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Team Medical Decision Making: Available Research and Future Directions

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TEAM MEDICAL DECISION MAKING:

AVAILABLE RESEARCH AND FUTURE DIRECTIONS

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ABSTRACT

As part of the shift toward team-based care, many clinical decisions are now made by intra- and interprofessional teams. Team medical decision making is a recommended practice that is believed to reduce error and improve clinical judgment. However, surprisingly few studies have examined the accuracy of team decisions and little is known about the efficacy of various team strategies. Consequently, practice guidelines are lacking. To address the paucity of research, this dissertation addresses possible starting points for future studies based on research to date and current practices. Accordingly, Manuscript I will discuss team research from various fields with an emphasis on strategies to pool disparate information and increase accuracy. Manuscript II will present the findings from a study examining individual and team decision making practices in rehabilitation medicine. Both manuscripts provide recommendations for research that might advance knowledge and thereby assist in developing practice guidelines for team decision making.

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PREFACE

This dissertation is in manuscript format. The first manuscript will be submitted after feedback from the dissertation defense. The second will be submitted after the first is accepted for publication. In accordance with the required format of the journals of interest, both manuscripts are in AMA format.

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Manuscript I

To be submitted for publication to Medical Decision Making.

Title: Team Medical Decision Making: Available Research and Future Directions

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Abstract

As part of the shift toward team-based care, many clinical decisions are now made by intra- and interprofessional teams. Team medical decision making is a recommended practice that is implicitly or explicitly assumed to reduce error and improve clinical judgment. However, surprisingly few studies have examined the accuracy of team decisions and little is known about the efficacy of various team strategies. Consequently, practice guidelines are lacking. Given the importance of evidence-based healthcare, the paucity of research represents a significant gap in the literature, and reduces the chances of identifying or ultimately approaching optimal practices. In an effort to encourage and inform future research, this article highlights team decision making research with a focus on accuracy. Rather than providing a formal literature review, the current work uses what research is available on team decision making as a foundation to design and suggest future studies that may prove productive. We propose that establishing practice guidelines for team decision making entails developing and enhancing strategies to pool disparate information and, as such, discuss research from the hidden profile paradigm with priority given to studies using medical decisions. Scientifically supported strategies to pool information and suggestions for future studies are offered.

Introduction

Health care in the United States is increasingly being provided by teams.[1] Team-based care is described as essential to navigating the immense complexity of modern healthcare,[2] including rapidly changing clinical practice guidelines.[3] In fact, by the time a health professional enters the field many of the previously learned practice guidelines are out of date.[4] Thus, proponents argue that a team approach allows providers to keep pace with current practice standards.[3]

According to Mitchell et al,[3] team-based care is defined as two or more health professionals working together to coordinate care and achieve mutual goals. Although research on team-based care is still in a relatively early stage of development, available evidence warrants optimism for both patients and providers. For instance, research has linked a team approach to improved patient safety,[5] higher patient satisfaction,[6] and improved patient outcomes,[7] as well as higher job satisfaction[8] and reduced risk of burnout for providers.[9]

Given the favorable literature to date, the advantages of a team approach would seemingly extend into clinical decision making. For example, it seems evident that in various instances a team approach to decision making would almost certainly be superior to an individual approach. To illustrate, consider a scenario, as is often the case in healthcare, where improving the quality of a judgment depends on combining essential pieces of information, components of which may be known to only a single individual. For instance, a nurse may have just found out that, despite initial reports to the contrary, a patient has been misusing a medication, thereby helping to clarify a differential diagnosis. In this situation, a team approach that includes the nurse is likely to improve diagnostic accuracy.

Although it is easy to identify circumstances under which a team approach would be superior, an extensive review of the literature revealed a scarcity of research on team decision making in which accuracy is the targeted outcome of interest or even discussed. In fact, the dearth of research precluded a formal literature review to determine best practice based on the evidence. Considering that team decision making is a recommended practice and widely implemented, the lack of research in this area is surprising.

For example, the Institute of Medicine described diagnosis as a "team endeavor" [10(p145)] in a recent report and recommended that, "health care organizations…facilitate and support intra- and interprofessional teamwork in the diagnostic process."[10(p157)] Although the authors acknowledged that "the literature on the role of teams in diagnosis is limited,"[10(p149)] they concluded that teams are "likely to improve diagnosis and reduce diagnostic errors because teamwork has been found to mitigate communication and coordination challenges in other areas of health care."[10(p149)] However, no team strategies or practice guidelines were offered.

The paucity of research in this area may be related to the assumption that team decisions are inherently superior and therefore research is unnecessary. This assumption is concerning because a) many team decisions directly impact patient outcomes (e.g., diagnosis, treatment), and b) as discussed below, teams are susceptible to many of the same biases as individuals as well as group level biases.[11] Thus, team decision making is a matter of patient safety and warrants research to determine best practice based on the evidence. Establishing practice guidelines for team decision making entails developing and enhancing strategies to increase accuracy, which is often best accomplished through programmatic research. For example, while a team approach may decrease error in comparison to individual decision making, some team-based approaches may be more or less effective than others; and even the best approach might be meaningfully improved by collecting systematic evidence on efficacy.

Therefore, this article highlights research relevant to team decision making with a focus on accuracy (see table 1 for a summary of key studies discussed in this manuscript). Our aim is not to present a formal review of the literature, which is not possible due to the lack of research, but rather to encourage and inform future studies that may help advance the field. We prioritize research with medical decisions but review studies with non-medical tasks as well. It is not assumed that research with dissimilar tasks will necessarily or always be directly applicable to healthcare settings, but given the limits in direct research that is available, related research creates a sensible place to start and may well help to inform future research and research design. Moreover, although we prefer the term "team" to be consistent with interprofessional team research, given the vague distinction between teams and groups (see Kerr &

Tindale[12]), we review both team and group research and use the terms interchangeably.

The remainder of this article is organized as follows: First, we consider the relative accuracy of individuals and teams, and then discuss accuracy and the bias toward shared information. Next, we highlight strategies to pool unshared information and increase accuracy, followed by suggestions for future research. Finally, we conclude with limitations and a summary.

Individual v. Team Decisions

Despite receiving little attention in medicine, research in the social sciences has long been interested in comparing the performance of individuals and teams. Such a comparison is relevant to applied settings, such as corporations and government entities, where the benefits of a team approach must be weighed against the additional resources required.[13] Research suggests that on average teams outperform individuals on many tasks, but they often fail to outperform their most accurate member.[14–19] In fact, although they are usually more confident,[19] teams generally perform about as well as their second most accurate member.[15]

Kerr and colleagues[20] postulate that a comparison between individuals and teams is more complex than it appears and there may not be a simple answer as to which is more accurate. Rather, the presence of error at both the individual and group level depends on various factors including group size and group processes, as well as the type of bias and level of bias present in the individual group members.[20] Taken together, available evidence suggests that, although teams are more accurate in many instances, they often do not live up to their potential.[12,13]

It should be noted, however, that the research cited above was conducted using non-medical decisions. For example, Sniezek and Henry[19] asked groups to estimate mortality base rates. This is significant because, as Kerr[21] argued, the task moderates group behavior. Therefore, it cannot be assumed that research with one task will necessarily generalize to another task. In other words, although research from the social sciences may provide insight into the performance of clinical teams, one should not assume it is directly applicable to healthcare settings.

