Collaborative Medical Decision Making

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Collaborative decision making occurs whenever two or more individuals contribute their diverse knowledge and expertise to the decision-making process. In medicine, this happens during morning rounds, case conferences, consultations, and elsewhere. This paper presents an analysis of collaborative medical decision making, focusing on two factors that can powerfully influence the kind of information that gets discussed, and hence the nature of the decisions that are made. These are 1) the pre-discussion distribution of problem-relevant information/knowledge, and 2) each participant's awareness of other individuals' knowledge and talents. The authors review previous psychological research on group decision making that concerns these factors, and call attention to several lines of inquiry that might fruitfully be pursued in clinical settings. *Key words*: decision making; group decisions; group process; collaborative diagnoses. **(Med Decis Making 1993;13:339–346)**

While a substantial amount of research has focused on the psychological processes employed when physicians make clinical decisions *individually*,[1–5] few studies have examined *collaborative* medical decision making.[6,7] Yet, collaborative decision making is an integral part of clinical medicine. Morning rounds, case conferences, and consultations are but a few of the many venues in which two or more individuals contribute their diverse knowledge and expertise to the decision-making process. Collaborative efforts of this sort are designed to ensure that relevant information is brought to bear on clinical decisions, and to facilitate the coordinated action of all involved toward appropriate and mutually agreeable treatment goals. Collaboration is also an important vehicle by which novice physicians are trained in the art of clinical reasoning.

To be sure, the clinical decisions resulting from such collaborations are seldom the products of simple democratic processes. Furthermore, the individuals involved often vary widely in background, authority, and patient responsibility. Nevertheless, medical teams do have much in common with other professional decision-making groups. It therefore seems important to examine the existing literature on group decision making, explore its relevance for the domain of medicine, and identify potential sources of strength and weakness in team-based clinical decision making.

In this paper we give primary attention to two factors that characterize collaborative decision making in clinical settings: 1) the pre-discussion distribution of problem-relevant information/knowledge among team members (and the resultant need to pool that information), and 2) each team member's awareness of other participants' knowledge and talents (what we call "meta-knowledge"). These two factors can powerfully influence the kind of information that gets discussed in team meetings, and as a consequence, the nature of the decisions that are made. Of course, how that information is ultimately evaluated and weighted by various team members is also important. However, evaluation and weighting cannot occur until *after* team members are made aware of the information. Thus, as a first step toward understanding the process of collaborative medical decision making, it seems useful to focus on those factors that influence the discussion of information not initially held by all team members (referred to here as "unshared" information). We review previous psychological research on group decision making that bears on this issue, and call attention to several lines of inquiry that might fruitfully be pursued in clinical settings. Our aim in presenting this review is to offer an analysis that is suggestive, not definitive, and that applies broadly to almost any situation in which multiple health care professionals join together to exchange and evaluate information in order to make diagnostic or case management decisions.

The Distribution of Information

An obvious difference between individual and team-based decision making is that at the individual level all of the decision-making activity is carried out by one person, whereas in a team, portions of that work are often carried out by different people. Different team members may attend to and analyze different aspects of a case using different tools and procedures, and may take very different kinds of actions in order to evaluate potential solutions. For example, the management of a critically ill geriatric patient with multiple medical problems may require input from several phy-

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sicians in specialties ranging from internal medicine to psychiatry, as well as from such allied health care professionals as nurses and nutritionists. Because of their different roles and orientations, when they first approach the case these various individuals will naturally seek out and obtain different types of patient information. Moreover, different members of the medical team may be privy to different sets of information because of differential access to family members and/or variability in the patient's self-reports. To the extent that the different types of information obtained by team members are all relevant to the case, successful decision making requires that that information somehow be integrated.[8]

One important mechanism for integrating case information is the patient's chart. The chart is designed to be a standard, fixed reference point for depositing and retrieving information that is relevant to the case. Unfortunately, patient charts seldom offer a truly comprehensive record of all the information that has actually been acquired. There is wide variability in the amounts and details of information catalogued, some of that information may not be fully understandable to all members of the decision-making team, and certain types of information (e.g., psychosocial information, patient desires or preferences, conflicting opinions of staff members) are not always included.[9,10]

A second mechanism for integrating information is group discussion. When entering a case conference for the purpose of deriving a final diagnosis and treatment plan, the various members of a medical decision-making team may not be fully aware of all of the information that has been gathered, and may have rather different understandings of the patient's overall situation. In particular, while each team member undoubtedly possesses some information that other members also share (e.g., much of the information that *is* in the chart), they may each also hold a certain amount of unshared information, that is, information acquired from the patient or others that is *not* recorded in the chart and that consequently no one else on the team possesses. To the extent that such unshared information is important to the patient's case, one significant, though often unappreciated, goal of the case conference is to ensure that such information is somehow brought to light.

