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Professional associations and CME: A mutually beneficial relationship?

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Dr. Margolis is the CEO of EviMed corporation, the company where several of the experiences regarding international online CME were collected.

Dr. Parboosingh has nothing to disclose.

Abstract

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In this paper, social network analysis, based on the application of network theory and other theories, is proposed as an approach to better understand the contribution networking and interactivity between health professionals in professional communities make to their learning and adoption of new practices over time.

Key words

Continuing medical education, socio-cultural learning, communities of practice, social network analysis, Internet.

Background

Studies show differences between generalists and specialists in their participation in CME in different settings[1,2], including Latin American countries. Specialists in Latin America tend to have higher rates of attendance, participate more actively in discussions and feel more comfortable sharing personal practice experiences with peers and faculty. Specialists are more likely to complete course requirements. [3-7] Author AM and colleagues report that less than 10% of the general practitioners and family physicians of the invited audience in the Latin American region attended CME courses that were free and designed to meet their practice needs. [3,6] Similar CME courses for specialist Pediatricians, Cardiologists and Nephrologists attracted in general 20 to 30% of invited specialists. Less than 15% of generalists compared with 35 to 45% of specialists who participated in online courses completed all course requirements and received a diploma. [3,4] In our experience, specialists feel more comfortable presenting their own cases at CME events and innovative ways to improve practice frequently emerge from these interactive sessions. Similar trends in differences between specialist and generalist participation have been observed in national and in International CME programs held in 20 countries in Latin America. [3-7]

AM and colleagues observed that specialists attending CME courses tend to know each other, which leads to the suggestion that differences observed in participation at CME events could be partially explained by differences in the networking habits of specialists and generalists. Specialists at CME events network more effectively than generalists and build relationships that facilitate learning together. Unlike generalists, specialists attending CME courses are often members of specialty associations which may in part explain the ease with which they interact with each other and with faculty.

Impact of interactivity

The contribution interactions between health professionals make to the learning process is reported in the education literature.[8-10] Recent reports highlight characteristics of group member interactivity that encourage learner engagement and commitment to practice improvement. For instance, there is a growing body of evidence that interactivity conducive to learning and behavior change occurs, when people who have built up trusting relationships express concern or dissatisfaction with their personal practice; [11] and when conversation between professionals includes recall of personal stories of events in practice which often result in expressions of a collective vision of how practice might be improved.[11-13]

To date, most studies that assess the impact of interactivity between group members on learning and behavior change have used mixed qualitative and quantitative methods. For instance Gittell and colleagues use a relational coordination score to assess the frequency, timeliness and accuracy of communication between group members, as well as the impact of interactivity on their ability to solve problems, share knowledge, build relationships and collectively create goals for the group. [14]

Few studies have used social network analysis methods (SNA) to explore how networking and interactivity between health professionals impact capacity to learn and adopt new practices.

SNA is the use of network theory to analyze social networks. In particular, it has four main features: [15]

1. Network analysis focuses on patterns of linkages between elements;
2. it is grounded in empirical data;
3. it makes frequent use of mathematical and computational models; and
4. it is highly graphical.

In this paper, a more comprehensive meaning is intended, where other theories are also considered (see below). Few studies have used social network analysis methods to explore how networking and interactivity between health professionals impact capacity to learn and adopt new practices. Gainforth and colleagues used SNA to examine the role of interpersonal communication in the adoption of practice innovations among medical staff in a community-based organization[16] Their findings support the contention that interpersonal communication between networked health professionals enhances knowledge flow and uptake. Gainforth and colleagues, informed from their findings, offer ways in which changes in network structure might improve knowledge transfer and uptake among health professionals.[16-17]

The potential of physician networks

Physicians recognize the contribution networking with peers makes to their continuing professional development. [18,19] We contend that better understanding of the networking characteristics of physicians has the potential to assist CME and professional associations to better serve physicians. For instance, CME planners could invite networks of physicians with similar practices to CME courses customized to meet their practice needs. Also, associations focused on creating networks to enhance interactivity among members, could ask questions such as: Who are the opinion leaders in the association? Are the right connections between members in place? Are any key connections missing? Which members are in the core, and which members are in the periphery of the association's social interactions? [20] This in turn would allow professional associations to be more knowledgeable of the network characteristics of physician members and establish programs to enhance relationships in needed areas, thereby helping members to make better use of CME courses, among other consequences. Conversely, CME supported by information technologies and social media could have the potential to impact the network structure of professional associations and the behaviors of their members. [4]

The purpose of this article is first to review characteristics and measurements currently used to describe the structure and function of networks of people. And suggest how research into physician networks may be used to make CME and physician communities more effective learning environments.

