Factors Affecting Influential Discussions Among Physicians: A Social Network Analysis of a Primary Care Practice

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BACKGROUND: Physicians often rely on colleagues for new information and advice about the care of their patients.

OBJECTIVE: Evaluate the network of influential discussions among primary care physicians in a hospital-based academic practice.

DESIGN: Survey of physicians about influential discussions with their colleagues regarding women's health issues. We used social network analysis to describe the network of discussions and examined factors predictive of a physician's location in the network.

SUBJECTS: All 38 primary care physicians in a hospital-based academic practice.

MEASUREMENTS: Location of physician within the influential discussion network and relationship with other physicians in the network.

RESULTS: Of 33 responding physicians (response rate = 87%), the 5 reporting expertise in women's health were more likely than others to be cited as sources of influential information (odds ratio [OR] 6.81, 95% Bayesian confidence interval [CI] 2.25–23.81). Physicians caring for more women were also more often cited (OR 1.03, 95% CI 1.01–1.05 for a 1 percentage-point increase in the proportion of women patients). Influential discussions were more frequent among physicians practicing in the same clinic within the practice than among those in different clinics (OR 5.03, 95% CI 3.10–8.33) and with physicians having more weekly clinical sessions (OR 1.33, 95% CI 1.15 to 1.54 for each additional session).

CONCLUSIONS: In the primary care practice studied, physicians obtained information from colleagues with greater expertise and experience as well as colleagues who were accessible based on location and schedule. It may be possible to organize practices to promote more rapid dissemination of high-quality evidence-based medicine.

KEY WORDS: consultation and referral; primary care; communication; physician behavior.

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INTRODUCTION

The accelerating growth of the medical literature poses challenges to the ability of generalist physicians to remain abreast of current information. Textbooks or journal articles are important sources of information for many physicians,¹ particularly as electronic access to these sources becomes widespread.² Nevertheless, physicians often rely on colleagues for new information to help them interpret the medical literature, and to obtain specific advice about the care of their patients.^{1,3–8} In addition, many physicians rate colleagues as their most valued source of information.^{3,8–10} As a result, the knowledge and beliefs of one's colleagues and how they understand and share information may shape how a physician learns and may influence the care he or she provides to patients.

Given the influential role of physicians' colleagues, understanding the social networks through which they interact becomes important. Networks among physicians have been shown to play an important role in the diffusion of new technologies,¹¹ likely by shaping beliefs, attitudes, preferences and sharing of new information. Similarly, physician opinion leaders have been shown to be effective in speeding adoption of clinical guidelines.^{12–14} Understanding how physician networks are structured will provide insights into how social networks influence physicians' beliefs and behaviors and may point toward improved strategies for disseminating medical information and guidelines.

We applied methods of social network analysis to study influential discussions about women's health issues among primary care physicians in 1 hospital-based academic primary care practice. We first surveyed physicians about discussions with their colleagues regarding women's health issues because at the time of the survey (spring 2000) there was substantial uncertainty about the role of hormone replacement in the prevention of cardiovascular disease among women. We then described the network of influential discussions within this practice, and examined individual factors predictive of a physician's location in the network, including expertise and experience, as well as demographic factors such as gender and age. We also assessed whether patterns of interactions in the network reflected opportunities for contact based on office location, other practice characteristics, and similarities in physician demographic factors.

We hypothesized that physicians most frequently cited by others as influential sources of information about women's health issues would have greater experience and expertise in caring for women. We also hypothesized that temporal and spatial proximity would predict the structure of the influential discussion network, as would similarities in physician characteristics including gender, age, and years in practice. Physicians similar in these respects may share similar views about clinical issues or may be more comfortable discussing them with, or seeking advice from, one another.

METHODS

Subjects

The study population included all faculty primary care physicians ($N=38$) at a major Boston teaching hospital. Each physician practiced in 1 of 4 physically separate clinics, all located in the hospital. The study protocol was approved by the hospital's Human Research Committee.

Data Collection

In April 2000, we mailed a survey to each of the 38 faculty physicians. Participating physicians were enrolled in a lottery for a \$150 gift certificate at a local restaurant. A second mailing to nonresponders was sent 3 weeks after the initial mailing, and physicians who still had not responded were contacted by electronic mail and encouraged to complete the survey. Completed surveys were returned by 33 of 38 physicians (87%). Nonrespondents did not differ from respondents by gender ($p=0.98$), clinic ($p=0.56$), or number of patient sessions per week ($p=0.45$). Two nonrespondents were never cited by others as being part of an influential conversation, 1 was cited by only 1 other physician, 1 by 5, and 1 by 13. All analyses include only the 33 responding physicians.