While it seems highly likely that information recognized as important will be brought forth and thoroughly discussed during a case conference, there may be situations in which the importance of a given piece of information is not fully appreciated. If so, the chances of that information's actually coming to light during discussion are substantially reduced. Consider, for example, the following case:

A 45-year-old woman presents to an emergency room late at night complaining about a loss of consciousness. She had been at home with her daughter when she collapsed, and had been brought to the hospital by EMTs. In the examining room, the patient reports to an experienced ER physician that she has had a severe headache for most of the day, as well as vision problems, decreased sensation in her arms, and occasional heart palpitations. She describes nothing unusual about her activities over the past week, except to say that she was upset about a fight with her ex-husband four nights ago, and that she had been drinking heavily as a consequence. In the course of recounting this incident, the woman admits to a history of alcohol abuse.

Meanwhile, in a separate conversation with an intern who is working her first rotation in the ER, the patient's daughter confirms several of her mother's physical symptoms, including her severe headache and vision problems. She also expresses concern about her mother's general lifestyle and mental health. She reports that her mother was fired from her job as a secretary three months ago, and seemed very depressed as a result. She says her mother has lost all interest in maintaining her appearance, and is unmotivated even to cook for herself. She estimates that her mother has not eaten in several days. The daughter says nothing however, about her mother's drinking habits, which she finds embarrassing.

In this case, the patient's own report seems to implicate a variety of potential causes for her syncope, including perhaps migraine headaches or vertebral basilar insufficiency. The actual cause, however, is alcohol-induced hypoglycemia. Key to this diagnosis is the fact that the patient has recently ingested large quantities of alcohol and has not eaten for several days. However, this diagnosis is not likely to be reached unless the unique information obtained by the experienced physician (alcohol ingestion) and by the intern (fasting) comes out in discussion. But, because there is a chance that neither piece of information will seem particularly critical for reaching a diagnosis when considered by itself (i.e., prior to discussion, and hence in the absence of the other important diagnostic cue), the likelihood that both will actually come to light during discussion is considerably lower that it would be had both pieces of information been obtained by each individual in the first place.

Given the potential importance of case information held by just one team member, the need to efficiently communicate that information to others during a case conference seems obvious. Yet, there is evidence to suggest that sometimes teams have difficulty surfacing important unshared information. For example, Larson and colleagues[11] asked university students to individually study written descriptions of three hypothetical faculty members, and then to meet in three-person groups to decide which of them would be the best person to teach an introductory psychology course. The written descriptions consisted mainly of factual

information. However, not all of the information available about each faculty member was included in the written description given to every student. Rather, while some of the faculty information that each student held was also held by every other student in the group (shared information), some of it was read by that student alone (unshared information). Although the students were told in advance that they were going to receive a mix of shared and unshared information, no one knew precisely which pieces of information were shared and which were unshared. Audiotape recordings of the group discussions revealed that, overall, groups discussed 44% of the information they shared in common, but only 24% of the unshared information. Moreover, of the information that was mentioned, 41% of the shared information, but only 30% of the unshared information, was repeated one or more times. Similar results have been reported by Stasser et al.[12]

This tendency to discuss (and repeat) more shared than unshared information is clearly not an optimal use of group resources. In fact, it would actually be of greater help to discuss more of the unshared information, since the unshared information is in a sense more valuable to the group as a whole.[13] That is, discussing previously unshared information can add to the group's *collective* (i.e., shared) knowledge base, whereas discussing already shared information cannot. Given two pieces of information (one shared, one unshared) that are both important for making a correct decision, it seems more critical for a group to surface the previously unshared information than it is for them to perseverate with the information already available to everyone. Even without discussion, the shared information can be evaluated by all group members. This is clearly not the case for the unshared information. Yet, despite the usefulness of discussing unshared information, it often receives less attention.