In one of the few medical studies to compare individuals and teams, Hautz et al[22] examined diagnostic accuracy in a sample of advanced medical students randomly assigned to work by themselves or in pairs. Participants were tasked with evaluating six simulated cases of respiratory distress, select 1 of 20 possible diagnoses for each case, and indicate their level of confidence. Cases included a video presentation of the "patient" and the option to view data on 30 diagnostic tests. The diagnosis of each case was previously validated by experts, with accuracy measured dichotomously as correct or incorrect. The results showed that teams were significantly more accurate than individuals (about 68% and 50%, respectively) and were also more confident; however, increased confidence was not associated with increased accuracy.

These findings are encouraging and suggest a team approach to diagnosis may reduce medical error, the third cause of death in the United States.[23] However, given the conditions in which this study was conducted (i.e., small intra-professional teams with access to the same information), it may not accurately represent the environment in which team decisions are often made. For example, in most clinical settings team decision making requires pooling expertise and information from various specialties.[13] Further, as healthcare continues to shift to a team approach, increasingly fewer decisions in medicine are likely to be made by a single individual. Therefore, to develop practice guidelines, it may be more appropriate to ask, "which team strategies increase accuracy?" rather than "when should teams make decisions over individuals?" The answer to this question requires an examination of the impediments to team accuracy, such as the bias toward shared information.

The Bias Toward Shared Information

Following Stasser and Titus's[24] landmark study, an important line of research has explored the relationship between individual and group preference by studying the exchange and integration of information during discussion.[25] In the *hidden profile* research paradigm information is unevenly distributed amongst individuals prior to discussion, and teams are told to discuss their information and make the best decision.[26] Some information is distributed to all team members (shared information) and some is distributed to only one or a few individuals (unshared information). The task is designed so that teams can make an informed decision based solely on shared information, but the most accurate decision requires pooling unshared information.[27]

Based on the purported benefits of teams (e.g., integration of disparate knowledge and expertise), one might expect the corrective function of discussion would allow teams to easily solve the hidden profile.[25] However, this is not the case. In fact, a consistent finding over the last 30 years is that during discussion *teams focus on shared information at the expense of unshared information which leads to non-optimal decisions*.[24,26–32] The bias toward shared information may increase as the size of the team increases and as the percentage of information held in advance by individual team members increases.[31,33] Moreover, teams rarely discover when a hidden profile exists.[26,34]

Given the conditions in which clinical decisions are often made, research from the hidden profile paradigm is salient to team medical decision making. For example, Christensen and colleagues[28] describe how a hidden profile can occur in medicine:

> Clinical decisions often involve people from different subspecialties and those with diverse amounts and types of previous experience. 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 physicians 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-report. To the extent that the different types of information obtained by team members are all relevant to the case, successful decision making requires that information be appropriately integrated.[28(pp48-49)]

In a series of hidden profile studies on diagnostic accuracy,[28–30] clinical teams mentioned 67% to 81% of shared information during discussion but only 46% to 64% of unshared information. Shared information was more likely to be pooled early in the discussion and was repeated more often than unshared information.[29,30] Pooling unshared, or unique, information significantly increased accuracy whereas pooling shared, or common, information was unrelated to accuracy.[30] In one study, Christensen et al[28] found that teams correctly diagnosed 100% of control cases, in which information was evenly distributed, but only

71% of the hidden profile cases. They concluded that clinical teams may be susceptible to error when the correct diagnosis requires pooling unique information.

In each study the teams were comprised of three individuals: a resident, intern, and medical student in two studies,[28,29] and two interns and a medical student in the other.[30] Given that these studies were conducted with intra-professional teams, it is conceivable that the bias toward shared information may be even more pronounced for interprofessional teams (e.g., see Blomqvist & Engstrom[35]).

One explanation to account for the bias toward shared information is the collective information sampling (CIS) model which states that when fewer people in a team have information there is a lower probability that information will enter into the discussion.[25,26,31] In other words, by mere probability shared information is more likely to be discussed because it can be sampled from the memory of multiple individuals whereas unshared information can only be sampled from one (or a few) individual's memory. However, violations of the CIS model (e.g., Wittenbaum[36] and Wittenbaum et al[37]) suggest that the probabilistic explanation does not entirely account for the bias toward common information and additional processes play a role in this phenomenon.[25] Based on a review of the literature, Kerr & Tindale[12] suggest the following explanations:

First, teams may prefer shared information because it can be socially validated.[25,26,32,37] For example, shared information may be perceived as more valid because it can be corroborated by other team members whereas unshared information cannot and therefore its value is more difficult to establish.[30,32] Consequently, teams are more likely to attend to shared information because its accuracy and relevance can be validated.[25] Furthermore, individuals who communicate shared information are viewed more positively (e.g., more competent and knowledgeable), and rate themselves more positively for sharing information that was well received by the team.[37] Wittenbaum et al[37] describes this "mutual enhancement" as follows:

> Shared information validates members' knowledge and eases interaction by helping members relate to each other. Those who communicate shared information receive positive evaluations from other members for doing so. Moreover, recipients of shared information feel better about their own task knowledge when another member mentions their information. Members who are positively reinforced (verbally or nonverbally) for communicating shared information may continue to do so because they enjoy the validation and encouragement from others. It may be this interactive validation process that fuels a group's tendency to repeat previously mentioned information.[37(p977)]

Interestingly, the repetition of unshared information during discussion appears to be moderated by one's status within the team.[25] For instance, in a study using clinical teams consisting of a resident, intern, and medical student, Larson et al[29] showed that unshared information was more likely to be repeated by the resident than by the lower status members. These findings are consistent with the results of a follow-up study using clinical teams,[30] with the notable difference being that the role of team leader was randomly assigned in the follow-up study. One interpretation of these results is that there are social consequences to mentioning unique information for lower status members.[25] Specifically, these individuals are already perceived as less credible and because their unshared information cannot be validated, it is more likely to be ignored by the rest of the team.[25]

Second, the "need for closure" may lead to reduced information processing via premature closure.[38–40] Need for closure is closely related to confirmatory bias and refers to a desire for a clear answer and general dislike of ambiguity, which can impact group discussion through "seizing" and "freezing."[39] Seizing, for example, occurs when an individual is easily persuaded to agree with another member who has already formed an opinion, whereas freezing occurs when an individual already has a firm opinion and is resistant to changing his or her mind.[38] Research has found that when an individual has an enhanced need for closure (e.g., due to situational circumstances or a trait disposition), he or she is more likely to reject views that threaten the group consensus[41] and exert pressure on the rest of the team to conform to a decision once one has been proposed.[38] Importantly, time pressure appears to heighten the need for closure.[39]

Third, once formed, team members prefer their pre-discussion preference.[34,42,43] This bias influences group processes in at least two ways: a) team members are more likely to perceive information that supports his or her pre-discussion preference as more believable and pertinent,[34] and b) team members are more likely to share information that supports his or her pre-discussion preference.[44] As an example, Kee and colleagues[45] studied the extent to which team discussion influenced clinician's treatment recommendations for patients with lung cancer. The results showed that in most instances the clinician's pre-discussion treatment preference agreed with the teams' subsequent recommendations; however, when the clinician's preference differed from the team, he or she stuck to their pre-discussion preference 58% of the time.