Survey

The survey included an alphabetized list of the 38 primary care physicians. Respondents were asked to "circle the number of conversations that you have had with each of the following primary care physicians in the past 6 months that have influenced your thinking on women's health issues" (response options were 0, 1–3, or ≥ 4). Physicians were also asked to report "the one individual, inside or outside of the practice, who is most likely to influence their practice regarding women's health issues."

Physicians were also asked about their age, race, and ethnicity and the year they graduated from medical school, whether they did their residency training at the hospital where they currently practice, and the number of years they had practiced in Boston and in their current practice location. They were asked the percentage of their patients who were women and their areas of expertise or special interest¹⁵ within primary care. Information about each physician's gender, specific clinic within the hospital, and number of half-day clinical sessions per week was obtained from administrative files.

Analyses

We used graphics software¹⁶ to construct a diagram of the influential discussion network. Points in the diagram represent physicians, whereas lines connect pairs of physicians who had 1 or more influential discussions. The graph-drawing algorithm seeks to place related physicians close to one another while separating pairs of physicians not involved in discussions.

The unit of analysis in this study was the pair of physicians. To analyze statistical patterns in the data, we used a P2 logistic regression model to examine the 1,056 (33×32) binary variables indicating whether 1 physician cited another as a partner in influential discussions about women's health.^{17,18} These analyses distinguished only between reports of no discussions and 1 or more discussions. Predictors included characteristics of the citing physician, characteristics of the cited physician, and variables describing the pair of physicians. This model takes account of interdependencies of network variables within physicians who cited others (i.e., who were recipients of information), within physicians cited by others (i.e., who provided influential information), and within pairs of physicians (who may tend to cite each other). The model accounts for tendencies toward reciprocity in citations by analyzing pairs of binary variables (e.g., whether physician i cited physician j and whether physician j cited physician i) jointly.

Our analyses considered similarities and differences in the following physician characteristics as predictors of whether 2 physicians were involved in influential discussions: gender, clinic within the hospital, percentage of patients in the physician's panel who were women, self-reported women's health expertise (defined as expertise in women's health and/or endocrinology), number of clinical sessions per week, years practicing in Boston and at this hospital, years since medical school graduation, and location of residency training. Preliminary analyses considered these characteristics individually as predictors of the network structure (predicting being cited, citing another physician, and density of citations based on similarities in the covariates). Those analyses revealed that no characteristics significantly predicted the propensity to cite others. We developed a final model by selecting significant predictors from the preliminary analyses. We report odds ratios and 95% Bayesian confidence intervals (credible intervals) for the coefficients indicating how strongly predictor variables are associated with the odds that 1 physician cites another as providing influential information. Additional details about the modeling strategy are included in an Appendix available from the authors.

RESULTS

A majority of respondents (61%) were women, and most (73%) were White (Table 1). The physicians saw patients a mean (SD) of 4.2 (2.6) sessions per week, and the mean (SD) proportion of their panels who were women was 67.4% (23.1%). Five of the physicians (15%) reported expertise in women's health.

Network Description

Nearly all physicians (94%) reported having had at least 1 influential discussion regarding women's health with a col-

Table 1. Characteristics of Participating Physicians

	Physicians N=33
Sex, N (%)	
Female	20 (61)
Race, N (%)	
White	24 (73)
Black	2 (6)
Hispanic	1 (3)
Asian	6 (18)
Practice clinic, N (%)	
1	4 (12)
2	18 (55)
3	6 (18)
4	5 (15)
Number of half-day clinical sessions per week, mean (SD)	4.2 (2.6)
Self-reported expertise in women's health, N (%)	5 (15)
Proportion of panel who are women, mean (SD)	67.4 (23.1)
Years since graduation, mean (SD)	14.7 (9.3)
Years in Boston, mean (SD)	10.6 (9.0)
Years in current practice, mean (SD)	8.5 (8.0)
Trained at this institution, N (%)	20 (61)

SD = Standard deviation

league in the previous 6 months; the median physician reported discussions with 4 others (interquartile range 3 to 8), or about 13% of their colleagues. In most cases (78%), these relationships involved 1–3 influential discussions during the past 6 months, but a sizable minority of relationships (22%) involved 4 or more. The 2 physicians who reported no influential discussions were cited as conversation partners 2 and 5 times by others.