The failure to give at least equal consideration to unshared information during group discussion can be attributed in part to the statistical fact that when fewer people hold a given piece of problem-relevant information beforehand, there is simply a lower probability that that information will be mentioned.[14,15] Thus, what occurs during the group's discussion is similar to what would happen if a single individual were to draw random samples from multiple, partially redundant pools of information—he or she would over-sample the redundant (shared) information, and under-sample the non-redundant (unshared) information. This suggests that the tendency to mention more shared than unshared information during a group discussion can be expected to increase as 1) the group's size increases, 2) the overall amount of problem-relevant information increases, and 3) the percentage of shared (vs unshared) information held in advance by individual group members increases. Research evidence supports these predictions.[12,14–17] Even under the most favorable conditions (i.e., small group size, low information load, and a small percentage of shared information), however, groups still tend to discuss disproportionally less of the previously unshared information.

Failing to discuss items of unshared information can be particularly harmful when a "hidden profile" exists. The term "hidden profile" refers to any situation in which either the correct solution to a problem or the correct approach to attaining that solution is obscured from team members because of the particular way in which problem-relevant information is initially distributed among them.[14,16] As an example, consider a team of four physicians asked to evaluate two mutually exclusive diagnostic hypotheses for a particular patient. Imagine that a total of seven symptoms/findings are present, four implicating Disease A, and three implicating Disease B. If all seven pieces of information were known to the entire team, and if each were weighted equally in the overall evaluation, then the team should be slightly more inclined to believe that the patient has Disease A than Disease B (since slightly more of the symptoms point to Disease A). Suppose, however, that prior to discussion the information favoring Disease A is distributed such that one piece is held by each team member, while all of the information favoring Disease B is distributed to all team members. Thus, each member holds four pieces of information—one favoring Disease A and three favoring Disease B. The profile that is apparent to each team member prior to group discussion—the manifest profile—favors Disease B. On the other hand, the profile that would appear if all group members were to divulge *all* of their information favors Disease A. Yet, the implication of the information favoring Disease A is initially hidden from the team members because it is so widely disbursed among them (i.e., unshared). Indeed, the hidden profile is likely to come to light only if there is a complete and open exchange of information among the team members. But, as we have seen, the research literature suggests that a complete exchange of information may not always take place.

Given the considerable difficulty that groups have in surfacing unshared information during discussion, it is of interest to speculate about what can be done to improve the situation. One suggestion might be to structure the problem-solving discussion in such a way that greater opportunity is given for problem-relevant information to emerge before any solution alternatives are considered. Larson and co-workers found that unshared information came to light earlier and more systematically when subjects considered the decision alternatives one at a time, that is, when they discussed one alternative before turning to the next.[11] Another possibility is to increase group members' awareness that other individuals may possess important pieces of information. For example, Stasser[16,17] found that when members knew who in the group had expertise in which specific knowledge domains, the amount of unshared information discussed in-

creased significantly. In the clinical domain, this would argue for an explicit understanding of the specific information-gathering roles (not just the medical specialties) of each group member. The strong guidance of a designated or informal group leader who possesses knowledge of these activities might also be useful.

Meta-Knowledge

Both cognitive and developmental psychologists have long been interested in meta-cognition or "cognition about one's own cognition."[19] A key aspect of meta-cognition is the accumulated autobiographical knowledge that people have about what they do and do not know. For example, physicians differ widely with respect to their knowledge of cardiovascular disease. Some know more, while others know less. In general, patients should be better served by physicians who possess more self-awareness, and who more accurately know the extents and limits of their understanding of this class of disease, regardless of what those limits actually are.

Groups, just like individuals, possess something akin to meta-cognitive knowledge. In the course of managing a patient, team members acquire two different types of knowledge. First, and perhaps most important, they acquire *declarative* knowledge,[20] which includes information about the specific clinical case, as well as ties between case knowledge and appropriate underlying pathophysiology.[21] Second, team members acquire knowledge of the various kinds of information and expertise held by *other* team members. The total pool of knowledge that each team member has about the types of information and expertise other team members are likely to possess is referred to as his or her "*meta-knowledge base*."[22] Meta-knowledge is indispensable for a team's decision-making activity. It serves an essential integrative function in that it enables team members to make more efficient use of each other's declarative knowledge.[23,24] Thus, rather than waiting for important bits of problem-relevant information to be volunteered spontaneously during a case discussion, team members can make specific requests for such information from those individuals they think are likely to hold it. Conversely, important pieces of information are much more likely to be brought forth without such a request if the individual who holds that information can anticipate that it may be relevant to what someone else probably knows.

