Measuring the Effectiveness of a Discussion Forum for Knowledge Sharing Among Emergency Practitioners: A Social Network Approach

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Abstract. Peer to peer knowledge sharing is recognized as a key contributor to the development of expert practice for health care professionals. EDs with access to extensive expertise, such as in urban hospital settings, present greater potential for rich collaborative learning opportunities as compared with rural settings where expertise is at times scarce. Collaborative technologies such as electronic discussion boards may assist in leveling the "knowledge" playing field and increase opportunities for the growth of a strong social network for emergency clinicians. A social network perspective is used to explore the effectiveness of a discussion forum to support knowledge sharing among emergency practitioners in rural and urban EDs in Nova Scotia.
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1. Introduction

Healthcare knowledge is vast; it exists in a variety of modalities and is dispersed across the healthcare organization. Clinical practice in an Emergency Department (ED) demands knowledge from different sources in terms of both published best evidence and case-based experiences of peers. In practice, ED practitioners work in teams and collaborate to acquire and share their knowledge in order to address the knowledge gaps inherent within the healthcare system. EDs with access to extensive expertise, such as in urban hospital settings, present greater potential for rich collaborative learning opportunities as compared with rural settings where expertise is at times scarce. However, given the nature of the ED setting it is often quite challenging to sustain meaningful knowledge sharing activities amongst peers within the same department, let alone with ED practitioners in other organizations.

Having recognized the importance of knowledge sharing in ED settings and the challenges present in the regard, we believe it is prudent to investigate the efficacy of electronic mediums for knowledge sharing purposes. The outreach and ubiquitous nature of the Internet allows for electronic discussion forums that provide a common meeting point for the community and a medium for exchanging and sharing knowledge. More so, one may argue that Internet-based discussion forums provide an excellent medium for ED practitioners to interconnect and communicate with peers and experts from other institutions—in fact diminishing the traditional rural vs. urban divide experienced in Canadian ED settings.

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In this paper we present our investigations towards understanding the communication patterns between ED practitioners to share practice-related knowledge in an electronic discussion forum. Social network analysis methods will be used to measure the effectiveness of the discussion forum in terms of the knowledge seeking and sharing patterns of urban and rural ED practitioners. The primary research question under investigation is: How do emergency clinicians in rural and urban ED's seek or share information in an online discussion forum? The following hypothesis will be tested to address this question:

- The extent to which practitioners use an online discussion forum as a means for seeking information is a function of geographic location
- The extent to which practitioners use an online discussion forum as a means for sharing information is a function of geographic location

2. Knowledge Sharing in Health Care

Research supports that people rely heavily on their network of relationships to find information and solve problems. Practitioners generally cite colleagues or peers as a key source of practice knowledge [1]. Comparisons of information seeking behaviors among rural and urban primary care clinicians indicate that both have the same needs for information and rely on colleagues and personal libraries as their main sources of information [2]. However, rural clinicians' access to information sources is limited by isolation, inadequate library sources, and limited access to onsite specialist practitioners.

According to Wenger [3], in a community of practice (CoP) members interact and learn from each. In clinical practice, interactions and relationships with colleagues facing similar problems and clinical scenarios enhance learning and the development of clinical expertise. As such, social relationships are important in acquiring expert practice knowledge. The representation of social relationships in a CoP can be useful in depicting the flow of information in the community and can be further described as a social network that depicts social relationships, such as friendship, co-working or information exchange [4].

3. Methods

The **Multidisciplinary Pediatric Emergency Care Web Based Learning Centre** was established for 9 rural and 2 urban EDs in Nova Scotia and populated with 12 learning modules on Pediatric Emergency Care topics. This web resource also hosted a multidisciplinary discussion board facilitated by expert ED clinicians and structured to complement the learning modules. The content experts (CE's) were available on the discussion board to address specific queries related pediatric emergency practice posed by the network participants. The discussions were organized at two levels: (1) **Topics** corresponded to the themes of the content modules (pediatric trauma, diabetic emergencies, poison management etc) and (2) **Subjects** within topics allowed for more focused discussion of issues related to the parent topic. Although the administrator set *topic* headings, participants and content experts initiated *subjects* within the topics. A threading feature organized the series of replies to a principle subject message. Threading of messages allowed information seeking and associated information sharing episodes to stay connected. All interactions were tagged with the authors name and time of posting.

The online discussion forum created an opportunity for emergency practitioners from multiple ED sites to engage in dialogue around topics that were

relevant to their practice. To this end, data from the discussion forum was analyzed using UCINET, a Social Network tool. Social network analysis provides a means for mapping and analyzing relationships among people and/or organizations. Graphical representation or a sociogram makes visible patterns of knowledge sharing within and across important networks. Network data are generally defined by two elements; actors (nodes) and relationships or ties that connect a pair of actors [5]. These *relational* and *positional* measures can be a useful guide to describe control over information as well as sources and barriers to information flow [6].