Figure 1 depicts the network of influence for primary care physicians in this hospital-based practice. Five physicians in the network (E1, E2, 22, 25, and E5) were cited more than 10 times by others as being influential regarding women's health issues (depicted with arrows); E5 was cited by 24 of the other 32 respondents. These 5 included 3 self-identified women's health experts, all of whom practiced in the women's health clinic (green symbols). Physicians having panels consisting of more than 80% women (large symbols) tended to be in the center of the network. Men (square symbols) and physicians serving panels with fewer than 50% women (small symbols) tended to lie in the periphery of the network. Clustering within clinics is also evident in the diagram, particularly for physicians in the 2 clinics that operated like private practices and were staffed primarily by full-time clinicians (blue and yellow symbols).

Factors Predicting Interaction Patterns in the Network

Table 2 presents adjusted odds ratios and 95% Bayesian confidence intervals for factors associated with the likelihood that physicians were cited by others and the likelihood that physicians cited 1 another as sources of influential information. None of the physician characteristics that we examined was associated with citing others. Physicians in this practice tended to seek information from colleagues with expertise and experience. Self-identified women's health experts were much more likely to be cited than non-experts (OR 6.81; Table 2). Similarly, physicians having a greater proportion of women in

their panels were more likely to be cited (OR 1.03 for a 1 percentage-point difference in proportion of women in one's panel).

Influential discussions also appeared to be shaped by opportunity and organizational structure. Physicians were much more likely to report having influential discussions with others who practiced in the same clinic than with physicians in other clinics (OR 5.03; Table 2). Additionally, colleagues tended to cite physicians with greater numbers of weekly patient-care sessions as having provided influential information, likely as a result of their greater accessibility to others in the clinic and/or their clinical experience (OR 1.33 for each additional session).

We found that sociodemographic differences were more weakly associated with the network structure. Although women were frequently in the center of the network (Fig. 1), this appears to be a result of their greater expertise and experience caring for women patients rather than gender per se. We found an association of borderline statistical significance, suggesting that gender differences between the citing and cited physicians may reduce the likelihood that they have influential discussions (OR 0.64, 95% Bayesian CI 0.39–1.03; Table 2). We did not find any associations based on number of years since medical school graduation, number of years in Boston, number of years at the current practice, or whether a physician completed residency training at their current institution.

The results also suggest a reciprocity effect. If 1 physician reports having an influential discussion with a second, the second physician is substantially more likely also to cite the first (OR 3.64; Table 2). This suggests that many of these discussions among physicians involve more than unilateral advice, entailing joint deliberation over interpretations of the

Figure 1. Network of influence among primary care physicians in a hospital practice. Points represent physicians, identified using arbitrary identification numbers. An arrow from 1 physician to another indicates that the first cited the second as someone with whom they had influential discussions about women's health. Thin lines indicate relationships involving 1–3 influential discussions, thick lines 4 or more discussions. "E" before an identification number indicates that the physician is a self-identified women's health expert. Circles denote female physicians, squares male physicians. Size of plot symbols corresponds to the percentage of women patients in a physician's panel. Colors distinguish 4 physically separate clinics within the hospital; physicians designated with green points are part of the hospital's women's health clinic.

Table 2. Predictors of Patterns of Network Interactions

Predictor	Odds ratio (95% Bayesian confidence interval)*
Cited physician characteristics	
Self-reported expert in women's health	6.81 (2.25 to 23.81)
Percent of women in panel	1.03 (1.01 to 1.05)
Number of half-day clinical sessions per week	1.33 (1.15 to 1.54)
Cited physician/Citing physician similarities/differences	
Same clinic	5.03 (3.10 to 8.33)
Different gender	0.64 (0.39 to 1.03)
Reciprocity	3.64 (1.65 to 8.76)

*Using logistic P2 model with random effects for differences between citing physician and physician cited. Constant=0.0010 (0.0002 to 0.0053). Models adjust for all variables in the table.

medical literature and what it implies for the treatment of patients.

Our analyses focused on discussions among physicians within the practice. To assess the importance of physicians outside of the practice, we examined reports of the 1 individual inside or outside of the practice named as most likely to influence a respondent's practice regarding women's health issues. Only 4 respondents named someone outside of the practice as most influential. Four of the 5 experts named a person inside of the practice, and the fifth named no one. Among the 28 non-experts, 19 named someone in the practice, 4 named someone outside of the practice, and 5 named no one.

DISCUSSION

Informal consultations with colleagues are an important source of information for practicing physicians.^{1,3-7} However, few data are available about how these interactions among physicians are organized and whether they are structured in a way that is likely to promote timely access to up-to-date medical information. Our study provides evidence that within 1 academic primary care practice, physicians interacted with colleagues in a manner that would appear to encourage efficient dissemination of clinically relevant medical information.