Because of its importance for team functioning, the organization within which the team operates is likely to take some responsibility for developing team members' meta-knowledge bases. Thus, as new employees undergo job training, the work of other individuals with whom they may need to interact is likely to be explained. This may include descriptions of some of the critical kinds of information than those other individuals possess or can obtain, as well as how that information may be of use to the new employee. In other cases, job rotation programs and systematic job progression schemes are specifically designed to give employees first-hand experience with the information associated with other roles.[25,26] In medicine, the wide array of clerkship and residency experiences available during training provide students with the knowledge needed to make future specialty and subspecialty choices, as well as an opportunity to begin developing meta-knowledge about the "typical" kinds of information held by potential colleagues.

However, formal organizational interventions of this sort can account for only part of the development of team members' meta-knowledge bases. This is because teams often evolve idiosyncratic ways of performing their jobs. Personal interests and the specific mix of talents within the team may lead certain members to assume responsibility for particular tasks or content areas. For example, a physician who enjoys using the computer may perform MEDLINE searches when faced with a diagnostic alternative for which the team has little information. Over time, other team members will naturally become aware of this, and may even begin to depend upon the computer-savvy physician. Similarly, team members will gradually become familiar with the medical content areas, interests, and expertise of their colleagues (i.e., some internists may know more about renal failure than others) and come to depend upon certain individuals to address particular issues. Thus, as a function of working together, teams evolve sets of work roles that, although not formally recognized or documented, nevertheless have important effects on how the work gets done. Organizational interventions such as job rotation are not likely to be effective in supplying meta-knowledge of this sort if the rotation plan has the individual working with different teams. Past experience in other teams that have their own unique characteristics and ways of doing things still leaves gaps in one's meta-knowledge about the current team and work situation.

Thus, because work roles are to some extent shaped informally within virtually every team, there is never likely to be a completely satisfactory substitute for on-the-job experience as a way of gaining team-relevant meta-knowledge. This suggests that experience working together should always tend to increase a team's ability to coordinate its activities. Such experience should enable team members to interact more efficiently and to make more effective use of each other's declarative knowledge. This in turn should result in better team performance, both in terms of the efficiency of group interaction (i.e., the amount of time needed to exchange information and reach a decision, making appropriate offers and requests for information) and in terms of the quality of the decisions eventually made.

One interesting implication of this analysis is that team performance may be hampered in an organizational setting where job assignments change frequently, and where teams are together for relatively short periods of time. Consider, for example, a case study reported by Denison and Sutton[27] of a Michigan hospital with a traditional nursing-pool method of assigning nurses to surgical operations, which subsequently changed to a team-based approach. In the traditional approach, the operating room administrator would, each afternoon, assign nurses to the 50 or so operations scheduled for the next day. The administrator made her assignments based on input from the nurses, her own prior experience, and intuition, and took into account the probable length of each operation, the number of nurses needed, and the specific skills required. In this way, 25–30 nurses were constantly mixed and matched in temporary work groups of two to four members as they moved from one operating room to another. When the hospital changed to a team-based system, the "mixing and matching" decreased dramatically. Under the new system, there were four nursing teams, each consisting of six to ten members. Each team had its own surgical specialty, each had responsibility for scheduling its own operations, and the nurses in each team always worked exclusively with other nurses from the same team. The latter fact meant that the nurses now were in surgery with the same partners much more frequently than they had been previously. Following the change to the new system, the nurses reported greater job satisfaction, there was lower turnover, and there was more cross-training of surgical skills. Moreover, the physicians who worked with these teams reported that the overall quality of surgical nursing had improved.