Data analysis focused on specific episodes of information seeking and information sharing. *Information seeking* is characterized as any person looking for information from a clinical (patient specific) or health systems perspective. *Information sharing* is characterized as any person sharing information from a clinical or health systems perspective.

4. Results

4.1 Network Demographics

The online discussion forum was available to 188 multidisciplinary practitioners from 9 rural and 2 urban EDs in Nova Scotia. Forty seven percent (N=89) of participants accessed the discussion board at least once and 72% of those (N=64) posted at least one message. However, only the postings that included a seeking or sharing reference to patient related issues were included in the analysis. This reduced the number of participant actors in the network to 42. The message postings reflected contributions from 8 rural and 2 urban centers. For the purposes of this analysis, content modules that were supported by more than one content expert (CE) were merged into one actor profile (CE1, CE2, CE3 etc) resulting in a total of 12 actor profiles for the CEs. These changes brought the total number of actors in the network to 54 (k) and the total number of possible connections for each actor to 53 or (k − 1). Distribution of actors in the seeking and sharing networks included 12 CE's, 24 rural participants (dispersed across 8 different sites) and 18 urban participants (dispersed across 2 sites). Data in the sharing and seeking networks is asymmetric (directed) therefore there were a total of k * (k-1) or 2,862 possible relationships or ties in each network.

4.2 Knowledge seeking and knowledge sharing networks

We use NetDraw to visualize the knowledge seeking and sharing activities within the ED community (Fig 1 & Fig 2, respectively). The social network depicts the different groupings of actor nodes and relationships (directed edges). A visual inspection of the social networks suggest that the majority of nodes in both networks are connected by at least one relation but there is a small subset of nodes that have multiple ties, which may indicate that they have central roles in the flow of information in the network. There is one isolated actor in the seeking network and two in the sharing network. The square node identifies them as content experts.
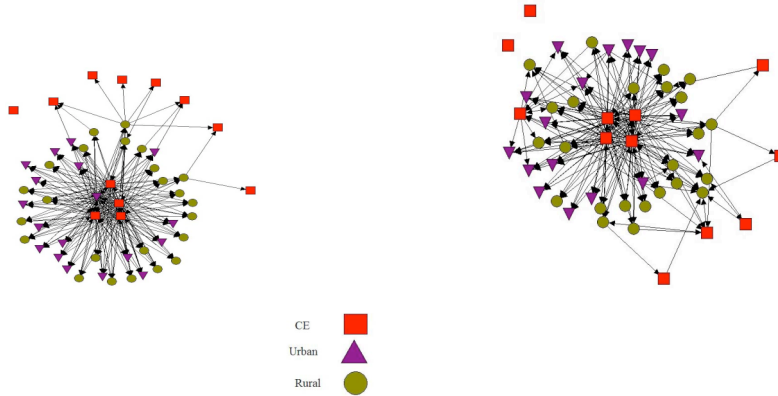
CE ■
Urban ▲
Rural ●

Fig 1. Knowledge Seeking   **Fig 2. Knowledge Sharing**

4.21 Density

The density of a binary network reflects the percentage of all possible ties that are actually present in the network. Density can provide an indication of the rate at which information diffuses through the nodes. We note that the overall density of the information seeking network is .1866; that is 18.6% of all possible ties are present. The overall density of the information sharing network is .1943; that is 19% of all possible ties are present. Table 1 shows density measures for each relationship block in the seeking and sharing network. Density measures tended to be higher in the CE-Rural and the CE-Urban relationships for both the seeking and sharing networks.

Table 1. Density Blocking

Relationship	Seeking Density	Sharing Density
Rural-Rural	.125	.250
Rural-CE	.076	.010
Rural-Urban	.185	.250
Ce-Rural	.417	.368
Urban-Rural	.222	.167
Urban-Ce	.050	.000
Urban-Urban	.222	.167
Ce-Urban	.418	.361

4.22 Centrality

Measures of centrality depict the distribution of useful/active actors in a network; identifying actors who are in favorable or prestigious positions [8]. Examining the out-degree and in-degree of the nodes in a network provides a summary of the contribution of an actor to the community. Freeman's Degree Centrality Measures were used to identify the out-degree and in-degree points for both networks. The range of out-degree and in-degree for the seeking network is 0 to 48 and 0 to 13, respectively. The range for the sharing network is out-degree, 0 to 42 and in-degree, 0 to 14. We see the range of out-degree is much larger in both networks than the range of in-degree. This can be reflective of a population that is heterogeneous in structural positions.

