Introduction

Communication is a prominent feature of organization and optimizes team interaction and effectiveness (Brown et al., 2009). Effective communication and interpersonal interactions are critical in any organization, especially in complex and dynamic environments. Without proper communication and cooperation between hospitals managers, they will lack vital information and this will likely lead to poor quality care (Creswick et al., 2009). Communication can be formal or informal. Each administrative system has a planned and officially organized structure of roles (Amjad et al., 2015). Along with formal relations of the organization, there is a network of informal relations that connects members of the organization (Whetsell et al., 2021). In contrast with formal relations, informal relations are not based on a determined framework. These relations are an inevitable and inseparable component of any organization that may accelerate achieving the goals or, vice versa, may act as an obstacle (Neubert & Taggar, 2004). The essential role of informal relationships within an organization has been widely recognized. Informal roles have a great impact on operational and decision-making processes and knowledge sharing in organizations (de Toni & Nonino, 2010). Managers’ proper understanding of the depth of informal relations’ structure and network affects the activities and performance of the organization would be useful to increase the productivity of the organization (Chen & Ke, 2016).

Informal relations are also an essential source of the hospital’s activities and can be used as a way to coordinate
affairs. Besides, it can be used to find the human and capital resources needed for patient care (Mejia et al., 2010). Informal relations among health staff can potentially affect the operation and development of the health system (Maneechay & Pongpirul, 2015).

Previous studies showed that informal relationships can be both beneficial and harmful; these relationships help individuals to communicate with each other, support each other, and satisfy needs for social interaction. Support for organizational goals, effective communication, and the effect of compensating for managers’ lack of ability are also mentioned as the benefits of these relationships. Informal relationships, on the other hand, may be to the detriment of the organization; these relationships may be prone to spreading rumors (negative rumors), resisting change, and even diverting employees’ efforts from organizational goals. Also, people who do not join informal groups may feel uncomfortable and dissatisfied with their work. Although various studies have shown that the informal organization imposes constraints on the efficiency of the organization, there is also evidence that the informal organization can be a constructive force for the organization’s workflow and a tool for change (Amjad et al., 2015; Iosim et al., 2010; Kratzer et al., 2005; Kuipers, 2009; Lai, 2016).

Social network analysis (SNA) is the fundamental methodology used to analyze, visualize, and manage these invisible informal networks (Das et al., 2018). Previous studies were confirmed the usefulness of SNA in analyzing and visualization of informal communications, evaluating social structures and identified key informal roles in health care and any other organizations (Adlassnig, 2009; Allen et al., 2007; Creswick et al., 2009; Johansen & LeRoux, 2013; Scott et al., 2005).

Health-care system in Iran is governed by Iran’s Ministry of Health and Medical Education. The Ministry of Health (MOH) is responsible for planning, monitoring, and supervision of health related activities for the public and private sectors in Iran. Iranian hospitals are mostly public and are funded by the government and the budget, although there are also private hospitals (Rostamigooran et al., 2013). Due to the expansion of informal networks in the Iranian health system, the use of these networks is common. The purpose of our study was to use social network analysis to measure informal communication patterns and hospital manager’s interactions in hospitals. In this way, these networks can be properly managed and used for the purposes of the organization. To carry out this, two aspects of communication and interaction amongst managers were analyzed: a problem-solving and financial information/advice-seeking. Problem-solving network is the “network of advice relationships within the organization which allow solving working issues” (Cross et al., 2002; de Toni & Nonino, 2010), or “a problem-solving network is a general network which encompasses organizational interactions” (Creswick et al., 2009). The information and advice-seeking network involves key interactions related to working communications within the organization (Creswick & Westbrook, 2010; Cross et al., 2002). In this study, the problem-solving network is a network that is used to help managers to solve work-related problems, and financial information/advice-seeking network are used to obtain advice for financial decisions and tasks.