Structure and function of networks

Professionals with common interests and practices, acting like agents in complex adaptive systems, form networks and collectively generate goals for their networks; consciously or unconsciously maintain an adequate governance to ensure stability of their networks over time; create appropriate linkages with organizations and communities important to the goals; involve members from all positions in organizations including frontline people, leaders and peripheral members; and, foster interaction between members based on trust and commitment to network goals. [21] Chisholm (1996) identifies four functions of effective networks: creating and maintaining a vision and goal; serving as a social space for growing solutions for complex issues; developing norms and values for members' professional development; and providing opportunities for members to interact with each other and build trusting relationships. [22]

Physician associations are a type of such a social network. An example of an international physician association where SNA could be beneficial is described in box 1.

Underlying theories

Increasing connectedness is part of the landscape of the 21st century in so diverse areas as international trade, disease epidemics and the flow of information in organizations. And so is the theory and methods to analyze it, coming from different disciplines, such as computer science, mathematics, sociology, genetics or epidemiology. Theory and tools for analysis come from

network theory[23], game theory,[24] complex adaptive systems theory,[25] theory of planned behavior and social cognitive theories[26] and socially oriented theories of learning such as situated learning[27] and communities of practice theories.[28] No longer can outcomes of teaching and learning interventions be attributed to the sum of the individuals only, but to them *and* how they are connected *and* their resulting group dynamics, referred to as network structure and behavior. In this paper, we will focus on network theory and related tools for analysis, referring to other theories when deemed appropriate.

As an introduction to concepts and metrics of social network analysis, a network, also called "graph", is a set of elements called "nodes" connected by ties, also called "links" or "edges".[23,29-31] A social network is a series of people connected by their varying types of relations [20].

There are at least two types of social network analysis (SNA) tools currently in use for the assessment of social networks such as professional associations: tools that assess characteristics of connections between members summarized in table 1[20]; and tools that describe and assess the quality of communication and relationships between members, summarized in table 2.[14]

The study of aggregate behavior is largely based on game theory, a branch within mathematics with wide applications in economics and social sciences that shows how individual behavior influences others, when decisions are made simultaneously by a series of individuals (such as selecting a highway or a restaurant).[24], Cascading effects such as a social contagion may take place. In our case, an example would be how networked physicians decide to register on mass for a particular CME course and how decisions made by some, for instance to register for a CME course, influence others in the network.

A network structure can also be displayed graphically. It should be noted that a network is not a snapshot, but an evolving structure, that can be modeled mathematically.

Studying networking properties of physician association members

We contend that social network analysis provides a valid methodology to assess and, where appropriate, enhance the network properties of physician associations.[20,32] Information could be harvested from databases that monitor member interactivity in physician associations and at CME courses, and linked with data traditionally collected from course participants, such as levels of participation and satisfaction, changes in knowledge, attitudes and skills. An example of such a data collection process is summarized in Box 2. The analysis of the multi-source data would enable course evaluation to seek associations between levels of networking and interactivity between course participants and the benefits derived from CME events. In addition the analysis could provide a quantitative description of network structure and changes over time and highlight relationships between network changes and physician participation in CME interventions. In parallel, qualitative techniques would help contextualize and interpret the data obtained through quantitative methodologies.

A practical application

We are carrying out research to apply the above-mentioned concepts in a real-world setting. There currently is running a hybrid CME two-month course in Uruguay about hypertension management, for both cardiologists and general practitioners, belonging to these two distinct professional communities. There are over 150 physicians participating in this course. Participants were asked before the course started whether they knew each of the other participants on a personal basis, following the classical research question in Milgram's experiment.[23] A graphical display of their answers is shown in figure 1, and a degree distribution of the number of connections of each of the participants is shown in figure 2. As expected, there

is an asymmetrical distribution, where some people are hubs. At the end of the course, a detailed analysis of course results will be performed individually and for each of the two groups, and individual and group connectedness will be a variable to be included in the analysis.

