Social networks enabled coordination model for cost management of patient hospital admissions

Shahadat Uddin
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Mohammed Shahadat Uddin, Liaquat Hossain

Abstract: In this study, we introduce a social networks enabled coordination model for exploring the effect of network position of “patient,” “physician,” and “hospital” actors in a patient-centered care network that evolves during patient hospitalization period on the total cost of coordination. An actor is a node, which represents an entity such as individual and organization in a social network. In our analysis of actor networks and coordination in the healthcare literature, we identified that there is significant gap where a number of promising hospital coordination model have been developed (e.g., Guided Care Model, Chronic Care Model) for the current healthcare system focusing on quality of service and patient satisfaction. The health insurance dataset for total hip replacement (THR) from hospital contribution fund, a prominent Australian Health Insurance Company, are analyzed to examine our proposed coordination model. We consider network attributes of degree, connectedness, in-degree, out-degree, and tie strength to measure network position of actors. To measure the cost of coordination for a particular hospital, average of total hospitalization expenses for all THR hospital admissions is used. Results show that network positions of “patient,” “physician,” and “hospital” actors considering all hospital admissions that a particular hospital has affect on the average of total hospitalization expenses of that hospital. These results can be used as guidelines to set up a cost-effective healthcare practice structure for patient hospitalization expenses.

Keywords: coordination model, cost management, degree centrality, hospitalization cost, patient centered
ent actors of patient-centered care network, we can explore the rationale behind differences or gap in the average of total hospitalization expenses shown by different health service providers or hospitals for the same type (i.e., patient have similar disease) of patient admissions. The outcome of this empirical investigation could help to make suggestions about the design of hospital settings that support the attributes of those actors. The following two questions motivate this research:

(a) Does patient-centered care network illustrated in Figure 1 have effect on the average of total hospitalization expenses shown by different hospitals for their similar type of hospital admissions?

(b) If yes, what are the characteristics of different actors of patient-centered care network that minimize the average of total hospitalization expenses for hospitals?

The rest of the paper is organized as follows: a background description of coordination in the context of healthcare organizations is described in the next section. Our proposed coordination model is also presented in this section. Further, in this section we developed a set of hypotheses for the study. An overview of data preparation as well as the methods used for data analysis is presented in the third section, which is followed by research findings and discussion. Finally, there is a conclusion and future research guidelines for the study.

Coordination and Social Networks (SNs) in Healthcare Organizations

Researchers have been working to develop cost-effective coordination models to improve the service quality of existing healthcare systems. Care Transition Model, for example, which provides care across different healthcare settings to patients with chronic or acute illness, shows lower hospital readmission rate which in turn reduce the total medical cost (Coleman et al., 2006). Another cost-effective patient care system is Guided Care Model which is a practical and interdisciplinary model of healthcare; showing impressive results from small controlled experiments (Sylvia et al., 2008). There are also healthcare models with creative designs, such as Virtual Integrated Practice Model, have been developed to meet the standard patient expectations (Rothschild & Lapidos, 2003). However, none of these is based on the network analysis of patient-centered care network as in Figure 1 that develops during inpatient stay of patient in hospital. There is a lacking of such a network-based coordination model in healthcare system. However, in recent research, the analysis of network involvement of actors has been successfully applied to model coordination in
other domain, for example in the emergency preparedness of soft-target organizations including shopping malls and transit hub (Uddin & Hossain, 2009).

In the growing literature of integrated delivery system such as hospital healthcare system, coordination has been considered a central issue. It has been a long-standing interest of organizational scholars; so many definitions for coordination had been proposed since 1970s—the early stage of the coordination theory development. Coordination has been defined as the additional activities need to be performed to synchronize differentiated work efforts so that they function properly and harmoniously during the course of achieving desired goals (Haimann & Scott, 1974). Coordination has three components in organizational settings such as in healthcare organization: (a) set of actors; doctors, nurses, and other staff working to provide services to patient, (b) who perform task; which includes the services to hospital inpatient and outpatient patients, and (c) to achieve goals; better care with high level of patient satisfaction (Comfort & Kapucu, 2006; Malone & Crowston, 2003).

