptualization and on interactions with practitioners to develop the socio-metric questions for capturing STL and STT networks in each patient-care unit. Standard steps were followed to ensure the validity of network data (Marsden 1990). We also conducted extensive validity checks to ensure the empirical distinctiveness of the two networks from each other.

To capture STL contacts, we asked respondents: Who do you go to for advice when you encounter a problem with [name of the EMR] in your work? Asking respondents about problems faced with "the EMR in [their] work" encouraged focus on problems that arose in patient-care practices enabled by the EMR system, rather than simply on technical problems with the EMR system. In addition, the phrasing of the question emphasized that these interactions were initiated by the person seeking to learn ("Who do you go to…"), and also that the advice sought was specific to a problem that the seeker had encountered and needed to resolve, rather than being of a general nature about the system or the work practice ("… when you encounter a problem…").

To capture STT contacts, each respondent was asked: Even without your asking, who voluntarily shares useful tips, tricks and insights with you regarding [the EMR] in your work? We chose to ask recipients to name those who "seek to teach" to them, rather than asking the teachers who they "seek to teach" to. This was done for two main reasons. First, people are less likely to remember all the people that they taught something to, unless the person being taught or the circumstances of the teaching were somehow remarkable or out of the ordinary (for example, how likely is a professor to remember every single student that he/she has taught compared to remembering every single teacher that has taught him/her?). As such, asking the recipients was expected to yield complete STT networks. Second, this approach also ensured that only those unsolicited insights that the recipient considered "useful" were incorporated as STT ties, as mentioned earlier in the theory development section. This is because any insights shared by someone would result in the theorized benefits only if they are perceived as being useful by those receiving these insights. This way of asking the socio-metric question ensures that we weed out "seeking to teach" attempts that simply bombard inane meaningless information that then largely gets ignored by its recipients.

Finally, we phrased our socio-metric questions as being about "the EMR in [their] work" without explicitly restricting this to medication administration work per se. Since medication administration is a core practice in patient-care (Brady et al. 2009; Teunissen et al. 2013), this practice was automatically a core aspect of all work-related discussions. Also, other major patient-care practices that intersected with the medication administration practice, such as entering vitals information on patients' electronic charts, or processing orders and results from patients' laboratory work and other diagnostic procedures, would often indirectly cause delays in medication administration work. As such, overall "seeking to learn" and "seeking to teach" interactions relevant to any of these related work practices were salient to our research model.

The responses of all individuals in each unit were compiled to generate STL and STT networks for that unit. Measures for independent variables were then calculated for each network matrix using standard procedures available via UCINET (Borgatti et al. 2002; Marsden 1990; Scott 2000; Wasserman et al. 1994).

We used an aided-recall approach for data collection, which is preferred for collecting data on large networks (20-120 members) (Marsden 1990; Perry-Smith 2006). In this method, respondents were encouraged to consult a reference list that was provided to them while responding to socio-metric questions, as well as to write down additional names not on the list as appropriate (Marsden 1990). Reference lists were constructed in consultation with field-site experts to include all clinicians working in the hospital, not just those within a given patient-care unit.

### Control (non-network) Variables

Control variables span both levels in our nested dataset. Level 1 controls include *technology experience, organizational tenure,* and *total number of medications administered* by each healthcare provider. Level 2 controls include *unit size*, *unit type*, and *unit location.*

Among level 1 controls, the amount of experience a provider has with the technology ('technology experience') as well as with working in the hospital in general ('organizational tenure') is likely to affect timely performance on all aspects of work, including EMR documentation of administered medication. Having to administer more number of medications in total ('total no. of meds administered') is also likely to afford greater practice, which could help the provider become more timely with documenting administered medication on the EMR, although this could come at the cost of a more challenging workload that could impede timeliness.

At level 2, the total number of employees in the patient-care unit ('unit size') can serve as a resource and a constraint in medication administration work by increasing the pool of people who can help each other out but also increasing the costs of coordinating between them. The nature and design of work on the unit ('unit type') as well as the broader organizational culture in which the unit has to function ('unit location') can also affect timely EMR documentation of administered medication.

Prior to survey launch, detailed multi-step instrument development and testing, including a pilot test, was conducted to ensure data validity and reliability. We undertook several steps to safeguard against common method bias (Podsakoff et al. 2003), including the use of different types of measures and scales across constructs and the use of different data sources for dependent versus independent and control variables. We also conducted the Harmon single-factor test on our survey data, which indicated that common method bias was not a significant issue. Nonresponse bias was also assessed and determined to not be an issue following multiple tests (Armstrong et al. 1977; Fowler 2009).