Discussion

Frontline practitioners form networks as they share practice experiences and build relationships with colleagues.[8-12] Associations of health professionals and CME providers in universities, for instance, recognize networks of practitioners as ideal learning environments for promotion of practice improvement.[12,13] Increasingly, professional associations create opportunities for networked practitioners to meet and share working knowledge and create visions of better practice. As Coiera states. *"the biggest information repository in most organisations sits in the heads of the people who work there, and the largest communication network is the web of conversations that binds them. Together, people, tools, and conversations—these form the "system.""* [33] We contend the mission of today's professional associations, acting as knowledge networks, should be to create and maintain networks of knowledgeable health professionals and assist members to form sub-networks of practitioners with similar practices, join in on their conversations and create new knowledge with the potential to enrich and improve their practice.

Reports suggest that educational activities of networked practitioners may be enhanced by a better understanding of the structure and function of networks. For instance, practitioners who build trusting relations and interact with each other are more likely to adopt new practices compared with those who work in relative isolation.[16] Professional associations can provide skilled educators or partner with CME educators to foster emergent learning and practice change from conversations about personal practice between members.[12] Spontaneous connections between physicians tend to emerge slowly and network managers referred to by Krebs & Holley (2004) as *network weavers* should be recruited to actively build networks.[20]

Network weavers help members, for instance physicians, to make connections with others with similar practice profiles and start conversations about practice.[20]

Professional associations that function as knowledge networks may take advantage of new methods of facilitating learning by partnering with providers of CME with this expertise. For instance, CME educators skilled in facilitating structured dialogue may assist networked practitioners to use innovative techniques of conversation, including narrative-based and sense-making dialogue, to enhance learning and affordances for practice improvements that emerge from conversations between members.[12,34]

Not surprisingly, designers of CME programs, cognizant of the contribution that interactivity between networked practitioners makes to their learning and ability to improve practice, may tap into the knowledge professional associations have of their physician networks to target practitioners who have similar practices and similar educational needs. Accurate knowledge of connectedness of physician participants at CME programs enables meaningful evaluation of learning outcomes. For instance, poor outcomes and absence of learning found in a group of physicians evaluated after a CME course may be partially explained by their lack of connectedness. Similarly, CME programs that result in learning and behavior change may be explained by network analysis data and relational scores that describe close connections between program participants and high quality communication habits when back at work.

But changing the habits of professionals used to being lectured to is not easy. Guan et al studying social interaction in peer discussions in online CME courses found low participation in social activity which they attributed to lack of time and inadequate social bonding.[35] As mentioned above, facilitators needed training in facilitation skills.[34] On-going conversations between networked practitioners outside of formal courses may foster more social interaction

and better course participation.[12]

Evaluation is an important element for course design of the next editions of the same and similar courses;[36] that is why it could be important to include a set of variables, such as network properties, that may be accounting for a significant part of the results of CME courses. Further research is needed to demonstrate and quantify a relationship, including causality.

These concepts particularly apply to international professional associations and online CME, where there is a great space for improvement regarding the integration of sub-networks (country and regional professional societies, for example).[4, 37]

Conclusions

We are currently living in an era when technology is allowing for disruptive innovations, both in CME [38,39] and in clinical practice. [40] One of the main impacts of technology is related to the way people interact with one another over spatial coordinates[41] and over time, in relation to their learning and to their clinical practice. Therefore, it seems reasonable to introduce formal and sequential measurements of connectedness both in qualitative and quantitative terms, as it is changing dramatically and could be a variable accounting for CME results.

Lessons for practice

Social network analysis probably is a dimension that should be utilized in analyzing CME, since it seems to affect the results of CME interventions.