Thus, the bias toward shared information can be summarized as follows: 1. Many clinical decisions require pooling essential information known to only one or a few team members (i.e., hidden profiles), 2. During discussion teams tend to favor shared information at the expense of unshared information which increases error, 3. The mechanisms underlying this effect are not fully understood but a number of explanations have been proposed including: a) the probability of information entering a discussion is greater for shared information compared to unshared information, b) shared information may be perceived as more valid, c) a heightened "need for closure" may lead to reduced information processing via premature closure, d) team members prefer their pre-discussion preferences, and e) team members of lower status may be reluctant to voice unshared information.

Strategies to Pool Unshared Information and Increase Accuracy

Given the magnitude of the bias toward shared information, open group discussions may not be the optimal method to pool unshared information.[28,29,43] Therefore, the following corrective strategies and procedures are tentatively recommended based on available research.

First, an explicit understanding of each individual's area of expertise and the knowledge he or she possesses may help facilitate the discovery and integration of unique information.[28,32,33] For example, transactive memory theory suggests that, because information is dispersed across multiple individuals in teams, specific members are assigned responsibility for domains of knowledge (which, in healthcare teams, is usually based on his or her specialty) and are referred to when their expertise is needed.[46] However, teams are often unsuccessful as a transactive memory system.[25] For instance, in an analogue study on team diagnosis, Tschan and colleagues[47] found that oftentimes the physician holding the chart possessed information that could improve the diagnosis but failed to communicate that information to the rest of the team, leading to the false assumption that all relevant information was already known.

Therefore, it is crucial for healthcare teams to not just be aware of each member's specialty, which may be less relevant in intra-professional teams, but his or her role in the information gathering process.[28]

Second, teams may benefit by waiting to state their judgment until all team members have discussed their information.[30,48] For example, Larson et al[30] found that teams were more accurate when they waited to discuss specific diagnoses until everyone in the team had conveyed their information (however, it should be noted that this effect was not mediated by information pooling).

Third, teams may benefit by increasing the length of the discussion. For example, according to Larson et al,[48] unshared information is more likely to enter the discussion over time. Hence, extending the time allotted for discussion increases the number of opportunities for unshared information to be discussed, which, by extension, reduces error.[12]

Finally, team leaders can help facilitate pooling unshared information.[29,30] For instance, team leaders may be able to use their role to repeat information and ask questions in such a way that allows unique information to remain in the discussion, thereby increasing the probability of unique information being considered in the final decision.[30]

Furthermore, team leaders may be able to use their role to model and encourage communication strategies that have been shown to reduce error, such as explicit reasoning and "talking to the room." For example, Tschan et al[47] reported that clinical teams increased diagnostic accuracy when they used causal conjunctions, such as "because," "if-then," and "therefore," to communicate their impressions to the rest of the team. The authors hypothesized that explicit reasoning may allow other team members to more easily correct thinking errors or misinformation. Another strategy, "talking to the room," entails speaking to the entire group in a louder voice and verbalizing one's evaluation of the task at hand.[47] It is an approach that invites the team to participate in the diagnostic process and allows team members to feel more comfortable contributing to the discussion.

Thus, strategies to pool unshared information and increase accuracy can be summarized as follows: Teams may increase the probability of pooling unshared information by: 1) having an explicit understanding of each individual's area of expertise, the knowledge he or she possesses, and his or her role in the information gathering process, 2) waiting until all team members have discussed their information to reveal one's judgment, 3) increasing the time allotted for discussion, and 4) using team leaders to ask questions and keep unshared information in the discussion. In addition, teams may increase accuracy by using explicit reasoning and "talking to the room" during discussion.

Suggestions for Future Research

Despite the methodological challenges to research in this area, the potential benefits to patient safety and improved outcomes are well worth the effort. To that end, we offer the following suggestions for future studies.

First, future studies could continue to assess impediments to team accuracy, including the impact of uneven information distribution (i.e., hidden profiles). For example, only a handful of studies have applied the hidden profile paradigm to clinical decisions[28–30] and, although some have questioned the generalizability of hidden profile research to applied settings,[49] as Christensen and colleagues[28] cogently described, many clinical decisions may represent hidden profiles. Therefore, a more thorough understanding of the significance of information distribution and exchange is justified. Future studies, for instance, could compare accuracy between intra- and interprofessional teams when a) information is evenly distributed and available to *all* members, b) information is unevenly distributed and unique information is available to only a *few* members, and c) information is unevenly distributed and unique information is known by only *one* member. Moreover, naturalistic decision-making methods, such as studying the decisions of one team, may also prove to be fruitful.

Second, future research could assess the efficacy of team strategies on accuracy. For instance, studies could begin with the aforementioned corrective procedures, as these have been demonstrated to be effective, and compare error rates by strategy. Further, researchers might also consider combining strategies as it may be that a combination of corrective procedures is most effective.

Third, to inform analogue studies, future research could collect data on current practices in the field. For example, investigators might administer an online survey within a hospital system to assess: a) which clinical decisions are made by teams, b) which disciplines are represented on various teams, and c) which, if any, decision strategies teams use. Data on team decision making in the "real world" is important because it is fundamental to the dialectical relationship between research and practice. Specifically, science helps determines if a particular practice has promise or represents an improvement, the practice is disseminated and implemented in the field, and further data are collected on the effectiveness of the practice, which often becomes a basis to modify and improve the practice prior to redistribution. This feedback loop, which is vital to the progression of a field, cannot function optimally, or even effectually, without information on current practices.

In addition, given the cost of team meetings (e.g., see Simcock & Heaford[50]), both financial and in terms of resource depletion, future studies might consider approaches that do not require teams to meet in person. For example, an hour team meeting is an hour that one or more team members might spend providing reimbursable patient care, or during which team members might be providing various forms of help to patients. Therefore, research should investigate strategies to streamline team decisions. As an example, future studies could assess the utility of an "advisor" approach to decision making, which has been explored in psychology[51]; wherein a single individual makes a decision after receiving input from all team members. Although we are unaware of specific data, anecdotally the "advisor" approach appears to be commonplace in healthcare settings.

Further, future studies could explore strategies to pool independent judgments without meeting, which may be appropriate when a hidden profile is less likely. For example, research suggests that collective intelligence may be a mechanism to attenuate group bias and increase accuracy.[52–54] Collective intelligence approaches entail pooling independent judgments through various decision rules, including statistical aggregation, and, although more work is needed, initial studies suggest that these approaches increase accuracy over individuals.[52–54]

Limitations

This article should be interpreted in light of several limitations. First, due to the lack of sufficient research on interprofessional medical decision making and accuracy, this article is not a formal literature review and many of the studies reviewed used non-medical decisions. Second, the bias toward shared information is one of *many* possible impediments to accuracy and was highlighted because we believe it is salient to developing practice guidelines. Third, the recommended strategies to pool unshared information and increase accuracy are based on only a handful of studies and should be considered tentative. Fourth, although considerable effort was made to include all relevant research, it is possible that some important studies were overlooked.