Methodology

This descriptive-analytical study was conducted in hospitals affiliated to a university of medical sciences in Iran in 2020. This study was conducted as a mixed method. Mixed method study is an approach that involves collecting, analyzing, and interpreting quantitative and qualitative data in a single study or in a series of studies that investigate the same underlying phenomenon. One of the reasons for using this approach is developing a tool based on qualitative study results (McKim, 2017; Mele & Belardinelli, 2019). Since this study was need to suitable tool for assessing informal communication, the mixed method approach was used. Therefore, this study was conducted in two stages. The first stage was a qualitative study conducted using semi-structured interviews to identify key actors related to the hospitals managers’ problem-solving and financial information and advice-seeking networks. The research population in this stage included senior hospital managers and other health professionals who had sufficient knowledge and experience in the field of research. Purposeful and snowball sampling was used to select individuals. The study sample consisted of 34 people including managers of hospitals. The selection criteria were people who were aware of the issue and interested in participating in the study. The interviews continued until the data were saturated. The recorded material was transcribed word by word. After that the written interview read several times to gain a deeper understanding the participants’ feelings and experiences, and then analyzed. Finally by analyzing the data of this stage, 17 key actors who informally influenced the problem-solving and financial information/advice-seeking networks of hospitals managers were identified and they used as answering options for questions in final questionnaire.

The second stage was conducted using social network analysis to identify powerful actors in this process. The relations between identified actors in the first stage were analyzed using the SNA. SNA is defined as a distinct set of special methods developed to investigate, measure, and analyze social structures between individuals, groups, and organizations (Blanchet & James, 2012). Indeed, SNA is an important method for identifying the power of various actors based on their structural and communicational characteristics, which in turn reveal their power, position, and role in political decisions (Wang, 2013). It can be used as a basic method for analyzing, visualizing, and managing invisible informal networks in the organization (Marin & Wellman, 2011). A questionnaire was used to collect data related to network analysis. The questionnaire was designed
based on standard questions of network analysis used in other studies (Creswick & Westbrook, 2010; Cross et al., 2002; Mohammadi et al., 2011; Scott et al., 2005) as well as information collected from interviews. It was reviewed according to the objectives of the study and its validity and reliability were evaluated and confirmed. The validity of the questionnaire was evaluated and confirmed based on the opinions of eight experts using the face validity assessment method by considering difficulty, inappropriateness, and ambiguity of the questions.

The reliability also was assessed using filling this questionnaire with 15 experts and evaluating Cronbach’s alpha that it was reliable ($\alpha \geq .7$). This questionnaire was divided into two sections. Section A dealt with demographic data of the respondents and Section B contained network analysis questions. This section contained a list of the names of all individuals who were identified in semi-structured interviews and participants must choose from these individuals and mark those with who they are in informal contact. The survey instrument included the following questions:

a. Which of these people do you usually want to help you solve a work-related problem?
b. Which of these people do you seek advice on financial decisions/tasks?

The study population consisted of senior managers of hospitals affiliated to the Tehran University of Medical Sciences. The whole network approach was used to identify their interactions. Accordingly, all senior hospital managers ($n = 70$, response rate = 97%) were selected.

UCINET software was used to carry out social network analysis. For this purpose, a two-mode matrix was designed in Excel, the managers were on the row and positions related to problem-solving and financial information/advice-seeking were on columns. Then, this two-mode matrix entered the UCINET software and converted into a one-mode matrix (actor-actor). Moreover, NetDraw software was used to visualize the networks of problem-solving and financial information/advice-seeking. Network properties were analyzed using density, degree centrality, and betweenness centrality.

Density is defined as the number of direct relationships between factors in a network and contains the highest possible share of the relationships in the network. The value of the network density is between 0 and 1, where the value of 1 means the complete network density (Blanchet & James, 2012).

Degree centrality is one of the centrality measures in the network. “For an actor, it is the proportion of nodes that are adjacent to that actor in a network. It highlights the node with the most links to other actors in a network” (Das et al., 2018).