A very different example, and one that involves a more rigorous research methodology, comes from the airline industry. Foushee et al.[28] conducted a study in which two-person flight crews composed of professional airline pilots "flew" in a high-fidelity, full-mission simulator scenario that assessed their skills at handling a number of technical problems. The scenario involved routine flight operations plus an unexpected mechanical abnormality that created a period of very high crew workload. Half of the flight crews participating in the study were run through the simulation within two to three hours after completing a three-day duty cycle, while the other half had had the preceding two to three days off and had not flown together recently. It was found that despite being more fatigued, the crews that had flown together continuously during the three days preceding the simulation experienced significantly less difficulty coordinating their activities during the simulation than did those that were rested but had not flown together recently. This was evidenced by more efficient verbal communication, as well as by better overall performance. The performance data are particularly striking. Crews that were rested but had not flown together recently produced over twice as many errors in handling the simulator as did those that were not rested but had flown together continuously for three days.[29]

We believe that one reason for the superior performances of both the newly formed nursing teams and the flight crews that had just come off a three-day duty cycle is that these teams had acquired meta-knowledge as a function of working closely together, which enabled them to make more effective use of each other's talents. Even for highly trained professionals whose activities might otherwise seem carefully prescribed and closely regulated, on-the-job experience is essential for clarifying ambiguities in member roles and for gaining team-specific meta-knowledge.[30] What is more, the benefits of this process appear to manifest themselves in a relatively short period of time (e.g., in less than three days in the flight crew study).

While the results of such studies carry clear implications for dynamic enterprises such as surgery, it is interesting that medical decision-making teams with stable memberships in the long term are presently being employed in some teaching hospitals in the form of "firms" or academic group practices.[31–35] Although the specific compositions, durations, and operations of these firms differ from one department of medicine to the next, the system typically involves setting up small teams consisting of several residents, led by one (or a few) attending staff members. These teams function together for extended periods of time—ideally, for the duration of a resident's training. In many cases, such a firm handles both outpatient and inpatient cases, which allows the team to follow patients throughout the entire courses of their illnesses.

The goals most often stated regarding the use of firms include the desires to 1) improve longitudinal patient care, 2) acculturate residents and students by providing a realistic simulation of their future practices, 3) minimize dissociation of the residents from patient responsibilities in the outpatient arena, and 4) link residents' inpatient and outpatient activities.[33] In addition to these stated goals, our analysis of the impact of team rotation suggests that firms may have the added benefit of enhancing decision-making quality by allowing members to develop extensive meta-knowledge. That meta-knowledge may include a better understanding of colleagues' general cognitive capabilities (e.g., poor memory, good quantitative skills), content area expertise (e.g., interest in and knowledge about neurologic disorders), procedural expertise (e.g., how to perform an efficient literature search, how to calculate an A-a gradient), and awareness of the informal information-gathering roles that develop in light of the mix of personalities present (e.g., Dr. A often seeks out discussions with patients' family members; Dr. B always double checks for inconsistencies in lab results; Dr. C worries about drug interactions). All of

this meta-knowledge should enable team members to interact more effectively during case conferences, and lead to more effective decision making. That is, meta-knowledge should enable team members to exchange information with their colleagues more efficiently. Factors that enhance meta-knowledge and encourage members to utilize it (e.g., experience working together, group norms that support the volunteering and soliciting of information) should therefore improve group decision making, while factors that inhibit the accumulation of meta-knowledge and discourage members from utilizing it (e.g., team-member rotation) may hinder group decision making.

The Influence of Status on Information Exchange

The perspective on collaborative medical decision making presented in this paper highlights information distribution, exchange, and meta-knowledge. These are important because they provide the critical linkage between group-process factors on the one hand and decision-making effectiveness on the other. That is, they help to explain how factors that have traditionally been the focus of group-process research (e.g., roles, status, leadership styles, communication styles) come to affect group decision making. For example, a clear and explicit understanding of various members' information-gathering roles should prompt teams to surface previously unshared information. And groups should benefit from leaders who employ strategies that encourage the development of meta-knowledge.

As a further and more extended illustration, consider the potential impact of member status upon the exchange of information during group discussion. Most medical teams are composed of individuals who differ in the amounts of training they have had and/or the amounts of time they have spent in clinical settings. Such differences generally confer differential status on the team members. Status refers to one's rank, worth, or prestige within the group as perceived both by oneself and by others. A physician's status is enhanced by having superior scientific training, more clinical experience, and more credentials of certification from professional associations.[36,37] This suggests that status is often correlated with expertise. However, the two are by no means synonymous. Furthermore, high-status members do not always have direct access to all of the important case information. Thus, by itself, status is no guarantee of decision-making effectiveness.