## Analysis and Results

Summary statistics and correlations between variables are reported in Tables 1a and 1b (Brady et al. 2012; Shin et al. 2012; Suh et al. 2011). Diagnostic tests for the distributional properties of our dependent variable, 'timely EMR documentation of administered meds,' led us to apply a square-root transformation. Given the nested nature of our dataset (level 1: patient-care professionals, level 2: patient-care units), we analyzed our data using 2-level hierarchical linear modeling (HLM 7.0), with restricted maximum likelihood as the analytical approach, which relaxes assumptions of normality in the data. 2-level model specifications are provided in Figure 4. The intra-class correlation coefficient of 22.48% indicated that 22.48% of the variance in our dependent variable was *between* the level 2 patient care units while the remaining variance was *within* units, confirming the appropriateness of a 2-level hierarchical analysis. Results are shown in Table 2. Although a true R-squared value cannot be obtained with hierarchical linear models, our model explains 9% of the within-unit variance and an additional 3.8% of the between-unit variance in timely task performance (Kreft and de Leeuw 1998; Singer 1998).[1] This means that adding the control variables to the null model causes 4% additional variance, beyond that explained by the null intercept-only model, to be explained by the control variables themselves, and further adding the hypothesized variables causes an additional 9% of the variance to be explained. These results indicate that our model was indeed statistically supported, i.e., the model with the hypothesized variables (2c) explains more variance than the model with only the control variables (2b) or the null intercept-only model (2a).

As described in Table 2, our analyses support all our hypotheses, except for Hypothesis 1. In hypothesis 1, we had anticipated a positive association between clinicians seeking to learn from positions of higher closeness centrality in STL networks and the extent to which these clinicians were timely in EMR documentation of administered medication. Our findings indicate that, in our dataset, the closeness centrality of a clinician's position in the STL network does not matter to the clinician's timely EMR documentation of administered medication. Hypothesis 1 was formulated based on the theoretical logic that fewer intermediaries would be more likely to allow quicker passage of less distorted information regarding the problem and the advice on its resolution. This would allow clinicians located in high closeness centrality positions to more quickly resolve their problem and get on with their tasks in the medication administration practice, which would ultimately relate to more timely EMR documentation of administered medication due to tight coupling of tasks within the medication administration practice. Non-significant results suggest that there is no significant difference between those in higher or lower closeness centrality positions in terms of the timeliness of their EMR documentation of administered medication. This could happen either because, in our dataset, those located in peripheral positions are just as effective at quick and non-distorted sharing of problem-specific information as their counterparts located in more central positions. A possible reason for this could be that all intermediary colleagues working in the high-skills high-stakes healthcare work environment are equally diligent about quickly and accurately transmitting patient-care related questions and advice through the STL network. Or, it could be that intermediaries working in these environments are overworked to the point that even a few intermediaries are unable to successfully relay problem-specific questions and their responses in the STL network, leading to centrally located individuals doing just as poorly with problem resolution as their counterparts in more peripheral locations. In other words, the non-significance of our finding on this hypothesis seems to suggest that smaller or larger numbers of intermediaries are equally effective or ineffective in the quick and non-distorted transmittal of problem-specific questions and answers through the STL network. Identifying which one of these scenarios is actually the case in a healthcare setting would require a new study design and additional data, and would be a worthy candidate for future research.

[1] $R_1^2 = [\sigma^2_{(\text{empty model})} - \sigma^2_{(\text{full model})}] / \sigma^2_{(\text{empty model})}$; $R_2^2 = [\tau_{00(\text{empty model})} - \tau_{00\,(\text{full model})}] / \tau_{00\,(\text{empty model})}$ (Kreft and de Leeuw 1998; Singer 1998).