To distinguish global patterns of coordination in organization, there are many typologies have been developed in the current literature of organizational coordination study. Coordination is categorized into two major types, programming and feedback, in one such typology (Hong et al., 2009; Mittu et al., 2009). The programming of coordination, which requires standardization and predetermination of work process, includes the use of rules, regulations, schedule, plans, policies, and protocols to identify activities to be performed and specify work responsibilities to be followed. This approach of coordination is found most effective when minimum interdependencies exist among staff and when work requirements are well understood and predictable (Young et al., 1998) as this approach require little time for personal interaction among actors. On the other hand, coordination by feedback involves the exchange of information, orally or written form, among actors or staff.

Healthcare organizations face situations in the course of their organizational functioning where either stable or uncertain or a combination of both work requirements is needed to promote patient health service outcomes. The uncertainty which entails higher level of staff dependencies (Eriksson & Andershed, 2008) is coming mostly from unpredictable patient arrival in the hospital emergency department and from the variability of patient responses to medical intervention. In contrast for some hospital admissions only stable work requirements are needed. For instance, patients who need hip replacement surgery might be best cared going through well-planned procedures in an environment where only stable work requirements are required. No matter which approach of coordination is exercised during the course of patient hospitalization period, it has significant affect on actor network involvement and contribution in the patient-centered care network as illustrated in the Figure 1. Therefore, both programming and feedback modes of coordination are equally important and should be used to their highest extent for healthcare organizations to fulfill patient requirements.

Coordination is not a new concept to the health services research community, however; little is known about how coordination is actually achieved in healthcare organizations. There are evidences in current literature where researchers rely on patient perceptions of quality to measure coordination (Inkelas et al., 2008). In recent years, there has been an increased trend on clinical measures of quality such as mortality and morbidity to study coordination in healthcare organizations (Kalkanis et al., 2003; Sylvia et al., 2008). However, to quantify the patient perception of quality is not an easy job and could result different responses from different patients for similar services. Moreover, not all hospital admissions are life-threatening. Some of them have very low or zero chance of death such as a hospital admission for a broken hand. Thus, there arise a necessity of a common measure of coordination in healthcare organizations and total hospitalization expenses for each admission could be a possible solution.

The theory and measure of SN play an important role in identifying and quantifying informal network which functions at level beyond the formal and traditional organizational structure of actor relationships. To identify actor network properties as like network position, and the strength and direction of network relations among actors, investigations of informal network such as patient-centered care network have been found very effective (Chung et al., 2005). The measures of SN theory, for instance network centrality, are very useful to unfold the
patterns of existing informal network (Brandes & Fleischer, 2005). The selection of SN measures and methods to study informal network mainly depends on the network under consideration and its associate level of data availability.

Social network analysis (SNA) is the mapping and measuring of relationships among actors (Carrington et al., 2005) which provides both a visual and mathematical analysis of network relation among actors. It has been successfully applied to evaluate the location of actors in the network. Network centrality or centrality of SNA is a structural attribute of nodes in a network that determine the relative importance of an actor within that network (e.g., how importance a person is within a SN or how well-used a road is within an urban network). Centrality measure of an actor in the network is useful to determine network position of that actor. There are three primary classification of network centrality: (a) degree centrality; (b) betweenness centrality; and (c) closeness centrality. The number of direct connections that a node has with other nodes in the network determines the degree centrality of that node. Degree centrality which is mainly relevant in the study of popularity and activity of actors (Everett & Borgatti, 1999), has been criticized for considering only immediate ties that an actor has, rather than indirect ties to all others. In the study of coordination, degree centrality is found useful depending on the nature of network structure under consideration. As in the patient-centered care network as illustrated in Figure 1, patients have direct link with other service providing actors, degree centrality could be useful to measure network position and contribution of actors.

We apply the measures of SNA to quantify the network position of actors in modeling the network-based coordination in hospital setting. In patient-centered care network, we have four actors, which have direct network relation, either “one-way” or “two-way,” among themselves. Also, the “doctor” actor might have “one-way” relation with patient of other hospital. Excluding the “patient” actor, the rest three actors have “two-way” direct network relations among themselves. The “patient” actor has “one-way” incoming network relation with the rest three actors. Considering the goal of these three actors to provide better care to the “patient” actor, we can consider the patient-centered care network as a star network where the central actor (patient) has “one-way” incoming network relation with the rest three actors which have “two-way” direct network relations among themselves. As the network structure determines the application of SN measures (Uddin & Hossain, 2009), we cannot apply all SN measures in quantifying the actor network positions in our patient-centered care network. For instance, “betweenness” measure of SN theory cannot be applied as the network is fully connected and the “patient” actor is a black hole, only receive care or support from all other actors. However, we can apply other SN measures such as degree, tie strength, or connectedness which all consider a single actor and its direct network relation with other network actors at one instance.