Summary

This article reviewed research relevant to team decision making with a focus on accuracy. We proposed that establishing practice guidelines for team decision making entails developing and enhancing strategies to pool disparate information and discussed research from the hidden profile paradigm. We highlighted scientifically supported strategies to pool information and increase accuracy and offered suggestions for future research. As the complexity of healthcare increases due to such factors as an aging population wth multiple or co-presenting conditions and active treatments, it stands to reason that the number of hidden profiles will similarly increase. Therefore, we conclude by reiterating that, despite the methodological challenges to team decision making research, the potential benefits to patient safety are well worth the effort.

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Table 1. Summary of Key Studies on Team Medical Decision Making and Accuracy

Study	Relevant Findings
Christensen et al., 2000 (28)	Teams (resident, intern, and 3rd year medical student) were more likely to: a) misdiagnose hidden profile cases compared to control cases (71% v. 100% accuracy rate), and b) discuss shared information over unshared information.
Hautz et al., 2015 (22)	Teams (2 advanced medical students) were: a) more accurate than individuals when diagnosing simulated cases of respiratory distress (68% v. 50% accuracy rate), and b) more confident than individuals but confidence was not a reliable marker of accuracy.
Kämmer et al., 2017 (52)	Pooling medical students' diagnosis of "patients" with shortness of breath (using virtual teams of various sizes and "collective intelligence" decision rules) increased accuracy over the average performance of individual team members.
Kee, Owen, & Leathem, 2004 (45)	When a clinician's treatment preference conflicted with the treatment recommendations favored by the team (respiratory physicians, oncologists, and thoracic surgeons) during lung cancer treatment planning, team discussion did not change the clinician's mind 58% of the time.
Kurvers et al., 2016 (53)	Virtual teams pooled judgments of breast and skin cancer diagnosis were more accurate than the most accurate team member, but only when the accuracy rate of each team member was similar.
Larson et al., 1996 (29)	Teams (resident, intern, and 3rd year medical student) were more likely to discuss shared information and shared information was mentioned earlier in the discussion. Residents mentioned unshared information more often than the lower status team members (i.e., intern and 3rd year medical student).
Larson et al., 1998 (30)	Teams (2 interns and a medical student) increased diagnostic accuracy when they: a) pooled unshared information (although they were more likely to discuss shared information), and b) waited to discuss possible diagnoses until everyone had discussed their information. Team leaders were found to play an important role in managing information during discussion.
Tschan et al., 2009 (47)	In simulated cases of diagnostic ambiguity, teams (2 or 3 experienced physicians) increased accuracy when they utilized two strategies during discussions 1) causal conjunctions, and 2) "talking to the room."
Wolf et al., 2015 (54)	Pooling radiologists' independent recommendations for follow-up based on mammogram screenings (using "collective intelligence" rules in virtual teams) increased accuracy over the most accurate team member.

Manuscript II

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Title: Clinical Decision Making in Rehabilitation Medicine: Results from an Online Survey of Physicians

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Abstract

Intro: Clinical decisions in rehabilitation are frequently made by intra- and inter-professional teams. Improving team decision accuracy can help reduce medical error, however, few studies have explored team decision strategies. The primary aim of this exploratory study was to develop and disseminate a survey assessing clinical decision-making practices in rehabilitation with the goal of informing research to develop team decision aids. A secondary aim was to assess beliefs about team decision accuracy and supporting literature.

Methods: The survey was developed through expert interviews and emailed to residents, fellows, and attendings in Physical Medicine and Rehabilitation. Participants were asked to estimate the percentage of individual and team decisions in their current practice/rotation for six clinical decisions, and their beliefs about team decision making and supporting literature.

Results: The results showed significant variability across settings. On average, diagnosis, prognosis, and treatment decisions are made solely by physicians with input from allied health professionals; in contrast, functional capacity and discharge readiness are collectively determined by teams. Participants believe team decisions are superior to individual decisions but overestimate the volume of supporting evidence.

Discussion: Research to develop decision strategies for rehabilitation teams should consider how decisions are made in clinical practice. Follow-up studies based on this work are discussed.

Introduction

Medical error, or preventable adverse events, is broadly defined as unintentional harm caused by a patient being in the care of a healthcare professional.[1] Recent estimates place it as the third leading cause of death in the United States with approximately 250,000[2] to 400,000 deaths per year,[1] although some have questioned the accuracy of these figures.[3] These estimates are significantly higher than the, now outdated, landmark 2000 Institute of Medicine report which estimated 44,000 to 98,000 annual deaths,[4] leading some to suggest that medical error is increasing.[1] Remarkably, at least 50% to 60% of medical errors may be preventable.[1]

Findings from research in rehabilitation are similarly concerning. For example, a recent government report on adverse events in inpatient rehabilitation hospitals[5] found that 29% of Medicare patients have experienced harm as a result of receiving care. The investigators reviewed the records of 417 Medicare patients recently discharged from rehabilitation hospitals and found 158 adverse events including medication errors, bed sores, and infections. At best, these events led to temporary harm requiring intervention and, at worst, these errors resulted in the patient's death. A panel of experts determined that nearly half of the incidents were preventable (46%), with errors of medical judgment and inadequate treatment plans among the causes cited.

Further, research suggests that diagnostic errors, including inaccurate and delayed diagnosis, are among the causes of medical error.[1,6] In fact, the Institute of Medicine has described diagnostic errors as a “blind spot” in healthcare.[6] To illustrate, consider the following statistics from the same report: postmortem examination suggests diagnostic errors contribute to 10% of patient deaths[6]; diagnostic errors constitute 6% to 17% of adverse events in hospitals[6]; diagnostic errors are the most common reason for paid medical malpractice claims[6]; and most people will experience a diagnostic error in their lifetime.[6] Although most studies have focused on inpatient settings, additional research suggests that 12 million adults are misdiagnosed in outpatient settings each year.[7]

Given the causes of medical error, efforts to ameliorate patient harm must include interventions to improve clinical judgment and decision making. In fact, in their discussion of medical error, Makary and Daniel[2] outline several steps to reduce patient harm including improvements to clinical judgment. Indeed, much has been published in the medical and psychology literature on the limitations of human cognition and corrective procedures at the individual level (e.g., Dawes, Faust, & Meehl[8]), however, few studies have explored strategies to improve clinical judgment at the team level.[9]

This significant gap in the literature is especially concerning as teams increasingly provide care.[10] For instance, in rehabilitation, clinical decisions are frequently made by, or in collaboration with, health professionals from an array of disciplines, each with unique expertise and jargon.[11] Consequently, corrective procedures at the individual level may be less beneficial to rehabilitation settings where team-based care is standard practice. Thus, research to develop team decision strategies is warranted.

