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The condition of interdisciplinary communication among various Educational and Research Departments of Isfahan University of Medical Sciences

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Abstract:

BACKGROUND: The study aimed to assess interdisciplinary communication among various Educational and Research Departments of Isfahan University of Medical Sciences (IUMS) in clinical medical sciences using social network analysis.

MATERIALS AND METHODS: The study was carried out using scientometrics method and interdisciplinary communication network analysis. Interdisciplinary network of 1298 articles in medical sciences published in Journal of Isfahan Medical School was evaluated using macro- and micro-level criteria of network analysis. Ravar Matrix, UCINET, and VOSviewer software were used to analyze the interdisciplinary network of medical sciences articles.

RESULTS: Findings showed that "Students Research Committee" and "School of Medicine," the affiliations of the medical students in general practice with scores of 272 and 197, "Epidemiology and Biostatistics," "Community Medicine," and "Internal Medicine" with 170, 101, and 99, respectively, possessed the first ranking of productivity index in scientific communication. Furthermore, in betweenness centrality index, "Epidemiology and Biostatistics" (3427.807), "Students Research Committee" (2967.180), and "Community Medicine" (1770.300) have an appropriate position in the network. Based on the centrality index, "Epidemiology and Biostatistics" (22.412), "Students Research Committee" (22.185) as well as "Community Medicine" and "School of Medicine" (both 21.554) acquired the least amount of distance with other nodes in network.

CONCLUSION: Given the increased specialization in medical fields in recent years, communication between researchers with various specializations and creation of interdisciplinary or multidisciplinary departments had turned into an undeniable necessity. Therefore, communication between educational or research departments can facilitate the flow of information between researchers; and consequently, the top ranking departments in this study had more participation in scientific production of IUMS and getting more scores in annual evaluation by scientometrics department. This network analysis showed that researchers in various medical fields closely collaborate with each other and are able to connect with <2 intermediates.

Keywords:

Clinical research, interdisciplinary communication, social network analysis

Introduction

Medical sciences are closely related to the individuals' health as well as society well-being, and specialists in these fields must use various information sources to improve their abilities and performances.[1] Advances in every field depend on publishing the outcomes of the

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researches in that field in a timely manner and using the best possible methods.[2] In the field of medicine and health, these results and accomplishments (in the form of articles) can not only improve the general knowledge but also play an important part in improving the health of the individuals.[3]

Given the speed of changes and advances in the field of medicine and due to the generating of the most modern methods of diagnosis and treatment, the importance of scientific and professional journals in sharing studies in the area of health and medicine and facilitating communication between researchers becomes more evident.[4] Today, unlike the ancient times, no one can boast a comprehensive knowledge of all fields and work alone in research.[5] Therefore, to produce more appropriate scientific output, researchers attempted to benefit from scientific and group communications. Scientific collaboration is an efficient method to accomplish new knowledge and technologies in developing and developed societies.[6]

Evaluating coauthorship networks to investigate the links and relationships between organizations and scientific institutions is one of the methods to assess the quality and quantity of scientific collaboration and analyze the structure of the relations in scientific community.[7,8] Until now, several studies carried out to investigate interdisciplinary networks in various scientific fields, especially in medical sciences using social network analysis (SNA) indexes. A study by Danesh *et al*. showed that fields of "General Medicine," "Cardiology," and "Dermatology" are the most active disciplines in Isfahan University of Medical Sciences (IUMS) in scientific production.[9] In another study by Vatankhah, in Zahedan University of Medical Sciences, educational departments of "Infectious Diseases and Tropical Medicine," "Biochemistry," "Epidemiology and Biostatistics," "Physiotherapy," "Pediatric Dentistry," and "Nursing" comprised the highest amounts of scientific production.[10] The results of the study by Nouri *et al*. about scientific production of faculty members of IUMS based on the Web of Science database showed that between years 2000 and 2005, Departments of "Pharmacology," "Internal Medicine," and "Pharmaceutics" allocated the highest scientific productions.[11]

Yu and Kak in their study on scientific communication of Chinese researchers in the fields of cardiology and myocarditis identified 63 constant research groups intending scientific communication in these fields and concluded that examining scientific communication networks play an important part in identifying the leaders of each group and their supporting role for future studies.[12]

In the study by Kronegger *et al*., about the structures of scientific collaboration in scientific communities of Slovenia in four fields of physics, mathematics, biotechnology, and sociology concluded that these fields influenced by organizing the local institutions and publishers. In addition, their structures had the features of a "small world" and "preferential attachment" obviously expressed in this coauthorship network.[13]

Given the importance of clinical studies and their relation to the health situation in societies and due to communication of researchers from various disciplines being the basis of research efforts in these fields, this study aims to investigate the collaboration networks between various Educational and Research Departments in IUMS for researches in clinical medicine using SNA to recognize the scientific efficiency and capacities of the educational and scientific departments in medical sciences to prepare the facilities of development and growth in the society.