**Proposed Model**

Considering the actor network relations and goal of the patient-centered care network proposed in Figure 1 we develop a coordination model as illustrated in Figure 2, where network properties of different actors are considered as independent variables and goal is used as dependent variable. The framework of our proposed model is intended to assess the cost of coordination for health service providers. The model is constructed in a way to assess the average of total hospitalization expenses as a product of network attributes value of different actors in the patient-centered care networks. We use *locality* of hospital, urban or rural, as moderating variable in our proposed coordination model as there are evidences in the current healthcare literacy showing locality of healthcare providers has impact on cost (Qureshi et al., 2007; Yip & Hsiao, 2008). For the “patient” actor the network attributes of degree and connectedness, for the “doctor” actor the network attributes of in-degree and out-degree, and for the “hospital” actor the network attributes of tie strength are considered as independent variables in our proposed coordination model.

**Degree, in-degree, out-degree**

Degree of a vertex in a graph is the total number of edges incident to that vertex according to graph theory. In SNA, degree of an actor is the count of the number of ties to other actors. Degree can be assessed for in-degree and out-degree in a directed network; where “in” represents other actors visit to a particular actor.
and “out” represents that particular actor visits other actors (Dwyer et al., 2006). From the perspective of professional practice, doctors who work only in one hospital have only in-degree values; however, doctors who work with more than one hospital concurrently have both in-degree and out-degree values.

Tie strength
It defines the quality of relationship between two actors in a network. The strength of relation between two actors can be expressed as a combination of the amount of time and the reciprocal services which characterize the tie between them (Gilbert & Karahalios, 2009). For example, the tie strength between doctor and patient could be a combination of time that doctors spent during their visits to patient and how much patient pay to doctors for their visits in return. Ties could be either directed or undirected. Directed tie infer that a node or an actor is sending or receiving information; whereas undirected tie illustrates the presence of a connection (Zhong et al., 2009).

Connectedness
Network connectedness or simply connectedness defines the frequency of communications between actors in the network. For the “patient” actor, it dictates the frequency of doctor visits to patients during their hospital stay.

Average of total hospitalization expense or “cost”
It indicates the average of total hospitalization expense for all hospital admissions for a single hospital in a given time.

Research Hypotheses
Based on the principle of coordination to healthcare organizations and in alignment with our coordination performance model, we propose the following hypotheses:

Hypothesis 1 (H1): The network attributes of different actors of the patient-centered care network have impact on hospitalization cost. To assess this hypothesis, we present another five subhypotheses to evaluate the principle theory:

\[(sH1) \text{Degree of “patient” actor correlates to Cost.}\]

We hypothesize that the number of times doctors visit to a particular patient has impact on the total hospitalization expenses of that patient.

\[(sH2) \text{Connectedness of “patient” actor correlates to Cost.}\]

We state in this subhypothesis that there is a relation between average number of times a
patient is seen by a doctor and the total hospitalization expense for each patient.

\[(sH3) \text{In-degree of “doctor” actor correlated to Cost.}\]

This subhypothesis states that number of times doctors visit the patients of their employer-hospital correlates with the patient total hospitalization expenses.

\[(sH4) \text{Out-degree of “doctor” actor correlates Cost.}\]

We here state that number of times doctors visit all patients except their employer-hospital correlates with the patient total hospitalization expenses.

\[(sH5) \text{Tie Strength of “hospital” actor correlates Cost.}\]

We hypothesize that the strength of relation that patients have with hospitals has impact on the total hospitalization expenses.

Hypothesis 2 (H2): The relations in sH1, sH2, sH3, sH4, and sH5 are mediated by the moderating variable locality of hospital—urban or rural. This means the strength of relation in these four subhypotheses differ significantly with the change in the hospital locality.