To develop procedures that might enhance team decision making, one must first understand how clinical decisions are made in practice, and in particular, the extent to which clinical decisions are made by teams. Such information is necessary to design follow-up studies to improve team decision making. For example, analogue studies may be a fruitful approach to develop team strategies; however, to accurately replicate the conditions of clinical practice, and thus increases the likelihood of generalizability, one must know how decisions are made in the field. To the authors' knowledge, no research has explored how clinical decisions are made in rehabilitation.

Aims

The primary aim of the present study was to develop and disseminate a survey examining team clinical decision making in rehabilitation medicine, with priority given to clinical decisions associated with patient outcomes. A secondary aim was to assess physicians' beliefs about team decision making and supporting literature.

Methods

This study was approved by the Institutional Review Board of the University of Rhode Island for meeting ethical criteria for research with human subjects.

Survey Development

Development of the survey initially started with key informant interviews, followed by cognitive interviews to cross-check the integrity of the developed survey questions. All participants in key informant and cognitive interviews were health professionals with experience in team decision making. Key informant interviews consisted of open-ended questions intended to inform item development and the parameters of the survey (see Appendix A for a sample of key informant interview questions). To the authors' knowledge a definition of team clinical decision making has not been established in the literature. Key informant interview participants included: 1) a clinical psychologist with 15 years of experience in a long-term acute care hospital, 2) a physiatrist with 10 years of experience on an inpatient brain injury unit, and 3) a board certified geropsychologist with 1 year of experience working in an acute care rehabilitation hospital. Of note, interviewee #1 has extensive experience as a psychologist on an interprofessional rehabilitation team, and interviewee #3 previously worked as a psychologist in an acute rehabilitation hospital on an interprofessional team. Both interviewees have experience contributing to team decisions such as diagnosis, treatment, and discharge.

During key informant interviews a significant distinction emerged in the conceptualization of team decision making. Namely, clinical decisions made *by* a team versus clinical decisions *informed* by a team. For example, participants suggested that some clinical decisions, particularly medical decisions, are made solely by physicians in consultation with other disciplines, or with information provided by other disciplines; whereas other clinical decisions are reached via a consensus between providers. As such, the survey was updated to capture the distinction between *individual decisions*, or decisions made only by the physician with input from the team, and *team decisions*, or decisions made collectively by an intra- or inter-professional team.

Following key informant interviews, the survey was reduced from 14 clinical decisions to six: diagnosis, prognosis, pharmacological treatment, non-pharmacological treatment, functional capacity (i.e., capacity for activities of daily living), and readiness for discharge. Given the present study's focus on increasing judgmental and decision accuracy, these decisions were selected for the final survey based on their association with patient outcomes[5,6,12] The inclusion rationale is as follows. Diagnosis: high rates of misdiagnosis across medical settings; prognosis: important for selecting appropriate level of care and treatment; pharmacological treatment: common cause of adverse events in rehabilitation; non-pharmacological treatment: additional cause of adverse events in rehabilitation; functional capacity: important for selecting appropriate level of care; readiness for discharge: premature discharge is associated with rehospitalization and worse patient outcomes.

Eight additional clinical decisions were identified during key informant interviews including mental capacity assessment, length of stay decisions, prognosis for mobility, decision to extend inpatient rehabilitation, determination of proper equipment, determination of safety of discharge to the home, determination of appropriate level of supervision, and end of life decisions. However, in an effort to reduce the response burden to participants, these decisions were removed from the final survey because: a) the decision was only appropriate to some rehabilitation settings (e.g., only inpatient) and/or b) the decision could be subsumed under another clinical decision (e.g., length of stay similar to discharge readiness).

Next, cognitive interviews were conducted with four new health professionals. The aim of the cognitive interviews was to refine the survey by assessing item appropriateness, item clarity, and response bias. Participants included: 1) a clinical psychologist with 5 years of experience in a long-term acute care hospital, 2) a geropsychologist with 20+ years of experience in team-based care and expertise in interprofessional teamwork, 3) a clinical health psychologist with professional interest in interprofessional education, and 4) a board-certified physiatrist with fellowship training in brain injury medicine.

The following changes were made to the survey based on feedback from cognitive interviews. First, items assessing team decision making strategies were removed due to participants lack of familiarity with explicitly defined decision strategies. Second, two items assessing beliefs about team accuracy were removed due to lack of clarity, and another item was modified to enhance clarity. Third, additional demographic items were added to capture the characteristics of each participants' clinical practice in greater detail. Fourth, to increase response rate, the inclusion criteria were widened to include residents and fellows in Physical Medicine and Rehabilitation (PM&R) in addition to attending physicians. Participation was limited to only rehabilitation physicians as they are considered the team leaders,[13] and it was assumed they hold the most knowledge of how clinical decisions are made.

The final survey was entered into Qualtrics and consisted of 40 items with the option to omit irrelevant items depending on the characteristics of each participant's clinical setting (e.g., participants could choose to skip diagnosis items if diagnostic decisions were not part of their practice). For attendings, participants were instructed to answer questions based on their current practice; if time was split between multiple settings (e.g., outpatient and inpatient), they were instructed to select their primary setting (if applicable) and answer questions for only that setting. Residents and fellows were instructed to select one rehabilitation rotation and answer questions based on only that rotation.

For each of the six clinical decisions, participants were asked to estimate the extent to which the decision was an individual decision or a team decision. More specifically, participants indicated the percentage of time each clinical decision was made by an individual or a team. In the context of this study, individual decisions were clinical decisions made only by the physician, which may or may not have included input from other disciplines (decisions made by residents or fellows are considered individual decisions). Team decisions, on the other hand, were clinical decisions made by two or more health professionals. Team decisions were considered distinct from individual decisions in that all team members judgments were weighed equally, and the final decision was reached via consensus. Teams may be unable to reach a consensus, but if reaching a consensus was the intention then it was considered a team decision. Teams could be intra-professional or inter-professional but did not include the patient or family.

Survey Dissemination

The recruitment method is as follows. First, an email was sent to the program director of all PM&R residency programs accredited by the Accreditation Council for Graduate Medical Education (ACGME) requesting they forward the survey to their residents and attending physicians. The ACGME is the accrediting body for medical residency and fellowship programs and includes an online database where users can search for program information, including program directors and/or coordinators, by specialty. At the time of this project, there were 88 accredited PM&R residency programs. Next, an email was sent to program directors of PM&R fellowship programs requesting they forward the survey to their fellows and attendings (fellowships include brain injury medicine, spinal cord injury medicine, pain medicine, pediatric medicine, and sports medicine). Then, follow-up emails were sent to the coordinators of the residency and fellowship programs, requesting they forward the survey if the program director had not already done so. Finally, programs that listed their resident, fellow, and attending's emails on their website were sent an individual email reminder to take the survey. A total of 570 emails were sent. Ten were "returned" because the email address was inactive. Sixty-four participants completed the full survey (11.4%) and an additional 15 participants partially completed the survey.

The survey was anonymous with no identifying information linking participants to their responses. Consistent with other online survey research, participants provided informed consent by reading a description of the study risks and benefits before beginning the survey; no signature was required. As an incentive, participants were offered the opportunity to enroll in a drawing to win one of five $25 Amazon gift cards. Email addresses collected for the drawing were kept separate from participant data.