Materials and Methods

This was an applied research that carried out using scientometrics method and network analysis to visualize the scientific collaboration network among various educational and research departments in the targeted journal. The study population consisted of 1298 articles published in JIMS between years 2010, indexed in the Scopus database, and 2014; data gathered from August to October 2015. The published editorials, letters to editor, and video clips during this period were excluded from the study for their different contents and subject with other articles. In the first step, the articles were downloaded from Scopus database, and the organizational affiliations of the researches were determined. Then, the titles for various educational and research departments, research institutes, and departments were regularized and standardized; the data were saved in plain text format. Ravar Matrix software (version 2, Ravar Matrix, Yazd, Iran)[14] was used to construct the collaboration matrix between educational and research departments.[14] In the second step, to draw and analyze the interdisciplinary network, UCINET (version 6.463, UCINET, Harvard, MA)[15] as SNA software[15] and VOS viewer software (version 1.5.4, VOSviewer, Leiden University, Leiden, Netherland)[16] were used.

After that, the scientific collaboration network among educational and research departments was analyzed at micro and macro levels. Macro-level indicators of SNA investigate the topology and possible performance of social structures, department performance, and overall network features. Among these criteria, density,

clustering coefficient, network components, and diameter were assessed. The ratio of the number of existing links in the network to the number of possible links demonstrates the network density and is always a value between 0 and 1 and shows the degree of cohesion for nodes. Clustering coefficient is the ratio of the links around each node to the total possible links and is between 0 and 1. Network components are sets of nodes that are linked to another node through one or several links meaning that all nodes in a network component are linked to each other either directly or through intermediates (a series of links).[17] Network diameter is the ratio of the longest path distance to the shortest one in the network. A shorter network diameter associates with the higher communication and faster data transfer.[18]

Besides the macro-criteria analysis, the performance of each node in the network was investigated using micro criteria. Centrality is one of the common micro criteria in SNA which investigates the importance and effectiveness of nodes in the network and provides useful information for assessment the performance of each educational and research department. The centrality of nodes was evaluated using three criteria of degree centrality, betweenness centrality, and closeness centrality. Degree centrality of a node in a social network shows the number of links between that node and other nodes in the network. On other words, in a cohort network, degree centrality of each node shows its cohesion with other nodes in the network. Betweenness centrality of a node shows the number of times that node is connected to other nodes using the shortest possible link in the network. Closeness centrality of a node is the shortest possible link between that node and other nodes in the network.[19]

Results

Interdisciplinary communication network and cluster analysis of the departments

The scientific communication network between educational and research departments for the articles was assessed in micro and macro levels. This network includes nodes and links. Each node represents a department, and a link between two nodes shows collaboration between those two departments. The collaboration network of this journal consisted of 195 nodes and 2754 collaborations (links) [Figure 1]. The network density was equal to 0.74, showing that 74% of all potential links have been actualized. The clustering coefficient was equal to 0.85 showing that if two departments of A and B have independent collaborations with department C, with a possibility of 85%, A and B will have communications in the near future.

Investigating the components of interdisciplinary communication network in the targeted journal shows

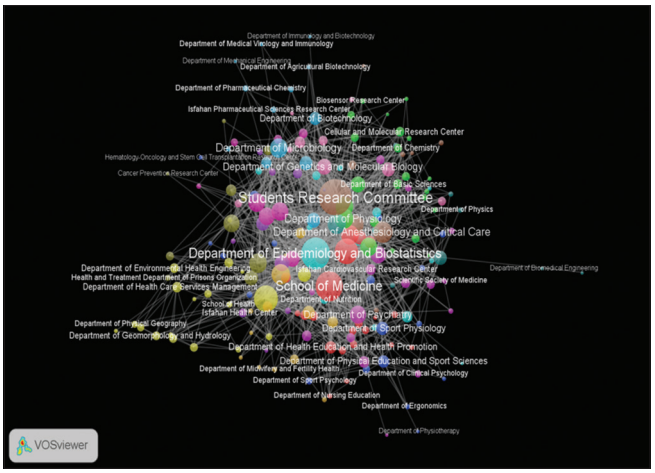

Figure 1: Interdisciplinary communication network for educational and research departments