Research Dataset

We test the hypotheses for our proposed coordination model by using health insurance claim dataset provided by a nonprofit health insurance organization, hospital contribution fund (HCF), a very prominent health insurance organization in Australia. It includes member claim data from January 2005 to February 2009. There are three different categories of claims coming from patient who are also member client of HCF, hospitals, and doctors: ancillary claim, medical claim, and hospital claim. Ancillary claims are auxiliary claims such as medical services of the type dental, optical, physiotherapy, dietician, and pharmaceutical. All claims coming from specialist doctors except of the ancillary type are medical claims. The claims for the services provided as a hospital inpatient in a private or public hospital approved by the Department of Health, Australia are considered as hospital claim. In general, patients have medical claims, hospital claims, and very few ancillary claims for their admissions to hospitals.

In our dataset, there are about 14.87 million ancillary claims, 8.98 millions medical claims, and 3.1 millions hospital claims HCF received from 2,507 hospitals for the health services to its 0.44 million members over the data collection time period. Because of this huge dataset, we have to choose subset of HCF health insurance claim data in order to test our proposed hypothesis. Further, our proposed model aims to model coordination of the hospital admission, we cannot consider claims of patients who do not have any admission to hospital for their illness. So, for the testing of our model, we considered only the subset of data for total hip replacement (THR). For this type of service, patients must need admission to hospitals; thus meeting our first data inclusion criteria for data analysis to test our coordination model. The second data inclusion criterion is to consider the average of total hospitalization expense of those hospitals that have at least 10 admissions for THR over the data collection period. Table 1 summarized the statistics of the portion of data that is considered for testing our proposed hypotheses. All data from HCF are deidentified. HCF made these data deidentified intentionally by applying encryption algorithm for privacy reasons. It is standard practice to make data deidentified in the research area of using health-related data.

Exploring the Data

We have five independent variables of “degree” and “connectedness” for “patient,” “in-degree,” and “out-degree” for “doctor,” and “tie strength” for “hospital,” and one dependent variable of “average of total hospitalization expenses” or simply “cost” as stated in our proposed model. Table 2 describes how these variables are measured from the research dataset. To give an illustration of variable measurement, suppose a hospital (H1) has two THR admissions for the patient P1 and P2 in one of the years of the data collection period. So, there have been evolved two patient-centered care networks in H1. The common statistics of these two admissions for the patient P1 and P2 is stated in Table 3. From the data of Table 3, we can measure the both independent and dependent variables of our proposed model: degree of patient is 38.5
77 and 77/2 = 38.5), connectedness of patient is 7 (35/5 + 42/6 = 14 and 14/2 = 7), in-degree of doctor is 20 (200/10 = 20), out-degree of doctor is 25 (250/10 = 25), tie strength of hospital is 0.775 (18,000/24,000 = 49,000 and 49,000/2 = 24,500). An examination of the distribution of independent variables of our proposed model reveals common distribution for all them which follow a nonnormal curve having tapered skew either to the left or to the right. We apply nonparametric Spearman test, which is a standard alternative to the parametric Pearson test to quantify association between independent and dependent variables of our proposed coordination model.

**Data Preparation**

To make the data ready in order to assess our proposed hypotheses, a three-phase data preparation method is applied to the HCF raw data. As the total data is placed in the PostgreSQL database server and we need data only for THR, the first phase includes the use of the sequential query language, PostgreSQL, for the extraction of claim data from the server. We use SELECT and COPY command to write queries which can reference more than one database tables in a single command. The COPY command is used to export search result from SELECT query statement into Microsoft Excel for further statistical data analysis purpose.

In the second phase, we calculate the values of the independent and depending variables of our proposed model in Microsoft Excel. In this phase, we exclude few hospital admissions data as they have only one hospital claim to HCF, no medical or ancillary claim. This type of hospital admission data exists in the database because HCF made written contract with some hospitals to pay a fixed amount of money for some procedures like THR. Those hospitals make only one hospital claim to HCF if they have any

<table>
<thead>
<tr>
<th>Variable</th>
<th>How to Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree (patient)</td>
<td>Find out number of times doctors visit each patient of a hospital (H). Then calculate the average of these values for all patient admissions of H.</td>
</tr>
<tr>
<td>Connectedness (patient)</td>
<td>First, find out average number of times a patient is visited by each doctor of a hospital (H). Then calculate the average of these values for all patient admissions of H.</td>
</tr>
<tr>
<td>In-degree (doctor)</td>
<td>Find out the group of doctors (DG) who visit THR patient at least once of a hospital (H). Then find out average number of times each doctor of DG visit patients of H.</td>
</tr>
<tr>
<td>Out-degree (doctor)</td>
<td>Find out the group of doctors (DG) who visit THR patient at least once of a hospital (H). Then find out average number of times each doctor of DG visit patients of other hospitals.</td>
</tr>
<tr>
<td>Tie Strength (hospital)</td>
<td>For each admission, measure the percentage of cost coming from hospital claim. Then, calculate the average of these values for all patient hospital admissions.</td>
</tr>
</tbody>
</table>

**Note.** THR, total hip replacement.
patient going through one of those fixed contract procedures during the hospitalization period, no matter how many doctor visit the patient or how much the total hospitalization expenses.