Analysis

Prior to the analysis, data were inspected for missing or incomplete data as well as data errors. One participant was removed from the primary analysis because this individual was a PGY-1 resident on a radiology rotation; however, their data was retained for the secondary analysis examining beliefs about team decision making accuracy and supporting literature.

In addition, partial data from 37 participants were removed for miscalculation (214 cells). Although intended to be viewed on a continuum, items assessing individual and team decisions were broken up to capture potential differences in the disciplines informing an individual decision versus the disciplines represented on a team during team decisions. For example, after estimating the percentage of individual diagnostic decisions participants were asked to specify which disciplines, if any, informed this decision; and after estimating the percentage of team diagnostic decisions participants were asked to specify which disciplines were frequently represented on the team making this decision. Although this format provided essential information to design follow-up studies, unfortunately, it permitted calculation errors. For instance, participants could specify that diagnostic decisions were made by individuals 100% of the time and by teams 100% of the time, which is mathematically impossible. Most calculation errors were minor (e.g., 85% diagnostic decisions individual + 20% diagnostic decisions teams); nonetheless, data from these cells were removed when applicable and treated as missing data.

The analysis including descriptive statistics, frequencies, and correlations. All analyses were run in IBM SPSS Statistics version 25.

Results

Respondent Characteristics

Among the 64 participants who completed the survey, 34 were residents, 2 were fellows, and 28 were attending physicians. The sample was evenly split by gender with 32 men (50%) and 32 women (50%). The majority identified their race as White (n = 41), followed by Asian (n=12), Black or African-American (n=4), Bi-racial or multi-racial (n=4), Hispanic or Latino(a) (n=1), and Native Hawaiian or Other Pacific Islander (n=1). Most participants did not identify as Hispanic or Latino(a), n=60 (95.2%). One participant did not specify their race or ethnicity.

The majority of the sample was between the ages of 25-34 (n=35), followed by 35-44 (n=14), 55-64 (n=8), 45-54 (n=4), and 65-74 (n=2). One participant did not disclose their age. Most attendings had worked for 1-10 years (n=11), followed by 21-30 years (n=7), 11-20 years (n=5), and 31-40 years (n=5). Of the residents who completed the survey, most were PGY-3 (n=13), followed by PGY-4 (n=11), PGY-2 (n=7), PGY-1 (n=2), and PGY-6 (n=1). Fellows were PGY-5 (n=1) and PGY-6 (n=1), respectively. See table 1.

Number of participants by state is as follows: Illinois, n = 17 (26.5%); Texas, n = 7 (10.9%); California, n = 5 (7.8%); Michigan, n = 5 (7.8%); Colorado, n = 4 (6.3%); Ohio, n = 4 (6.3%); New York, n = 3 (4.7%); Maryland, n = 2 (3.1%);

Minnesota, n = 2 (3.1%); Missouri, n = 2 (3.1%); New Jersey, n = 2 (3.1%); Tennessee, n = 2 (3.1%); Virginia, n = 2 (3.1%); Wisconsin, n = 2 (3.1%); Kentucky, n = 1 (1.6%); North Carolina, n = 1 (1.6%); Nevada, n = 1 (1.6%); Washington, n = 1 (1.6%); and West Virginia, n = 1 (1.6%). See table 2.

Clinical Setting Characteristics

The majority (76.6%) of participants worked in an academic medical center (n=49). Six participants worked in a VA (9.3%); 3 worked in a private, solo practice (4.7%); 2 worked in a private, PM&R only practice (3.1%); and 2 worked in a state/county/other public hospital (3.1%). One participant worked in a private hospital (1.6%) and 1 worked in a private, multispecialty group practice (1.6%).

Level of care for most participants practice was outpatient, n= 30 (46.9%), or an inpatient rehabilitation facility, n=21 (32.8%). Ten participants worked in a setting with both inpatient and outpatient services (15.6%), two worked in long term care (3.1%), and 1 participant worked in a setting with both outpatient and long-term care services (1.6%). See table 3.

Incomplete Survey Characteristics

An additional 15 surveys completed at least one key item (i.e., items beyond demographics questions) and are included in the final reporting of data where appropriate. Of those who partially completed the survey, 10 were residents (66.7%) and 5 were attendings (33.3%). Two of the attendings had worked for 1-10 years, followed by 11-20 years (n=1), 21-30 years (n=1), and 31-40 years (n=1). The majority of residents were PGY-3 (n=4), followed by PGY-4 (n=3), and PGY-2 (n=3). No PGY-1 or fellows were among the partially completed survey participants.

The majority worked in an academic medical center, n=11 (73.3%), followed by VA, n=2 (13.3%); private hospital, n=1 (6.7%); and a private, multispecialty group practice, n=1 (6.7%). Most worked in an inpatient rehabilitation facility, n=7 (46.7%), followed by outpatient, n=5 (33.3%), and a mixed inpatient/outpatient setting, n=3 (20.0%).

Data are unavailable for gender, race, ethnicity, age, or state as these items were at the end of the survey.

Number of Disciplines Present

Participants were asked to specify which disciplines are present in their current practice or rotation. Overall, inpatient and mixed inpatient/outpatient settings have significantly more disciplines represented in their setting than strictly outpatient settings. See table 4.

Correlation Between Disciplines Present and Decision-Making Practices

Pearson correlation showed a positive relationship between the number of disciplines present in a setting and the average number of disciplines informing individual clinical decisions ($r = .47$, $p < .01$). Moreover, there was a positive relationship between the number of disciplines present in a setting and the average number of disciplines represented on a team in instances when clinical decisions are made by teams ($r = .44$, $p < .01$).

Decision Making Practices Across Settings

A comparison of means across settings showed that diagnostic, prognostic, and treatment decisions are generally made solely by physicians with input from other disciplines, whereas functional capacity (i.e., ADL's) and discharge readiness decisions are generally made by teams (see Table 5 & 6). For example, on average, 73.9% of diagnostic decisions are individual decisions, and 22.6% of diagnostic decisions are team decisions.

Decision Making Practices by Setting

Table 7 and 8 shows the mean percentage of decisions made by physicians and teams by setting. In general, outpatient settings tend to rely more on physicians to make decisions while inpatient settings tend to make more decisions by teams. Mixed settings (outpatient & inpatient) show more variability in their use of teams.

Disciplines Informing Decisions and Disciplines on Teams

Tables 9 and 10 show the mean number of disciplines informing a decision and on a team by setting. In general, estimates are similar across settings.

Tables 11 and 12 show the top five disciplines informing individual and team decisions across all settings. Overall, the disciplines informing a decision are generally the same disciplines represented on a team in instances when teams are used.

Beliefs about Team Clinical Decision Making

Participants were asked the extent to which they agreed with the statement, “On average, team clinical decision making is more accurate than individual decision making (i.e., teams make better clinical decisions than individuals).” Among the 64 participants who completed the survey, 31.3% strongly agreed (n=20), 46.9% percent agreed (n=30), and 15.6% neither agreed nor disagreed (n=10). Only 6.3% disagreed (n=4). See table 13.