Betweenness centrality indicates the number of shortest paths of the node in question divided by the total number of shortest paths in the network. This criterion shows how much an actor is in the communication path of other actors and communication is done through him. The betweenness centrality measure identifies the position of an entity within a network in terms of its ability to communicate with other pairs or groups in the network. That is, actors who are in the shortest paths between pairs of other nodes have more betweenness centrality than other actors (Borgatti et al., 2009; Das et al., 2018).

**Results**

The results of the qualitative phase showed that informal communication is a way that hospitals managers usually solve the work-related problem and seek advice through it. Indeed, managers use informal channels to solve the work-related problem and seek advice because white these do things faster.

“One of the most important reasons for using informal relations is the slow pace of administrative affairs in hospitals. One of the main characteristics of informal structures is their speed.”

“Informal communications can facilitate doing activities, of course, if be used properly. When I correspond with an upstream department of the organization, it will take a long time to receive my answer, while through using informal channels, I can be informed of the outcome very fast.”

Another interviewee stated:

“The main reason why people engage in informal relations is speeding up doing works and not being subject to any time or place limitation.”

Based on the structure of the Iranian health system and findings from the interviews, the actors involved in these networks were at the University of Medical Sciences (UMS) such as financial manager, budget manager, human resources manager, deputy of treatment, deputy of management development and resources, deputy of development advisors, chancellor of the university, and budget experts and at the Ministry of Health and Medical Education (MOHME) such as deputy of management development and resources, financial manager, director of the office of physical resource development, deputy for treatment, budget manager and Minister’s Office and they may even be outside of healthcare systems such as planning and budget organization, Health Commission of the Parliament, and Parliament members.

**Problem solving network**

As indicated in Table 1, the key actors are determined based on their centrality. Actors with a higher degree centrality have more access to resources and information. Hospital managers need information to solve their problems. Informal communication can be an effective means of
obtaining and disseminating information when information is highly needed by the staff to perform their tasks.

"Managers can use informal communication networks as a way to gather useful information. In this way, they can identify the organization’s problems and consequently seize opportunities that arise. All organizations have access to a lot of information that can be transmitted through informal channels and discussions outside the framework of official relations."

When hospital managers need help to solve work-related problems, they usually ask the university’s budget experts, followed by the University’s budget manager, the University’s financial manager, and the University’s deputy of management development and resources.

Betweenness centrality also indicates the mediating role of network members. The university’s budget manager and budget experts have the highest betweenness centrality, followed by the University’s deputy of management development and resources and financial manager (Table 1). While in the formal organizational structure, the president of the university is the highest official, followed by the vice president for development, the financial manager and the budget manager and budget experts are at the bottom of the organization.

Figure 1 shows the frequency of interaction between hospital managers and other actors when they are asking for help to solve a work-related problem. The difference of centrality of actors is shown with a difference in the size of squares, so that actors with more centrality are shown in a bigger size. The value of density of the problem-solving network among actors was 23%. Based on the density index, it can be argued that the level of organizational cohesion among the actors of the network is weak and communication and collaboration between actors in the network were not desirable.

### Advice seeking network

In the financial advice-seeking network, the most common target of managers was the University’s financial manager, University’s budget manager and University’s budget experts. This means that hospital managers usually seek financial advice from these people. In contrast, informal methods, information is usually obtained in a hierarchically.

Also, The University’s budget experts and budget manager have the highest betweenness centrality, followed by the University’s deputy of management development and resources and financial manager (Table 2). While in the formal organizational structure, the president of the university is the highest official, followed by the vice president for development, the financial manager and the budget manager.