In the third and final phase, values for all independent and dependent variables are placed into SPSS to perform statistical analysis for hypotheses testing. We applied the Spearman correlation test to examine our hypotheses. For any correlation test technique including the Spearman test, a higher correlation coefficient, both in positive or negative direction, indicates stronger relation between the independent and dependent variables involved in that correlation test.

Results and Discussion

Table 3. Statistics for the Hospitalization of THR Patient P1 and P2 Who Had Admission to Hospital H1

<table>
<thead>
<tr>
<th>Measure Item</th>
<th>P1</th>
<th>P2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Total hospitalization expenses</td>
<td>US$24,000</td>
<td>US$25,000</td>
</tr>
<tr>
<td>(b) Total cost for hospital claims only</td>
<td>US$18,000</td>
<td>US$20,000</td>
</tr>
<tr>
<td>(c) # of times patient is visited by doctors</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>(d) # of doctors who visit patient</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>(e) # of doctors who visit at least one THR patient of H1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>(f) # of times doctors (e) of H1 visit patient of H1.</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>(g) # of times doctors (e) of H1 visit of patient of other hospitals.</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>

Note: THR, total hip replacement.

Results and Discussion

The Spearman correlation coefficient values as stated in Table 4 show positive correlation for all relations of the first hypothesis for our proposed coordination model. We also demonstrate graphically how the change in the dependent variable of cost associated with the changes in the each of the five independent variables of our proposed coordination model in Figure 3. The correlation coefficient values for all relations are significant at 0.001 levels (two tailed).

(sH1) Degree (patient) has a positive correlation with average of total hospitalization expenses or cost.

We find that an increased in degree correlates with an increased average of total hospitalization expenses or cost (ρ = .704, p = .001, two tailed). The increased number of visits by hospital doctors and external doctors to patients during their hospitalization period makes their total hospitalization expenses higher. There could be interdependency between doctor visits to patients. For example, before having a surgery, surgeons have to wait for all required medical tests to be done. For this kind of interdependent doctor visits, the dependent doctors have to wait for the patient being visited by the independent doctor, which longer the patient hospital length of stay that lead to higher cost.

(sH2) Connectedness (patient) has positive correlation with average of total hospitalization expenses or cost.

The Spearman correlation test shows a positive result for this subhypothesis (ρ = .584, p = .001, two tailed) such that for patients,

Table 4. Spearman Correlation Coefficient Values for the Associations Between Cost and Five Independent Variables

<table>
<thead>
<tr>
<th>Measure Item</th>
<th>Average of Total Hospitalization Expenses or Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree (patient)</td>
<td>0.704***</td>
</tr>
<tr>
<td>Connectedness (patient)</td>
<td>0.584***</td>
</tr>
<tr>
<td>In-degree (doctor)</td>
<td>0.396***</td>
</tr>
<tr>
<td>Out-degree (doctor)</td>
<td>0.395***</td>
</tr>
<tr>
<td>Tie strength (hospital)</td>
<td>0.308**</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (two tailed).**
Figure 3. How the Changes of Independent Variables Affect the Dependent Variable of Cost

Table 5. Correlation Coefficient Values Between Independent and Dependent Variables of Our Proposed Coordination Model for Urban and Rural Hospital