Participants then read the statement, “In your estimation, how many research studies have been published on team clinical decision making and accuracy in the last 10 years?” and were asked to specify a) 1-25, b) 25-50, c) 50-75, d) 75-100, or e) 100+ studies. Of the 64 participants who completed the survey, 35.9% estimated a) 1-25 studies (n=23), 35.9% estimated b) 25-50 studies (n=23), 17.2% estimated c) 50-75 studies (n=11), 6.3% estimated d) 75-100 studies (n=4), and 4.7% estimated e) 100+ studies (n=3). Estimates were similar across residents, fellows, and attendings. See table 14.

Of note, an extensive search using liberal parameters showed at the time of this manuscript only 7 studies have been published in the last 10 years on team clinical decision making and accuracy (see Appendix B for a list of references).

Training in Team Clinical Decision Making

Participants were asked the extent to which they agreed with the statement "I have received training in team clinical decision making." Of the 64 participants who completed the survey, 37.5% strongly agreed (n=24), 36.0% agreed (n=23), 15.6% neither agreed nor disagreed (n=10), and 10.9% disagreed (n=7). See table 15.

Discussion

The present study provides a framework to understand team decision making and, to the authors' knowledge, is the first to assess how clinical decisions are made in rehabilitation medicine. This approach can be adapted for other medical settings to inform research to develop team decision strategies unique to that setting. For instance, given the variability of team structures and team decisions, it should not be assumed that a team strategy in one setting will necessarily generalize to another setting. Therefore, strategies and corrective procedures must be tailored to each setting.

The results highlight the nuances of team decision making in rehabilitation medicine. Although team-based care is essential to rehabilitation, medical decisions, including diagnosis, prognosis, and treatment, are primarily made by physicians with input from supporting disciplines. Alternatively, decisions about functional capacity and readiness for discharge tend to be made by teams. This is in contrast to other medical settings, such as neurology and oncology, wherein diagnostic and prognostic decisions are often made collaboratively by multiple disciplines. For instance, in memory disorder clinics, diagnostic decisions are frequently reached via a consensus between neurologists and neuropsychologists, among other disciplines;[14] and in oncology, diagnostic, prognostic, and treatment decisions are often reached by teams of oncologists, pathologists, radiologists, and other specialties.[15–17]

However, it should be noted that there is considerable variability across settings and even specialty hospitals with expertise in the same patient population vary widely in their implementation of team decision making. In general, the more disciplines present in a setting the more disciplines, and likely individuals, are involved in the decision-making progress. On the one hand, diverse perspectives may increase accuracy by providing crucial information to improve a decision. On the other hand, however, communication errors are more likely when more providers are involved in the decision-making process.

In addition, the results underscore the gulf between physicians' belief about team decision accuracy and the volume of supporting literature. Specifically, 78.2% of participants agreed or strongly agreed that teams increase accuracy over individuals, but the majority overestimated the state of the literature with 64.1% *incorrectly* estimating the number of studies published on team clinical decision making and accuracy in the last 10 years. The discrepancy may suggest that physicians believe teams are more accurate than individuals because, as a practice, team decision making is well supported by the literature. However, surprisingly few studies have assessed the accuracy of team decisions, and, at present, the superiority of teams remains an untested hypothesis.

Further, 73.5% of participants indicated they have received training in team decision making, raising the question of how students and professionals are being trained. Given the dearth of validated team decision strategies, to the extent that team decisions strategies are being taught, they are not scientifically supported strategies. However, considering participants' responses to the aforementioned items, trainees likely *believe* they are learning validated decision strategies.

Implications for Future Research

Implications for follow-up studies based on the present work include the following.

First, follow-up studies could refine the survey and administer it to a larger sample of PM&R physicians. Possible improvements to the survey include combining the individual and team decision items into a single item, based on a continuum; and eliminating items assessing which disciplines contribute to decisions or are on a team, given that, in general, the same disciplines are involved in both individual and team decisions. Follow-up studies could also choose to narrow the scope of the study by specialty. For example, the implementation of team clinical decision making may vary by specialty (e.g., brain injury medicine, spinal cord injury medicine, or pediatrics) given the diversity of rehabilitation medicine. Future research could assess these differences in finer detail.

Second, analogue studies could compare error rates between the individual and team approach with priority given to treatment and diagnostic decisions as these decisions are most closely associated with medical error. Thus, lowering the error rate of these decisions is likely to have the most impact on reducing patient harm. For instance, follow-up studies could use the results of the present study to design comparative studies.

As an illustration, future studies could compare the accuracy of individuals and teams making pharmacological treatment decisions. One condition would be a single physician making a medication decision for a hypothetical patient based on input from three disciplines (the average number of contributing disciplines for pharmacological treatment decisions) including pharmacy, physiatry, and neurology. Another condition would be a team making a medication decision for a hypothetical patient consisting of three disciplines (the average number of disciplines on a team in outpatient and inpatient settings) including pharmacy, physiatry, and neurology.

Third, follow-up studies could explore strategies to improve accuracy within the individual and team approach. For example, given that diagnosis decisions are primarily made by physicians with input from various disciplines, follow-up studies could investigate communication strategies to facilitate accuracy. Similarly, follow-up studies could investigate team strategies to facilitate accuracy for discharge decisions.

Limitations

Interpretation of this work should consider several limitations. First, the relatively small sample was recruited online and therefore may not be representative. Second, survey items may have been interpreted differently by participants. Third, the survey's narrow definition of individual and team decision making does not capture all decision-making practices in rehabilitation. Fourth, some participants miscalculated the percentage of individual and team decisions which resulted in unusable data in some instances. Fifth, an anchoring effect on the item inquiring about number of publications in the last 10 years may have influenced responses on this item.

Conclusions and Implications

Reducing patient harm via medical error necessitates improving clinical judgment and decision making. This study developed and disseminated a survey assessing individual and team decision making practices in rehabilitation medicine in an effort to inform follow-up studies to develop team decision strategies. The results showed that clinical decisions are largely made by physicians with input from allied health professionals, although significant variability exists across settings. Information gained from this study can be used to inform future research to develop strategies to facilitate accuracy in rehabilitation teams.

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Table 1. Respondent Characteristics

	Frequency	%
Title		
Resident	34	53.1
Fellow	2	3.1
Attending	28	43.8
Gender		
Women	32	50.0
Men	32	50.0
Other	-	-
Race		
American Indian or Alaskan Native	-	-
Asian	12	19.0
Bi-racial or Multi-racial	4	6.3
Black or African-American	4	6.3
Hispanic or Latino(a)	1	1.6
Native Hawaiian or Other Pacific Islander	1	1.6
White	41	65.1
Ethnicity		
Hispanic or Latino(a)	3	4.8
Not Hispanic or Latino(a)	60	95.2
Age		
25-34	35	55.6
35-44	14	22.2
45-54	4	6.3
55-64	8	12.7
65-74	2	3.2
75+	-	-
Years of Experience		
Residents and Fellows		
PGY-1	2	3.1
PGY-2	7	10.9
PGY-3	13	20.3
PGY-4	11	17.2
PGY-5	1	1.6
PGY-6	2	3.1
Attendings		
1-10 Years	11	17.2
11-20 Years	5	7.8
21-30 Years	7	10.9
31-40 Years	5	7.9
40+ Years	-	-

a) One participant did not disclose their age, race, or ethnicity.