that this network consists of one single, main component that includes all 195 departments (nodes) and 2754 cohorts (links). The average distance between nodes in the network is 2.282. Based on these results, it can be said that the average distance of two nodes in this network is two, and two nodes representing departments can connect to each other through an average of two intermediates. In Figure 2, five departments with the highest centrality degree are shown. These departments are the most active nodes in the network and have the highest amount of scientific collaboration with other nodes.

Figure 3 shows the density of communication network between educational and research departments visualized using VOSviewer software. In this map, departments with higher number of scientific communications with each other are shown closer to each other while departments with less communication are further from each other. The density of each department is determined based on its number of scientific productions and the number and importance of its neighboring nodes. If a node be more close to the center of the density map, it can be more important in the communication network. Furthermore, the color spectra of red to blue show higher to lower density weight for the network nodes. Based on these results, "Students Research Committee," "School of Medicine," and "Department of Epidemiology and Biostatistics" had the highest amount of density in the network. On the other hand, cluster analysis shows that this network consists of 15 different clusters. Among these, the first cluster including "Internal Medicine," sixth cluster including "Epidemiology and Biostatistics," and tenth cluster including "Student Research Committee" are the most important clusters.

Performance of the departments based on production and centrality criteria

Investigating the scientific collaboration situation between educational and research departments

showed that "Students Research Committee" and "School of Medicine," the affiliations of the medical students in general practice with scores of 272 and 197 and "Departments of Epidemiology and Biostatistics" (170), "Community Medicine" (101), and "Internal Medicine" (99) allocated the best ranks in the productivity index. Table 1 shows the performance of 15 top departments based on production, centrality, betweenness, and closeness criteria.

Based on the centrality degree or the number of scientific collaborations, researchers of "Students Research Committee" (531), "Department of Epidemiology and Biostatistics" (387), "School of Medicine" (321), "Community Medicine" (231), and "Internal Medicine" (214) had the most number of communications with other departments and in other words were departments with the highest amount of communication in the network.

Based on the betweenness index, "Department of Epidemiology and Biostatistics" (3427.807), "Students Research Committee" (2967.180), "Community Medicine" (1770.300), "Internal Medicine" (935.631), and "Physiology" (918.473) had suitable positions in the network and had the shortest paths for communication

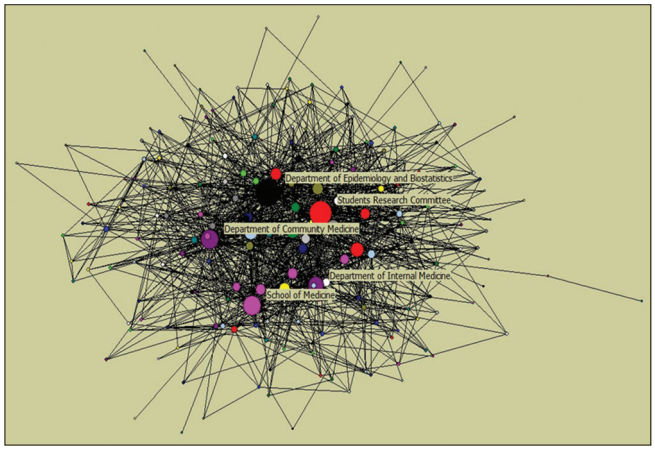

Figure 2: Five departments with the highest centrality degree

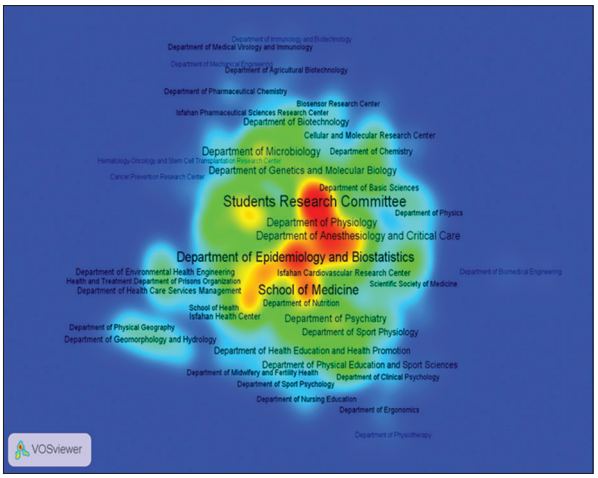

Figure 3: Density map of the interdisciplinary communication network between educational and research departments