Nevertheless, there is a good deal of empirical evidence that high-status group members generally have more influence on the group and its decisions than do low-status group members.[38–41] For instance, Maier and Hoffman[42] found that groups spent much more of their time addressing the ideas of high-status members than they did exploring alternative problem solutions suggested by lower-status members. Similarly, in a study examining the influence of induced status, three-person decision-making groups first received feedback arranged to create the impression that one of their members had performed extremely well on an initial problem (past accomplishments also confer status).[43] Later, group decisions on two problems (a personnel-selection task and a resource-allocation task) were found to be highly influenced by the opinions of the high-status member.

In addition, several investigations have documented the specific communication patterns that evolve among group members who vary in status. The status of a group member affects the overall amount of communication he or she initiates, the overall amount of communication he or she receives from others, and which particular group members he or she communicates with most frequently. In general, more communication is both initiated and received by high-status members than by low-status members, and the messages directed to high-status members tend to be more positive than those directed to low-status members.[44–48] Furthermore, low-status group members more often accept the opinions and ideas of high-status members than vice versa, in part because they fear retribution, and in part because they frequently are less confident in their own abilities.[49–52] Hence, we can expect that the low-status members of a medical decision-making team will sometimes communicate less information during group discussions than will high-status members, and in general will have less influence on the team's decisions.

These expected effects of member status on communication and influence in medical decision-making teams are not likely to be problematic in and of themselves. So long as status within the group is in fact based upon ability, and the high-status member(s) have direct access to all relevant case information, effective decision making is not likely to be impaired. However, there are clinical situations in which the high-status team member (e.g., the attending physician) must rely upon less expert colleagues to supply at least a portion of the case information. For instance, in teaching hospitals, expert faculty members are normally the individuals held responsible for decisions about patient care. However, it is often a novice physician who initially collects most of the case information. The faculty member eventually gets that information, in part by interrogating the novice. But as Cicourel[6] has pointed out, because such interrogations often take place when time is at a premium, there is substantial variability in the amounts of information that actually come to light. If any critical unshared information held by the lower-status physician is not brought forth, decision making may be significantly impaired.

In light of these difficulties, team organizers or leaders might try to implement strategies aimed at protecting low-status members of the group and encouraging the sharing of information by such members.

For instance, some Japanese companies employ a system in which the lowest-ranking member of a group speaks first, then the next lowest, etc. In this way, no one is held back by fear of differing with an opinion a superior has already expressed.[53] Similarly, Rogelberg and colleagues[54] have shown that groups produce significantly better decisions when members enter the discussion one at a time, with each new entrant first presenting her or his own ideas, information, and proposed solutions before hearing what others think or have already suggested. It is possible that, in medicine, a system like one of these could be applied to teaching rounds or case conferences in order to increase the amounts of information offered by lower-status team members.

Conclusions

We have emphasized several of the informational aspects of collaborative medical decision making, focusing upon the pre-discussion distribution of information and team members' awareness of the information held by others as critical variables impacting both information exchange and attendant group decisions. Clearly, this analysis does not provide a comprehensive view of group decision making. Furthermore, since a significant amount of the research we cite comes from laboratory settings and since several of our preliminary suggestions for improving collaborative medical decision making would require substantially increased decision-making time, it is essential that additional research in medical settings be undertaken.

On the other hand, our analysis does highlight the key role of information exchange in group decision making. In order to understand how a multitude of factors (e.g., status, self-presentation concerns, leadership style) influence group decisions, it is imperative to determine how these factors affect both the exchange of information among team members and each member's awareness of the knowledge possessed by others. While experimental and social psychologists can provide both theoretical models and empirical data explicating the role of information in group decision making, it is up to expert decision makers in crucial fields such as medicine to evaluate the relevance of such theory and research for their own applied settings and to develop appropriate interventions and educational programs. Physicians do not always function independently, and a better understanding of collaborative medical decision making may eventually provide useful insights for improving the quality of patient care.