<table>
<thead>
<tr>
<th></th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree (patient)</td>
<td>0.725**</td>
<td>0.609**</td>
</tr>
<tr>
<td>Connectedness (patient)</td>
<td>0.621**</td>
<td>0.425**</td>
</tr>
<tr>
<td>In-degree (doctor)</td>
<td>0.428**</td>
<td>0.308**</td>
</tr>
<tr>
<td>Out-degree (doctor)</td>
<td>0.527**</td>
<td>0.357**</td>
</tr>
<tr>
<td>Tie strength (hospital)</td>
<td>0.382**</td>
<td>0.096</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (two tailed).
It is evident from H1 that actor network attributes of degree, connectedness, in-degree, out-degree, and tie strength have impact on cost. In measuring these attributes (see Table 2), all patient admissions to a particular hospital are considered. By inference, it can be concluded that these attributes have influence on the actor network involvement and total hospitalization expenses of each patient hospital admission. The total cost of any patient hospitalization is paid either by patient or by health insurance organization or partially by both of them. Thus, from their perspective, the relations found from our proposed hypotheses can be used as guidelines to hospitals for developing their organizational healthcare practice structures to find a cost-effective way to provide treatments to patients.

Both in-degree and out-degree attributes of “doctor” actor show positive association with the average of total hospitalization expenses. For a doctor, high in-degree value indicates more visits to patients of his or her employer hospital. Conversely, higher out-degree value for a doctor represents frequent doctor visits to patients of hospitals except his or her employer hospital. So, higher value of both in-degree and out-degree make doctor professional life very busy in visiting patients who could have admissions in one hospital or in more than one geographically distant hospitals. Doctors then have less available time to see patients, which sometimes leads a long waiting period for patients to be seen by them. This long waiting time results longer stay in hospital for patients, which eventually make the patient hospitalization cost very high.

Healthcare managers or health insurance providers may use our relational hypotheses between attributes of patient-centered network and hospitalization expenses for developing healthcare practice culture, or motivating healthcare practitioner and other staff in order to find out a way about how to control or reduce total hospitalization cost for THR patient. For instance, the positive relation of sh4 denotes that the more doctors or physicians of a particular hospital visit patients of other hospitals; the average patient hospitalization cost for that hospital will be high. Using this relation, the healthcare managers may devote to develop an organizational culture where doctors or specialist surgeons do not visit outside patients frequently. Or health insurance organizations may provide suggestions for those hospitals they have explicit contract regarding patient payment policy to motivate their doctors to have less outside patient visit. In the similar fashion, other hypotheses could be celebrated by both healthcare managers and health insurance providers in order to reduce or control patient hospitalization expenses.

The network-based analysis of patient-centered care network contributes to the growing body of literature to the approach of coordination modeling. In this paper, the analysis of network involvement of actors has been successfully applied to model coordination cost in healthcare organizations. Actor network behavior is considered as independent variables and goals of actor network involvement are considered as dependent variable in our proposed coordination model. The measures and theories of SNA are applied to quantify actor network behavior. The hypotheses are based on the relation between independent and dependent variables of proposed coordination model. Hospitals or health service providers could be benefited in designing their organization settings using the hypotheses of our coordination model to minimize expenses.

This is a new approach for coordination modeling that enriches the current literature of modeling coordination.

Conclusion

In this research, we model coordination using SNA measures and techniques in the context of patient admissions for healthcare organizations. We present a model for coordination cost based on the analysis of patient-centered care network that evolve during patient hospitalization period. We hypothesize that the network attributes of this care network have effect on the total hospitalization expenses. Further, we demonstrate that locality of hospital moderate the relation between the independent and dependent variables of our model. In particular, the strength of relation between independent and dependent variables of our proposed coordination model is stronger for urban hospital than for rural hospitals. Using these relations from our hypotheses, the organizational setting of any healthcare providers can be reviewed and judged.

This research is not without its limitations. First, this research uses only THR dataset. However, people have hospital admissions for many other diseases as like ankle surgery and heart failure. For validity reasons, our proposed
model need to be tested by all types of hospital admission data. Second, we do not consider whether a patient has anyone at home to look after him or her after being discharged from hospital or not. If a patient has relative at home, hospital may discharge him or her early after giving proper training to the person who will take care of the patient at home. On the other hand, if a patient does not has anyone at home, he or she needs to stay at hospital until the complete recovery from disease, which will result longer length of stay in hospital that leads to higher cost. Third, we do not test the affect of these two factors on the relationships between independent variables and dependent variables of our proposed coordination cost model. Further, we do not set up either a minimum or a maximum threshold, for where network attributes of patient-centered care network no longer have any effect on cost. Despite these drawbacks possibly this is the first study to model hospital coordination cost by analyzing the attributes of patient-centered care network that develop during patient hospitalization period.

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