**Table 1a. Descriptive Statistics and Correlations for Level 1 Variables**

| | Mean | S.D. | Min. | Max. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.STLN Closeness Centrality | 12 | 9.65 | 0.00 | 56.7 | 1 | | | | | | |
| 2. STLN Betweenness Centrality | 0.75 | 2.12 | 0.00 | 20.63 | 0.440** | 1 | | | | | |
| 3. STTN Closeness Centrality | 3.38 | 7.20 | 0.00 | 69.23 | 0.009 | 0.304** | 1 | | | | |
| 4. STTN Bonacich Power Centrality | 2.36 | 6.77 | 0.00 | 88.41 | -0.139** | 0.051 | 0.476** | 1 | | | |
| 5.Technology Experience | 5.80 | 3.05 | 0.50 | 14.00 | -0.022 | -0.008 | -0.010 | -0.060 | 1 | | |
| 6.Organizational Tenure | 6.83 | 7.26 | 0.08 | 48.00 | -0.017 | 0.104** | 0.089** | 0.085* | -0.123** | 1 | |
| 7. Total Medications Documented | 149.07 | 100.42 | 1.00 | 564.00 | 0.138** | 0.019 | -0.077* | -0.074* | 0.048 | -0.171** | 1 |
| 8.Timely Documentation | 0.78 | 0.13 | 0.00 | 1.00 | 0.051 | 0.003 | -0.061 | -0.069 | -0.179** | 0.024 | 0.193** |

**Correlation is significant at the 0.01 level (1-tailed). *Correlation is significant at the 0.05 level (1-tailed).

**Table 1b. Descriptive Statistics and Correlations for Level 2 Variables**

| | Mean | S.D. | Min. | Max. | 1 | 2 |
|---|---|---|---|---|---|---|
| 1. Unit Size | 68.41 | 36.48 | 15.00 | 152.0 | 1 | |
| 2. Unit Type | 0.59 | 0.50 | 0.00 | 1.00 | -0.237 | 1 |
| 3. Unit Location | 0.52 | 0.51 | 0.00 | 1.00 | 0.011 | -0.045 |

**Correlation is significant at the 0.01 level (1-tailed). *Correlation is significant at the 0.05 level (1-tailed).

**Table 2. Results - 2-Level Hierarchical Linear Modeling Analysis of the Effect of Network Positional Variables on Timely EMR Documentation**

| **Variables** | **Model 2a: Empty Model Est. (std. error)** | **Model 2b: with Control Variables Est. (std. error)** | **Model 2c: with Hypothesized Variables Est. (std. error)** |
|---|---|---|---|
| **Dependent Variable: Square-root transformation of 'Timely EMR Documentation'** | | | |
| *Fixed Effects* | | | |
| **Grand Intercept** | | | |
| $\gamma_{00}$ | -0.004 (0.102) | 0.027 (0.213) | 0.274 (0.119)* |
| **Control Variables** | | | |
| Unit Size ($\gamma_{01}$) | | -0.004 (0.002) | -0.004 (0.001)* |
| Unit Type ($\gamma_{02}$) | | -0.084 (0.214) | -0.429 (0.132)** |
| Unit Location ($\gamma_{03}$) | | -0.151 (0.187) | 0.030 (0.135) |
| Technology Experience ($\gamma_{50}$) | | -0.001 (0.011) | 0.096 (0.029)** |
| Organizational Tenure ($\gamma_{60}$) | | -0.010 (0.005)^ | -0.055 (0.029)^ |
| Total Medications Documented ($\gamma_{70}$) | | -0.079 (0.052) | -0.093 (0.051)^ |
| **Hypothesized Variables** | | | |
| STL Network (ASN) Closeness Centrality (H1) ($\gamma_{10}$) | | | -0.009 (0.057) |
| STL Network Betweenness Centrality (H2) ($\gamma_{20}$) | | | 0.056 (0.019)** |
| STT Network (UAGN) Closeness Centrality (H3) ($\gamma_{30}$) | | | 0.119 (0.058)* |
| STT Network Bonacich Power Centrality (H4) ($\gamma_{40}$) | | | 0.070 (0.027)* |
| *Random Effects* | | | |
| | **Std. Deviation (Variance Component)** | **Std. Deviation (Variance Component)** | **Std. Deviation (Variance Component)** |
| $\sigma^2$ | 0.878 (0.772) | 0.851 (0.724) | 0.818 (0.670) |
| Intercept $\tau_{00}$ | 0.507 (0.257) | 0.620 (0.384) | 0.441 (0.194) |
| STLN Closeness Centrality $\tau_{11}$ | | | 0.252 (0.063) |
| STLN Betweenness Centrality $\tau_{22}$ | | | 0.060 (0.004) |
| STTN Closeness Centrality $\tau_{33}$ | | | 0.242 (0.058) |
| STTN Bonacich Power Centrality $\tau_{44}$ | | | 0.078 (0.006) |
| Technology Experience $\tau_{55}$ | | 0.031 (0.001) | 0.067 (0.004) |
| Organizational Tenure $\tau_{66}$ | | 0.014 (0.000) | 0.063 (0.004) |
| Total Medications Documented $\tau_{77}$ | | 0.181 (0.033) | 0.191 (0.036) |
| Deviance (D) | 2159.354 | 2055.709 | 1989.372 |
| p-values: ^=.10, *=.05, **=.01, ***<.001<br>Sample Size: n = 882, j = 27 | | | |