References

1. Balla J. The Diagnostic Process. New York: Cambridge University Press, 1985.
2. Barrows HS, Freightner JW, Neufeld VR, Norman GR. The clinical reasoning of randomly selected physicians in general medicine. Clin Invest Med. 1982;5:49–55.
3. Elstein AS, Shulman L, Sprafka S. Medical problem solving: An analysis of clinical reasoning. Cambridge, MA: Harvard University Press, 1978.
4. Johnson PE. What kind of expert should a system be? J Med Philos. 1983;8:77–97.
5. Miller RA, Pople HE, Myers JD. Internist-I, an experimental computer-based diagnostic consultation for general internal medicine. N Engl J Med. 1982;307:468–76.
6. Cicourel AV. The integration of distributed knowledge in collaborative medical diagnosis. In: Galegher JE, Kraut RE, Egido C (eds.). Intellectual Teamwork: Social and Technological Foundations of Cooperative Work. Hillsdale, NJ: Erlbaum, 1990;221–42.
7. Knightengale S, Miller D. Group polarization in medical decision making. Presented at the meeting of the Society for Medical Decision Making, Philadelphia, October 1988.
8. Sacket RP, Wilson MA. Factors affecting the consensus of group judgment process in managerial assessment centers. J Appl Psychol. 1982;67:10–7.
9. Christoffel R, Lowenthal M. Evaluating the quality of ambulatory care: a review of emerging methods. Med Care. 1975;15:877–84.
10. Ravitch MM, Rovner DR, Jennett PA, Rothert ML, Holmes MM, Holzman GB, Elstein AS. A chart audit study of the referral of obese patients to endocrinologists. Med Decis Making. 1983;3:69–74.
11. Larson JR Jr, Foster-Fishman PG, Keys CB. Information sharing in decision-making groups. Presented at the annual convention of the APA, Washington, DC, 1992.
12. Stasser G, Taylor LA, Hanna C. Information sampling in structured discussion among three- and six-person groups. J Pers Soc Psychol. 1989;57:67–78.
13. Sox HC, Blatt MA, Higgins MC, Marton KI. Medical Decision Making. Boston: Butterworths, 1988.
14. Stasser G, Titus W. Pooling of unshared information in group decision making: biased information sampling during discussion. J Pers Soc Psychol. 1985;48:1467–78.
15. Stasser G, Titus W. Effects of information load and percentage of shared information on the dissemination of unshared information during group discussion. J Pers Soc Psychol. 1987;53:81–93.
16. Stasser G. Computer simulation as a research tool: the DISCUSS model of group decision making. J Exp Soc Psychol. 1988;24:393–422.
17. Stasser G. Facilitating the use of unshared information in decision making groups. Paper presented at the 63rd annual meeting of the Midwestern Psychological Association, Chicago, 1991.
18. Stewart DD, Wittenbaum G, Stasser G. Expert roles and information exchange during discussion: the importance of knowing who knows what. Paper presented at the annual meeting of the Midwestern Psychological Association, Chicago, 1992.
19. Nelson TO. Metacognition. Boston: Simon and Schuster, 1991.
20. Anderson JR. Acquisition of cognitive skills. Psychol Rev. 1982;89:369–409.
21. Feltovich PJ, Patel V. The pursuit of understanding in clinical reasoning. Presented at a meeting of the American Educational Research Association, New Orleans, 1985.
22. Larson JR Jr, Christensen C. Groups as problem solving units: toward a new meaning of social cognition. Br J Soc Psychol. 1993;32:5–30.
23. Wegner DM. Transactive memory: a contemporary analysis of the group mind. In: Mullen B, Goethels GR (eds.). Theories of Group Behavior. New York: Springer-Verlag, 1987;185–208.
24. Wegner DM, Guiliano T, Hertel P. Cognitive interdependence in close relationships. In: Ickes WJ (ed.). Compatible and incompatible relationships. New York: Springer-Verlag, 1985;253–76.
25. Edstrom A, Galbraith J. Transfer of managers as a coordination and control strategy in multinational organizations. Admin Sci