Table 1: Fifteen superior departments based on centrality and production

Rank	Productivity		Centrality degree		Betweenness centrality		Closeness centrality	
	Department	Score	Department	Score	Department	Score	Department	Score
1	Students Research Committee	272	Students Research Committee	531	Epidemiology and Biostatistics	3427.809	Epidemiology and Biostatistics	22.412
2	School of Medicine	197	Epidemiology and Biostatistics	387	Students Research Committee	2967.180	Students Research Committee	22.185
3	Epidemiology and Biostatistics	151	School of Medicine	321	Community Medicine	1770.300	Community Medicine	21.554
4	Community Medicine	101	Community Medicine	231	School of Medicine	1353.752	School of Medicine	21.554
5	Internal Medicine	99	Internal Medicine	214	Internal Medicine	935.631	Internal Medicine	21.251
6	Microbiology	89	Anesthesiology and Critical Care	139	Physiology	918.473	Immunology	21.070
7	Anesthesiology and Critical Care	87	Pediatrics	125	Pediatrics	837.002	Pediatrics	21.070
8	Biology	74	Pathology	123	Biology	780.736	Physiology	20.980
9	Pediatrics	73	Physiology	119	Microbiology	729.902	Biology	20.957
10	Physiology	65	Infectious Diseases and Tropical Medicine	115	Physics and Medical Engineering	593.401	Pathology	20.957
11	General Surgery	64	Microbiology	114	Neurology	541.485	Neurology	20.825
12	Pathology	58	Immunology	110	Immunology	502.903	Cardiology	20.715
13	Neurology	56	Biology	106	Pathology	488.041	Microbiology	20.715
14	Infectious Diseases and Tropical Medicine	52	General Surgery	105	Hematology and Oncology	420.597	Mycology and Parasitology	20.650
15	Immunology	51	Neurology	104	Mycology and Parasitology	400.151	Psychology	20.564

with other departments. These departments control the information flow within the network.

Based on closeness index, "Department of Epidemiology and Biostatistics" (22.412), "Students Research committee" (22.185), "Community Medicine" and "School of Medicine" (21.554), "Internal Medicine" (21.251), and "Immunology" (21.070) had the least amount of distance with other departments in the network. The high closeness index of these departments shows the effectiveness, centrality, and the key role of these departments in information flow within the network. By considering all three indexes, it can be said that these six above-mentioned nodes have the most amount of influence in the network [Table 1].

Discussion

Interdisciplinary nature of some sciences demands the scientific collaboration between researchers with different specialties and course.[20] In clinical researches, due to the more specialty fields and also the experimental, laboratorial as well as interdisciplinary nature of the studies, scientific collaboration between various educational and research departments is inevitable. In addition, collaboration between departments can help better flow of the information between health-care providers and givers.[3] Therefore, this study aimed to investigate the scientific collaboration between Educational and Research Departments of IUMS in clinical medicine using scientometrics and SNA criteria to recognize the scientific efficiency and capacities of the educational and scientific departments in this domain to prepare the facilities of development and growth in the society.

The results of the study, in macro-level criteria, showed a high clustering coefficient of the journal network (85%) which indicates a high inclination of various departments to create different clusters and collaborate with others. Network density also showed high network cohesion and suitable links between departments in a way that 74% of all the potential links in the network have been actualized. These results are similar to studies by Erfanmanesh and Basirian Jahromi[21] and Zare-Farashbandi *et al*.[5] in regard to clustering coefficient index. The results are also similar to the study by Mazaheri *et al*. that evaluated the coauthorship network of the targeted journal in high density and clustering coefficient indexes.[22] The average distance of the nodes in the network is close to two which means every department in the network can connect to other departments using an average of two intermediates. Therefore, it can be concluded that the information needed for effective communication has a suitable flow in the network. Furthermore, close communication between departments in this network can be due to specialized nature of the journal and concentrating on articles in clinical medicine which is by nature an interdisciplinary field.