The degree centrality of actors involved in hospitals managers’ Advice seeking network is depicted in Figure 2. The difference of centrality of actors is shown with a difference in the size of squares, so that actors with more centrality are shown in a bigger size.
Discussion

The current study aimed to identify informal communications in hospitals. Our findings showed that for hospitals managers, these relationships play an important role in solving works related problems and seeking advice. An informal communication network is a structure through which personnel exchange work-related information or problems outside of standard formal structures. These networks are growing in critical situations where the need for cooperation is increasing. The application and usefulness of informal networks have been investigated in various studies (Bdeir et al., 2017). In fact, it can be said that the formal organization is like the skeleton of the organization, while the informal organization is the central nervous system (Krackhardt & Hanson, 1993).

Table 2. Degree and betweenness centrality in the hospitals managers’ advice seeking network.

| Organizational level | Actors                                                   | Degree centrality | Betweenness centrality |
|----------------------|----------------------------------------------------------|-------------------|------------------------|
| University of Medical Sciences (UMS) | Budget experts                                           | 54                | 3.551                  |
|                      | Budget manager                                           | 53                | 3.659                  |
|                      | Financial manager                                        | 49                | 3.925                  |
|                      | Deputy of treatment                                      | 47                | 2.891                  |
|                      | Deputy of management development and resources           | 47                | 3.556                  |
|                      | Deputy of management development advisors                 | 43                | 2.344                  |
|                      | Chancellor of the university                              | 35                | 1.577                  |
|                      | Human resources manager                                   | 33                | 1.541                  |
| Ministry of Health and Medical Education (MOHME) | Deputy of management development and resources           | 21                | 1.735                  |
|                      | Financial manager                                        | 17                | 1.105                  |
|                      | Director of the office of physical resource development   | 14                | 0.294                  |
|                      | Deputy for treatment                                      | 14                | 0.615                  |
|                      | Budget manager                                            | 17                | 1.717                  |
|                      | Minister’s Office                                         | 19                | 0.847                  |
| Others               | Planning and budget organization                          | 12                | 0.764                  |
|                      | Health Commission of the Parliament                       | 21                | 1.187                  |
|                      | Parliament members                                        | 13                | 0.840                  |
We identified some similarities between our findings and the results of previous research. A study showed that informal relationships increase collaboration and the knowledge sharing flow within the organization (de Toni & Nonino, 2010). The results of a study showed that informal networks promote formal and temporary community-based networks, thus improving the effectiveness of disaster medicine and public health preparedness (Bdeir et al., 2017). Creswick et al. examined the three networks including problem-solving, medication advice-seeking and socializing networks in an Australian hospital ED. The Result showed that to solve work-related problems ED staff relied on each other (Creswick et al., 2009).

The findings of the present study showed that the financial manager, budget manager, and budget experts were key roles in problem-solving and advice-seeking networks and acted as information brokerage agents. Informal communications act as facilitators of obtaining additional advice and information about financial problems. The structural or hierarchical position of the actors indicates their formal power in the organization, but sometimes informal power can be more effective than formal power in organizations. The search for informal power requires looking at the hidden aspects of organizations. Friendship groups or alliances that result from employees’ personal networking activities can create unpredictable power relations in organizations (Labun, 2012). The study by Boyer et al. (2010) showed that among health professionals, physicians had the highest scores in group centrality, credibility, and indicators, and played a key role in improving service quality and strengthening health care management and leadership. In addition, relations with legislators often lead to access to resources through informal methods (Davies, 2013). A study by Scott et al. (2005) also found that managers and physicians had the most authority in decision-making consultation patterns among the primary care practices. Informal relations with influential authorities are factors that affect resource allocation. Although the allocation of healthcare resources is based on predetermined formulas and indicators, informal relations with senior officials and managers of the MoHME often lead to receiving more resources (Mohsenpour et al., 2017). The power of each individual depends on its position in the official relations network, the density of its communications with other organizations, the organization’s position in the informal relations network, and having few, but influential and important relations with influential authorities in the network (Cross & Prusak, 2002). The findings of a study in this field showed that that communication with the country’s dominant political party is one of the main levers for allocating more financial resources to medical universities (Mohsenpour et al., 2017).