References

1. Pardell Alenta H, Ramos Torre A, Salto Cerezuela E, Tresserras Gaju R. [Physicians and continuing medical education. The results of a survey carried out in Catalonia]. An Med Interna. 1995 Apr;12(4):168-74.
2. Kempkens D, Dieterle WE, Butzlaff M, Wilson A, Böcken J, Rieger MA, Wilm S, Vollmar HC. German ambulatory care physicians' perspectives on continuing medical education - a national survey. J Contin Educ Health Prof. 2009 Fall;29(4):259-68.
3. Cohen H, Margolis A, González N, Martínez E, Sanguinetti A, García S, López A. [Implementation and evaluation of a blended learning course on gastroesophageal reflux disease for physicians in Latin America]. Gastroenterol Hepatol. 2014 Aug-Sep;37(7):402-7. doi: 10.1016/j.gastrohep.2014.01.004. Epub 2014 Mar 27.
4. González F, Noboa OA, Greloni GC, Noronha IL, Ribeiro A, Margolis A, Lorier L, Silvariño R, García S, López A, Fernández JM. A Latin American Continuing Medical Education Course for the Nephrology Community. Accepted at ASN Kidney Week 2014.
5. Llambí L, Esteves E, Martinez E, Forster T, García S, Miranda N, Arredondo AL, Margolis A. Teaching tobacco cessation skills to Uruguayan physicians using information and communication technologies. J Contin Educ Health Prof. 2011 Winter;31(1):43-8.
6. Margolis A, Santiago B, Martínez E, Dapueto J, Lorier L, Fernández Z, Forster T, Miranda N, Muñoz C, López A. Four-year Collaboration in CME Among Latin American Institutions. CME Congress, Toronto, Canada, May 2012.
7. Margolis A. Marco conceptual y lecciones aprendidas sobre educación médica continua a distancia. Book chapter of “Manual de salud electrónica para directivos de servicios y sistemas de salud”; Javier Carnicero y Andrés Fernández, editors. Sociedad Española de Informática en Salud (SEIS) and Comisión Económica para América Latina y el Caribe (ECLAC), 2013.

8. Aveling EL, Martin G, Armstrong N, Banerjee J, Mary Dixon-Woods M. Quality improvement through clinical communities: eight lessons for practice. J Health Organ Manag. 2012;26(2):158-174.
9. Lanham HJ, McDaniel R, Crabtree BF, et al. How improving practice relationships among clinicians and non-clinicians can improve quality in primary care. Jt Comm J Qual Patient Saf. 2009;35:457–466.
10. Miller WL, Crabtree BF, Nutting PA, Stange KC, Jaen CR. Primary care practice development: a relationship-centered approach. Ann Fam Med. 2010;8 Suppl 1:S68–79.
11. Parboosingh J, Reed VA, Caldwell Palmer J, Bernstein HH. (2011), Enhancing practice improvement by facilitating practitioner interactivity: New roles for providers of continuing medical education. J Contin Educ Health Prof. 2011;31(2):122-127.
12. Hess DW, Reed VA, Turco MG, Parboosingh JT, Bernstein HH. Enhancing engagement in practice improvement: a conceptual framework. Submitted to J Contin Educ Health Prof.
13. Senge PM. The Fifth Discipline: The Art and Practice of the Learning Organization. 1st ed. New York: Doubleday. 1990: pp 9, 142, 152.
14. Gittell JH, Fairfield KM, Bierbaum B, et al. Impact of relational coordination on quality of care, postoperative pain and functioning, and length of stay: a nine-hospital study of surgical patients. Med Care 2000;38:807-19.
15. Luke DA, Harris JK. Network analysis in public health: history, methods, and applications. Annu Rev Public Health. 2007;28:69-93.
16. Gainforth HL, Latimer-Cheung AE, Athanasopoulos P, Moore S, Ginis KA. The role of interpersonal communication in the process of knowledge mobilization within a community-based organization: a network analysis. Implement Sci. 2014 May 22;9(1):59.
17. Relational coordination research collaborative. Available at: rcrc.brandeis.edu. Accessed

August 31, 2014.