Based on the micro criteria and the performance of each department, in the production or communication index, "Students Research Committee," and "School of Medicine," the affiliations of the medical students in general practice and departments of "Epidemiology and Biostatistics," "Community Medicine," and "Internal Medicine" possessed the highest ranks of communication. These departments were closer to other nodes compared to other departments with fewer productions and had a more central position in the network. Kretschmer[23] in his study stated that departments with most productions often belong to the main component of the network. The results of the current study were similar to the results reported by Danesh *et al*., in which "General Medicine" was the department with the highest amount of communication in research projects.[9] The findings of Abazari *et al*.[24] also showed that a sizable portion of scientific productions in the field of medicine worldwide was in the area of general medicine which confirms the results of the present study. Of course, since the targeted journal mostly publishes the results of dissertations by the medical students in general practice and all these students are the members of "Students Research Committee" and "School of Medicine," it was expected for these departments to have the highest number of scientific productivity. In this study, in the productivity index, "Department of Infectious Diseases and Tropical Medicine" was in the 14th place while in the study by Vatankhah[10] about scientific productivity of Zahedan University of Medical Sciences, this department was in the first place. This difference can be due to personal differences as well as different policies offered by the scientific authorities in the universities for various educational departments.

In the centrality degree index, "Students Research Committee," "Epidemiology and Biostatistics," "School of Medicine," "Community Medicine," and "Internal Medicine" allocated the highest ranks. These departments are the active scientific departments in the network; in other words, the researchers of these departments are the most active and use various methods to meet their research needs and are less dependent on other individuals.[25] The rank of "Department of Epidemiology and Biostatistics" as the second most central department is in agreement with the results reported by Danesh *et al*. who reported "Biostatistics" to be the most active department in scientific communication in IUMS. This can be due to collaboration and research activities of this department in various clinical fields. Mazaheri *et al*.[22] in their study of coauthorship networks of this journal mentioned to the active communication of the

researchers of this department in the role of biostatistics consultants in clinical studies.

Based on the betweenness index, "Department of Epidemiology and Biostatistics," "Students Research Committee," "Community Medicine," "School of Medicine," and "Internal Medicine" were in the best positions in the network and had the highest possibility of being in the shortest possible distance of other departments. In other words, departments with high betweenness play an important role in linking the network nodes and have a central position in the network. These departments also play an important role in the information flow of the network. In the study by Vatankhah,[10] "Internal Medicine" was in the second place compared to other clinical departments. If we do not consider the "Department of Epidemiology and Biostatistics" as a clinical department, in our study, "Internal Medicine" is in the fourth place. Given the numerous subdepartments of this department (nephrology, gastroenterology, endocrinology, etc.), it was expected for it to have a better position in the network. It appears that one of the reasons for this result is the lack of coordination in giving affiliations and mentioning affiliated research centers of this department without mentioning the department itself in the articles.

Departments of "Epidemiology and Biostatistics," "Students Research Committee," and "Community Medicine" had the least amount of distance with other departments in the network based on closeness index. In other words, these three were the most accessible departments in the network. The high closeness index of these departments shows their influence, centrality, and key role in distribution of information in the network. In the study by Vatankhah, "Epidemiology and Biostatistics" also had a significantly better position compared to other departments in the School of Health, which can confirm the results of this study because the researchers of this department can be more accessible in the clinical studies that need statistical analysis. One of the interesting points of the study is the place of "Community Medicine" among the highest ranks in all indexes which, given the mission of this department which is institutionalization of basic health care in the society and prevention services, show high communication of this department in clinical fields and actualization of the "prevention is better than cure" policies. Furthermore, without doubt, the prominent role of Students Research Committee in all indexes can be due to research activities of the students and popularity of research in the university.

Conclusion

Given the increased specialization in the medical fields in recent years, communication between researchers with different specializations in clinical studies and creation of multidisciplinary or interdisciplinary departments has turned into an undeniable necessity. Communication between educational or research departments can facilitate the flow of information between researchers. The analysis of the communication network in the targeted journal showed that researchers in various areas of medical studies have close collaborations with each other and can play a critical role in facilitating the information flow between other scientific fields. The part of this communication is due to the simultaneous membership of researchers in educational departments, research centers, and university hospitals, and another part of this communication is due to supervision of students by various faculty members and membership of all students in student research community.

Suggestions

- Increased interdisciplinary communication to ease the information flow among the researchers and consequently the increase of the quality of scientific productions and more visibility
- Special attention to interdisciplinary fields and emerging trends in policymaking and development of the university disciplines.

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Conflicts of interest

There are no conflicts of interest.

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