The present study showed that network analysis is a tool to show the hidden communication and information flow between individuals and is used as a basic method for analyzing, visualizing, and managing informal networks in the organization. Undoubtedly, using social network analysis technique is useful for understanding the organization (Flynn, 2015). This approach can be useful in examining the interaction between emergency department employees, their leaders, policymakers, and researchers (Creswick et al., 2009) and provides indicators of team performance that can be used as predictor variables in care quality studies (Lurie

Figure 2. Advice seeking network graph based on betweenness centrality. 
Note. Green squares, university-level actors; blue squares, actors at the level of the Ministry of Health; and the red squares show the other actors.
et al., 2009). This method has been used in various fields such as emergency department in hospital (Creswick et al., 2009), primary health care (Scott et al., 2005), information systems industry (de Toni & Nonino, 2010), Research and Development (R&D) (Allen et al., 2007), Construction Business (Assaad & El-Adaway, 2020), and etc. In all these studies, network analysis has been introduced as a tool for understanding relationships in the organization.

**Study limitation**

There were some limitations to doing this study. One of the important limitations was about sample size. Since we selected our participants from hospitals affiliated to the Tehran University of Medical Sciences, the sample size was small. Therefore the generalization of this finding is unclear and we suggest that it was tested in future studies with more sample size. The second limitation was about showing informal relationships in the form of research and scientific work because gathering information in this field is not easily possible due to its sensitivity. The third limitation was about conservatism of some participants’ in answering questions or reluctant to record their actual opinions, in which case we tried to solve the problem by justifying them about the purpose of the study and making sure that all their opinions were considered confidential. The final limitation was about lack of cooperation of some managers due to busy work, which in some cases was solved with the help of supervisors and consultants.

**Conclusion**

Despite formal communication methods, managers are sometimes forced to use informal methods. In this study, we analyzed the informal networks of managers and identified key informal roles in these networks. Hospital Managers need to have a better understanding of invisible relationships because these relationships improve or may worsen collaboration and enable knowledge sharing in the organization and thus influence the decision-making process of managers. However, it should be noted that excessive use of such relations is subject to the law of diminishing return, which means the gradual decline of benefits that paves the way for the formation of informal, illegal relations and, consequently, corruption. Although informal relations are an integral part of employees’ daily activities, these relations should only be used in necessary cases. Therefore, if not used properly, may cause negative consequences. As much as informal relations have positive effects, lack of control and supervision of such relations can also divert employees’ attention from the organization’s goals. Using social network analysis, managers can identify the influential people of organization and knowledge of the organization and evaluate the amount, intensity, and type of information flow in the formal and informal network of the organization and use it in their decisions. In our country, due to the existence of a large government sector and its considerable resources, this sector operates in various fields and there is competition for resources from both members of the bureaucracy and some non-bureaucratic interest groups. To this end, managers of organizations are interested in informal contacts and close contacts with officials in the upper echelons of the decision-making position, because this way they can easily achieve their individual and organizational goals and gain more resources. For this reason, in some fields (such as attracting more resources), informal communication seems to be more effective than formal communication. In final, the finding of this study can be used by researchers and senior managers of health care organizations for improving collaborative networks, pooling financial resources, and human capital.

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**Author contributions**

MA and EJ generated the research idea and designed the work. BK and MT revised the research article for submission. BK and HM carried out data analysis and interpretation, and drafted the research article. BK collected the data. BK and MT revised the manuscript for submission. All authors have read and approved the manuscript.

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**Ethics approval and consent to participate**

The study was approved by the Ethical Committee of Tehran University of Medical Sciences (the ethical code: IR.TUMS.SPH.REC.1397.145). An informed written consent was obtained from each participant at the beginning of the study after explanation of the objectives of the study, procedures, and types of information to be obtained.

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