Actor # Rural28 has the greatest out-degree for the knowledge seeking network followed closely by Actor # Urban48. Ten other actors have out-degrees greater than 40 (CE1, CE2, CE5, CE7, CE11, Rural13, 17 and Urban45, 50 &51). Actor # Rural28 also has a high out-degree in the knowledge sharing network with

Actors # CE2, CE5, CE7 and CE11. Seventeen other actors also have high out-degrees in the knowledge sharing networks. Actors who have high out-degrees are generally actors who are able to share information with many others and are most often regarded as having influence. There are only a small number of actors in both networks with high out-degrees who serve to reach out to others. This situates influence with few members in the network. Actors with high in-degree measures receive information from many sources and are said to have high prestige as many actors seek to direct ties to them. Overall, in-degree measures in both networks are much lower than the out-degree measures, which is consistent with the limited number of actors who actively seek out ties in both networks. However, information that is sent out is widely distributed to all actors. This reflects the potential for information to flow through the network.

Betweenness measures can also be used to further describe the location of actors in terms of centrality. Actor A is said to be between actor C and D if there are no other actors between AC and AD and no direct links between C and D. In this way, any information flowing between C and D must pass through A. Actors with high measures of betweenness experience a high volume of information traffic and can greatly influence how information flows in a network. We can see from Table 2 that the CE's figure prominently with high betweenness measures in the knowledge seeking and sharing network. We note that Rural28 also appears as an actor with a high measure of betweenness in the seeking network. These actors have powerful roles as the key information channels. As a "knowledge broker" between sets of actors they can pass the information along and possibility in interpretation but they are also able to block knowledge flow from their positions.

Table2. Freeman's Node Betweenness

Betweenness: Knowledge Seeking	Betweeness: Knowledge Sharing
CE1- 259.75	Rural28 – 175.167
CE5 - 147.500	CE5 – 126.000
Rural28 - 84.611	Rural29 – 51.500
CE2 - 74.500	Rural36 – 20.500
Rural29 – 47.500	Urban39 – 11.667
CE7 – 24.000	Urban48 – 11.667
Urban48 – 18.528	Rural10 – 8.500
Urban52 – 17.083	
Rural36 – 10.833	
Urban50 – 9.750	
Rural18 – 9.000	

5. Discussion

It was hypothesized that geographic location would influence information seeking and sharing behavior. It was anticipated that rural practitioners would express a greater number of knowledge seeking ties than their urban counterparts, as the high number of face-to-face opportunities for clinicians in urban centres would make seeking in an online environment redundant. However, the out-degree measures for the seeking network did not support this idea. Rural28 did have the highest out-degree measure in the seeking network, but both urban and rural actors figured prominently in the high out-degree measures. The busy pace of an ED practice setting is not always favorable for sustained real-time information seeking interactions. Therefore, online discussion

forums may be equally enticing to urban ED practitioners as they seek knowledge in a challenging communication environment to support their practice.

Another unexpected finding in the sharing network was the high measures of out-degree and the low measures of in-degree for some of the CE's. It was anticipated that the identified experts CE's would be the target of the majority of the seeking behaviors and would be limited in their own seeking behavior. While the betweenness measures place two of the CE's in the top knowledge brokering positions, the block densities of the CE-Rural, CE-Urban, and Rural-CE, Urban-CE reveal an unexpected picture of information flow in the seeking network. It was anticipated that the percentage of possible ties leading from Urban and Rural sites to the CE's would be higher. This phenomenon may be explained by some of the natural characteristics of a CoP in which participants are brought together by a common interest in a topic and interaction in this context rich environment provides opportunities for all members to share and learn. Seeking behaviors may be more highly influenced by interest than expertise. It is also surprising that the only two isolated nodes in both the sharing and seeking networks were content experts (CE10 and CE12). It is possible that participants were not interested in the special content knowledge held by these actors.

An inherent weakness in using social network analysis to measure interaction in an online discussion forum is the inability to measure passive participation. The criterion used to distinguish a present or absent relation was evidence of posting on the discussion board. This measure does not capture the participants who read the postings and gained knowledge as a result.

6. Conclusion

This project demonstrates that an electronic discussion forum can provide an effective means for bringing rural and urban practitioners together to engage in a range of information seeking and sharing behaviors and may support the establishment of an online CoP for emergency clinicians. Further research is required to better understand the contextual and individual factors that influence participation. Collaboration must occur between rural and urban ED's to ensure that emergency care provided to children throughout the province is not only consistent but also validated by a community of emergency care practitioners. Supporting more effective knowledge-sharing practices through enhancement of a social network will have a great impact on the quality and safety of health service delivery in EDs in Nova Scotia.

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