Our findings support our hypotheses about factors important to the network structure within this practice. First, physicians seek out colleagues who are able to provide current and useful information. Not only were influential physicians more often self-reported experts in women's health, they also had greater proportions of women in their panels and they had more patient care sessions each week, suggesting greater experience with women's health issues.

Second, discussions among physician colleagues appeared to be channeled along lines of opportunity and convenience in terms of temporal and spatial proximity. Physicians practicing in the same clinic within the overall practice were much more likely to seek information from each other, suggesting that physical proximity allows for influential discussions that may not otherwise occur. Availability may also explain our finding that physicians with more weekly patient care sessions were more often cited by their colleagues as sources of influential discussions, although this finding may also reflect greater

clinical expertise among these more clinically active physicians.

Finally, physicians were slightly less likely to report having influential discussions with other physicians of different gender and thus more likely to have discussions with physicians of the same gender, although this finding was of borderline statistical significance. Physicians may be more apt to seek out and be influenced by demographically similar colleagues; however, we did not observe any association between interaction patterns and professional age or years in practice. In addition, we did not find that physicians consulted women about women's health issues just because they were women. Rather, they sought information from physicians with greater experience and expertise in women's health, which were more frequently found among women physicians in this practice. The greater expertise among women physicians may also explain observations of higher screening rates among women patients who see women physicians.^{19,20}

Primary care physicians' practices should recognize that informal discussions about clinical issues are occurring with high frequency and with a clear structure, and that it may be to their advantage to understand and use these informal networks to encourage diffusion of up-to-date and high-quality information. With relatively minimal effort, a practice could help to identify content-area experts, who may already be serving as the practice's "opinion leaders," and make them known to other providers in the practice. A practice could also support its content-area experts by assisting them with opportunities for continuing medical education and helping them obtain recent and reliable research information. Medical librarians could also play a role by helping to apprise such experts of new information.²¹

Primary care practices could also structure themselves so that members of the practice become content-area experts in complementary areas. Although this would require more organization, it might help to minimize unnecessary referrals to specialists and reduce additional office visits by patients. Practices could offer incentives for physicians to be recognized for content-area expertise, e.g., by encouraging them to schedule fewer patients on certain days or allocating blocks of free time during which they would be available to answer questions from colleagues. The clinical volume of such experts should not decline too much, however, as large drops could affect how others perceive their expertise. Practices could also provide bonus payments for colleagues recognized by others as helpful resources. Academic institutions could recognize the value of such expertise by considering it as a factor in promotion of its clinician educators.

Our finding that self-reported women's health experts tend to be centrally located within the network validates those self-reports, suggesting that physicians are able to effectively identify themselves as content-area experts. Nevertheless, it is conceivable that in other practices a network might be misaligned or organized in such a way that clinicians having special knowledge and expertise in certain areas are not sufficiently accessible or well-enough known to others.

Our findings should be interpreted in light of several limitations. First, we studied a relatively small practice of only primary care physicians affiliated with a single major teaching hospital. Additional research is necessary to determine whether patterns of informal discussions among specialists, between generalists and specialists, and among physicians in different

institutions and larger practices are similar. Second, we asked only about influential discussions about issues related to women's health. Additional studies are needed to determine whether the networks for influential discussions about other topics, such as cardiovascular disease, are similar or different. Third, we studied only physicians within the practice and cannot draw conclusions about the role of physicians outside of the practice in influencing practice patterns. However, when asked to name the person in or out of the practice who is most influential on their women's health practice, both expert and non-expert physicians predominantly cited physicians within the practice. Moreover, although we assessed the influence of prior training at the present practice site, we had limited information about prior educational relationships with other physicians in the practice which, in turn, might influence the likelihood of informal discussions.

Finally, our analytic strategy accounted for many interdependencies among network variables, and assumed that pairs of physicians were conditionally independent of one another. Other forms of interdependence are possible, however, such as "clustering" in which, for example, physician A is more likely to cite Physician C if physician A cites physician B and physician B cites physician C. Our "same clinic" predictor took some, although not all, such clustering into account.

In summary, informal discussions among physicians that influence clinical practice are frequent. Our data suggest that these discussions are clearly organized within a network of physicians in a hospital-based primary care practice. In addition to the influence of opportunity and convenience on these interactions, physicians also identified colleagues who had higher levels of experience and who were self-reported women's health experts. Recognition that networks of influential discussions are common within practices could potentially help to promote more rapid dissemination of high-quality evidence-based medicine within primary care settings.

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