Level-1 Model: *TimelyDocumentation*$_{ij}$ = $\beta_{0j}$ + $\beta_{1j}$*(*STL Network Closeness Centrality*$_{ij}$) + $\beta_{2j}$*(*STL Network Betweenness Centrality*$_{ij}$) + $\beta_{3j}$*(*STT Network Closeness Centrality*$_{ij}$) + $\beta_{4j}$*(*STT Network Bonacich Power Centrality*$_{ij}$) + $\beta_{5j}$*(*Technology Experience*$_{ij}$) + $\beta_{6j}$*(*Organizational Tenure*$_{ij}$) + $\beta_{7j}$*(*Total Medications Administered*$_{ij}$) + $r_{ij}$,

where $\beta_{0j}$ = mean 'TimelyDocumentation' for people within unit j, $\beta_{1j\text{-}7j}$ = expected change in 'TimelyDocumentation' for person i in unit j associated with a unit increase in the corresponding level 1 predictor variable characterizing person i within unit j, $r_{ij}$ = error term representing a unique effect associated with person i within patient care unit j. Per conventional modeling assumptions, $r_{ij} \sim N(0, \sigma^2)$.

Level-2 Models: (1) $\beta_{0j} = \gamma_{00} + \gamma_{01}$*(*Unit Size*$_j$) + $\gamma_{02}$*(*Unit Type*$_j$) + $\gamma_{03}$*(*Unit Location*$_j$) + $u_{0j}$,

where $\gamma_{00}$ = mean TimelyDocumentation for a person across all patient care units, $\gamma_{01}$ = mean TimelyDocumentation for a person located within a patient care unit whose 'unit size' is the same as the average 'unit size' across all units (unit size is grand-mean centered), $\gamma_{02}$ = difference in mean TimelyDocumentation for a person working in a general care unit versus an intensive care unit, $\gamma_{03}$ = difference in mean TimelyDocumentation for a person working in a patient care unit that is located within a teaching versus a non-teaching hospital setting, $u_{0j}$ = the unique effect of patient care unit j on mean 'TimelyDocumentation' holding all Level-2 indicators constant (i.e., conditioning on all level-2 predictors).

(2-8) $\beta_{xj} = \gamma_{x0} + u_{xj}$,

where $\gamma_{x0}$ = average Level 2 predictor variable$_x$-TimelyDocumentation slope across all patient care units; and $u_{xj}$ = the unique effect of patient care unit j on the Level 2 predictor variable$_x$-TimelyDocumentation slope holding all Level-2 indicators constant. x = 1-7.

**Figure 4. 2-Level Hierarchical Linear Model Specification**

## Discussion

Our study contributes in several unique ways. First, our study presents a novel twist on prior work related to advice networks (Sykes et al. 2009, 2014; Zhang et al. 2013). We show that the social structures through which the agency roles of "seeking to learn" versus "seeking to teach" are enacted can be significantly associated with timely EMR documentation. While prior work on advice networks has shown the value of the flow of advice between networks of people (Borgatti et al. 2003; Ibarra et al. 1993; Sparrowe et al. 2001), our study shows that even the flow of requests for advice and of contributions of unsolicited advice can, if done from strategically significant positions in the respective networks, create value for the active agents involved in initiating these flows. A second related contribution of our work is to show that seeking to teach others can also relate to tangible direct performance benefits for the teacher. This is a novel contribution to prior literature, which has recognized the obvious tangible performance benefits of advice receiving, but with respect to advice giving, has primarily recognized indirect reputational and emotional/psychological benefits that may or may not translate to actual performance gains (Tsai et al. 2013; Cheung et al. 2013). Finally, from a practical standpoint, our study contributes by providing insight into the frustrating paradox of accountability versus control faced by clinicians in interdependent patient-care contexts; an issue that also translates to other non-healthcare organizational contexts. Although employees are held accountable for timely completion of their tasks, they are not in full control of doing so due to the interdependencies across tasks in organizational work practices (Acheampong et al. 2014; Brady et al. 2009). Our study identifies the specific social structural patterns that can be used, despite this paradox, to facilitate timely task performance.

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