Q. 1977;22:248–63.
26. Hutchins E. The technology of team navigation. In: Galegher J, Kraut RE, Egido C (eds.). Intellectual Teamwork: Social and Technological Foundations of Cooperative Work. Hillsdale, NJ: Erlbaum, 1990;191–220.
27. Denison DR, Sutton RI. Operating room nurses. In: Hackman JR (ed.). Groups that Work (and Those That Don't): Creating Conditions for Effective Teamwork. San Francisco: Jossey-Bass, 1990;293–308.
28. Foushee HC, Lauber JK, Baetge MM, Acomb DC. Crew factors in flight operations: III. The operational significance of exposure to short-haul air transportation operations (NASA Technical Memorandum 88322). Moffett Field, CA: NASA Ames Research Center, 1982.
29. Foushee HC. The role of communication, socio-psychological, and personality factors in the maintenance of crew coordination. Aviation Space Environ Med. 1982;53:1062–6.
30. Ginnett FC. Airline cockpit crew. In: Hackman JR (ed.). Groups That Work (and Those That Don't): Creating Conditions for Effective Teamwork. San Francisco: Jossey-Bass, 1990;427–48.
31. Beeson PB. Soom good features of the British National Health Services. J Med Educ. 1974;49:3–49.
32. Cohen DI, Breslau D, Porter DK, Goldberg HI. Academic group practice: the physicians' view. Med Care. 1987;25:686–94.
33. Cebul RD, Dawson NV. Translating theory into practice: Metro Firm System. Soc Gen Intern Med Newsletter. 1987;10:2–3.
34. Neuhauser D. The Metro Firm Trial. In: Tanur JM, Mosteller F, Kruskal WH, Lehman EH, Link EF (eds.). Statistics. A Guide to the Unknown. Pacific Grove, CA: Wadsworth and Brooks, 1989;25–30.
35. Waggoner DM, Frengley JD, Griffs RC, Rammelkamp CH. A firm system for graduate training in general internal medicine. J Med Educ. 1979;54:556–61.
36. Bourdieu P. The specificity of the scientific field. In: Lemert C (ed.). French Sociology. New York: Columbia University Press, 1981;257–92.
37. Freidson E. Profession of medicine: A study of the sociology of applied knowledge. New York: Atherton, 1972.
38. Davis JH. Group decision and procedural justice. In: Fishbein M (ed.). Progress in Social Psychology. Hillsdale, NJ: Erlbaum, 1980.
39. Penrod S, Hastie R. Models of jury decision making: a critical review. Psychol Bull. 1979;86:133–59.
40. Penrod S, Hastie R. A computer simulation of jury decision making. Psychol Rev. 1980;87:462–92.
41. Torrance PE. Some consequences of power differences on decision making in permanent and temporary three-man groups. Research Studies, Washington State University, 1954;130–40.
42. Maier NRF, Hoffman LR. Quality of first and second solutions in group problem solving. Psychol Mono. 1960;78:580.
43. Kirchler E, Davis JH. The influence of status differences and task type on group consensus and member position change. J Pers Soc Psychol. 1986;51:83–91.
44. Bradly PH. Power, status, and upward communication in small decision making groups. Commun Mono. 1978;45:33–43.
45. Dean LM, Willis FN, Hewitt J. Initial interaction distance among individuals equal and unequal in military rank. J Pers Soc Psychol. 1975;32:294–9.
46. Fandt PM, Ferris GR. The management of information and impressions: when employees behave opportunistically. Org Behav Hum Decis Proc. 1990;45:140–58.
47. Shaw ME. Group Dynamics: The Psychology of Small Group Behavior. New York: McGraw-Hill, 1981.
48. Worcel P. Catharsis and the relief of hostility. J Abnorm Soc Psychol. 1957;55:238–43.
49. Costanzo PR, Reitan HT, Shaw ME. Conformity as a function of experimentally induced minority and majority competence. Psychonomic Sci. 1968;10:329–30.
50. Deutsch M, Gerrard H. A study of normative and informational social influence on individual judgment. J Abnorm Soc Psychol. 1955;51:629–36.
51. Rubin JZ, Brown BR. The Social Psychology of Bargaining and Negotiation. New York: Academic Press, 1975.
52. Ross LD, Amabile TM, Steinmetz JL. Social roles, social control and biases in social perception. J Pers Soc Psychol. 1977;28:69–76.
53. Russo JE, Schoemaker JH. Decision Traps: The Ten Barriers to Brilliant Decision-making and How to Overcome Them. New York: Simon and Schuster, 1989.
54. Rogelberg SG, Barnes-Farrel JL, Lowe CA. The stepladder technique: an alternative group structure facilitating effective group decision making. J App Psychol. 1992;77:730–7.