18. Nutting PA, Crabtree BF, Miller WL, Stewart EE, Stange KC, Jaén CR. Journey to the patient-centered medical home: a qualitative analysis of the experiences of practices in the National Demonstration Project. Ann Fam Med. 2010;8(suppl 1); S45-S56, S92.
19. Olson CA, Tooman TR, Alvarado CJ. Knowledge systems, health care teams, and clinical practice: A study of successful change. Adv in Health Sci Educ. 2010;15: 491–516.
20. Krebs, V. & Holley, J. 2004. Building sustainable communities through social network development. The Nonprofit Quarterly, Spring: 46-53.
21. Provan, K. & Milward, H.B. 2001. Do Networks Really Work? A Framework for Evaluating Public Sector Organizational Networks. Public Administration Review, 61(4):414-431.
22. Chisholm, R.F. (1996). On the meaning of networks. Group and Organization Management, 21, 216–236.
23. Barabási AL. Linked: The new science of networks. Perseus publishing, Cambridge, Massachusetts, 2002.
24. Easley David, Kleinberg Jon. Networks, Crowds, and Markets: Reasoning about a Highly Connected World. Cambridge University Press, 2010.
25. McDaniel R, Driebe D. Complexity science and health care management. In: Blair JD, Fottler MD, Savage GT, eds. Advances in Health Care Management. Stamford, CT: JAI Press; 2001:11-36..
26. Godin G, Belanger-Gravel A, Eccles M, Grimshaw J. Healthcare professionals' intentions and behaviours: a systematic review of studies based on social cognitive theories. Implement Sci 2008;3:36.
27. Lave J, Wenger E. Situated learning: legitimate peripheral participation. Cambridge [England] ; New York: Cambridge University Press; 1991.

28. Wenger E. Communities of Practice: Learning, Meaning, and Identity. Cambridge, UK; New York, NY: Cambridge University Press; 1998.
29. Barabási AL. Network medicine--from obesity to the "diseasome". N Engl J Med. 2007 Jul 26;357(4):404-7.
30. Barabási AL. Scale-Free Networks: A Decade and Beyond. Science 24 July 2009: Vol. 325 no. 5939 pp. 412-413.
31. Consoli, D and Ramlogan, R (2009). Scope, Strategy and Structure: The Dynamics of Knowledge Networks in Medicine. Manchester Business School Working Paper, Number 569.
32. Popp JK, et al. How do you evaluate a network? A Canadian child and your health network experience. The Canadian Journal of Program Evaluation Vol. 20 No. 3 Pages 123–150.
33. Coiera E. “Four rules for the reinvention of healthcare” BMJ, 2004; 328:1197-1199.
34. Jakubec S, Parboosingh J, Colvin B. Introducing a multimedia course to enhance health professionals’ skills to facilitate communities of practice: Experiences of the first cohort of course participants. J Health Organ Manag. 2014;28(4), p477-494
35. Guan J, Tregonning S and Keenan L. (2008), Social interaction and participation: Formative evaluation of online CME modules. J. Contin. Educ. Health Prof., 28: 172–179.
36. Moore DE. A framework for outcomes evaluation in the continuing professional development of physicians. In: Davis D, Barnes BE, Fox R, eds. The Continuing Professional Development of Physicians: From Research to Practice. Chicago, IL: AMA Press; 2003:249–74.
37. Liyanagunawardena TR, Williams SA. Massive Open Online Courses on Health and Medicine: Review. J Med Internet Res. 2014 Aug 14;16(8):e191.
38. Christensen, C. M., Armstrong, E. G. (1998), Disruptive technologies: A credible threat

to leading programs in continuing medical education?. J. Contin. Educ. Health Prof., 18: 69–80.

39. Harris JM Jr, Sklar BM, Amend RW, Novalis-Marine C. The growth, characteristics, and future of online CME. J Contin Educ Health Prof. 2010 Winter;30(1):3-10.
40. Arora S, Thornton K, Murata G, Deming P, Kalishman S, Dion D, Parish B, Burke T, Pak W, Dunkelberg J, Kistin M, Brown J, Jenkusky S, Komaromy M, Qualls C. Outcomes of treatment for hepatitis C virus infection by primary care providers. N Engl J Med. 2011 Jun 9;364(23):2199-207.
41. Onnela J-P, Arbesman S, Gonzalez MC, Barabasi A-L, Christakis NA (2011) Geographic Constraints on Social Network Groups. PLoS ONE 6(4): e16939. doi:10.1371/journal.pone.0016939

Figure 1. Graphical display of personal connections among participants of a CME cardiology course. Directed graph. Hubs are highlighted: Darker in gray-scale print version. Note: In the online publication, blue nodes are the “most popular” ones (highest number of incoming links); red nodes are the ones who report knowing most people.

See explanation in the text.

Graph produced with Gephi 8.2 software.

Figure 2: Degree distribution of links among participants in the previous course (undirected graph). Note the asymmetrical distribution, where a few participants have a large number of connections.

Graph produced with Gephi 8.2 software.

Box 1.

Example of international physician association: Latin American Society for Nephrology and Hypertension (SLANH)

SLANH acts both as a professional society for its members and a federation of national Latin American Societies of Nephrologists. There are about 9000 nephrologists in Latin America, one third in Brazil (where Portuguese is spoken) and two thirds in the Spanish-speaking countries. At the beginning of 2013, there were about 900 SLANH direct members, but most of the remainder nephrologists were related to SLANH through their 22 national associations. At the same time, SLANH has been allied in different initiatives with the American Association of Nephrology and the International Society of Nephrology, among others. Among other activities, SLANH has a scientific publication and hosts a Latin American Congress every two years with approximately 1300 attendees. In the second half of 2013, SLANH initiated regional online CME programs and courses with the goal of fostering networking and practice-based learning between Nephrologists in Latin America. After such a program, direct membership to SLANH increased by about 50% (from 900 to 1350, approximately).

Sources: Web page, reference 4, and personal communication.

Box 2

Steps in a typical social network analysis of a physician association

1) Gather general information about the networking properties of members of the association by interviewing key informants, to determine questions for a structured interview with a select sample of the membership.
2) Obtain information on networking habits and current interactivity from a select sample of physician members.

3) Gather information about the links among the individuals.
    a. If this information is automatically available, use it for analytical purposes after requesting permission when necessary: for example, exchanges of emails in discussion lists or links in an association's social platform, or bibliometric data from congress publications and their authors.
    b. If not readily available, ask this information at the beginning of a CME course: For example, basic information would be obtained from the question: Who do you know personally or exchange information about practice out of this list of attendees?
    c. Through surveys, with content similar to RCRC's Relational Scoring System (Ref), obtain frequency, timeliness and accuracy of communication between group members, as well as the impact of interactivity on their ability to solve problems, share knowledge, build relationships and collectively create goals for the group.
4) Perform a network analysis.
5) Graph results.
6) Analyze results in conjunction with other traditional variables used to analyze course results.
7) Hypothesize or provide alternate explanations on relationships observed between measures of quality of interactivity between physician learners at CME events and participant ability to demonstrate deep learning and adoption of new practices.

Table 1: Elements used in social networks analysis to monitor connections between members of a network

Number and intrinsic properties of nodes. For example, members of a professional association may have 1000 members who belong to many professions, regions or countries, having certain patterns of attendance and interactivity at conferences and so on.
Degree and degree distribution. Each node may be related to other nodes (members) of the network by links, establishing some kind of relationship, such as personal knowledge of each other's practices or recent exchange of emails about clinical matters. Most social networks have opinion leaders (hubs, in network terms), with a disproportionate number of links to the rest of the members, which can be quantitatively measured by the degree distribution.
Attributes of the links. Links may be categorized in many ways, such as ranking, weight (e.g., how many emails they have exchanged in the last year) or other properties.
Directed or undirected networks. (e.g., to whom messages were sent, who-follows-who on twitter or who-knows-who in a community).
Density: refers to the proportion of connections (links) relative to the total links possible.
Average path length: it is the average of distances between all pairs of nodes in the network, i.e., how many links someone needs to go through, in average, in order to reach any other person in the network.

Table 2: Items that assess the quality of relationships and communication between networked professionals

Assessment of frequency, timeliness and accuracy of communication between named individuals and the ability to this communication to solve problems, share goals and build mutual respect . (taken from Gittell's Relational Coordination Scoring System).[9]
Assessment of trust, mindfulness, heedfulness, respectful interaction, diversity, social and task relatedness, practice reflection and sense-making learning in conversations (taken from relationship characteristics reported by Lanham et al, 2009) [23]