Table 2. State of Practice

State	Frequency	%
California	5	7.8
Colorado	4	6.3
Illinois	17	26.5
Kentucky	1	1.6
Maryland	2	3.1
Michigan	5	7.8
Minnesota	2	3.1
Missouri	2	3.1
Nevada	1	1.6
New Jersey	2	3.1
New York	3	4.7
North Carolina	1	1.6
Ohio	4	6.3
Tennessee	2	3.1
Texas	7	10.9
Virginia	2	3.1
Washington	1	1.6
West Virginia	1	1.6
Wisconsin	2	3.1

Table 3. Clinical Setting Characteristics

	Frequency	%
Practice Setting		
Academic Medical Center	49	76.6
Private Hospital	1	1.6
Private, Multispecialty Group Practice	1	1.6
Private, PM&R-Only Practice	2	3.1
Private, Solo Practice	3	4.7
State/County/Other Public Hospital	2	3.1
VA	6	9.3
Level of Care		
Inpatient Rehabilitation Facility	21	32.8
Long Term Care	2	3.1
Outpatient	30	46.9
Outpatient & Inpatient	10	15.6
Outpatient & Long-Term Care	1	1.6

Table 4. Number of Disciplines Present by Setting

Setting	Mean	N	Minimum	Maximum
Outpatient	6.8	35	1	19
Inpatient	14.1	28	4	19
Outpatient & Inpatient	12.1	12	5	17

a) Includes completed and partially completed surveys (N = 75).
b) Long term care and long-term care/outpatient not reported.
c) One participant did not disclose number of disciplines present.

Table 5. Individual Decisions Across All Settings

	Diagnosis	Prognosis	Pharmacological Treatment	Non-Pharmacological Treatment	ADL's	Discharge Readiness
Mean	73.9%	78.8%	79.2%	62.2%	38.3%	42.4%
N	55	53	54	50	28	17
Minimum	10%	10%	9%	1%	0%	0%
Maximum	100%	100%	100%	100%	100%	100%

Table 6. Team Decisions Across All Settings

	Diagnosis	Prognosis	Pharmacological Treatment	Non-Pharmacological Treatment	ADL's	Discharge Readiness
Mean	22.6%	21.4%	19.6%	32.6%	56.5%	55.9%
N	48	47	47	48	28	17
Minimum	0%	0%	0%	0%	0%	0%
Maximum	80%	90%	90%	90%	100%	100%

Table 7. Individual Decisions by Setting

Setting		Diagnosis	Prognosis	Pharmacological Treatment	Non-Pharmacological Treatment	ADL's	Discharge Readiness
Outpatient							
	Mean	84.2%	89.1%	92.7%	77.2%	48.6%	30.0%
	N	22	23	23	24	11	3
	Minimum	40%	50%	48%	10%	10%	0%
	Maximum	100%	100%	100%	100%	100%	90%
Inpatient							
	Mean	64.5%	73.2%	71.9%	49.8%	37.6%	52.4%
	N	20	18	18	15	8	8
	Minimum	10%	10%	9%	1%	0%	0%
	Maximum	100%	100%	100%	90%	80%	90%
Outpatient & Inpatient							
	Mean	72.5%	67.3%	67.1%	48.2%	26.0%	42.5%
	N	11	12	10	9	7	4
	Minimum	20%	20%	10%	15%	0%	0%
	Maximum	100%	100%	100%	77%	80%	100%

a) Long term care and long-term care/outpatient not reported.

Table 8. Team Decisions by Setting

Setting		Diagnosis	Prognosis	Pharmacological Treatment	Non-Pharmacological Treatment	ADL's	Discharge Readiness
Outpatient							
	Mean	12.1%	10.3%	8.5%	18.3%	50.5%	70.0%
	N	18	20	19	22	11	3
	Minimum	0%	0%	0%	0%	0%	10%
	Maximum	31%	50%	50%	51%	90%	100%
Inpatient							
	Mean	29.9%	25.8%	24.4%	41.8%	55.3%	47.5%
	N	17	16	16	15	8	8
	Minimum	0%	4%	0%	10%	19%	10%
	Maximum	80%	90%	90%	90%	100%	100%
Outpatient & Inpatient							
	Mean	25.9%	35.1%	31.3%	50.1%	65.0%	57.5%
	N	11	11	10	9	7	4
	Minimum	0%	0%	0%	13%	20%	0%
	Maximum	80%	80%	90%	85%	100%	100%

a) Long term care and long-term care/outpatient not reported.

Table 9. Number of Disciplines Informing Individual Decisions by Setting

Setting		Diagnosis	Prognosis	Pharmacological Treatment	Non-Pharmacological Treatment	ADL's	Discharge Readiness
Outpatient							
	Mean *(SD)*	2.7 *(2.4)*	2.1 *(2.6)*	2.1 *(3.6)*	3.1 *(3.8)*	2.9	3.8 *(1.5)*
	N	32	29	26	27	19	5
Inpatient							
	Mean *(SD)*	4.3 *(2.9)*	3.8 *(2.7)*	2.9 *(2.9)*	5.0 *(3.4)*	2.7	5.3 *(2.4)*
	N	28	24	24	20	15	18
Outpatient & Inpatient							
	Mean *(SD)*	6.0 *(3.2)*	4.4 *(3.0)*	3.6 *(2.3)*	6.8 *(3.4)*	4.3	6.0 *(3.6)*
	N	14	11	13	12	6	4

a) Long term care and long-term care/outpatient not reported.

Table 10. Number of Disciplines Represented on a Team by Setting

Setting		Diagnosis	Prognosis	Pharmacological Treatment	Non-Pharmacological Treatment	ADL's	Discharge Readiness
Outpatient							
	Mean *(SD)*	3.9 *(3.4)*	3.7 *(2.7)*	2.6 *(1.7)*	3.9 *(3)*	3.6	6.4 *(3)*
	N	26	17	14	22	18	7
Inpatient							
	Mean *(SD)*	5.2 *(3.1)*	4.7 *(2.6)*	3.1 *(2.1)*	6.8 *(3.3)*	3.8	6.1 *(3.2)*
	N	24	23	20	22	16	19
Outpatient & Inpatient							
	Mean *(SD)*	6.5 *(2.9)*	4.6 *(1.9)*	4.3 *(2.8)*	6.5 *(2.9)*	5.3	5.4 *(2.0)*
	N	13	11	12	12	9	5

a) Long term care and long-term care/outpatient not reported.

Table 11. Top Five Rankings of Disciplines Informing Individual Decisions Across All Settings

Diagnosis	Prognosis	Pharmacological Treatment	Non-Pharmacological Treatment	ADL's	Discharge Readiness
1. PT 2. OT 3. Speech 4. Physiatry 5. Neurology	1. PT 2. Neurology 3. Physiatry/OT 4. IM 5. Speech	1. Pharmacy 2. Physiatry 3. Neurology 4. IM 5. PT	1. PT 2. OT 3. Speech 4. Physiatry 5. Nursing	1. OT 2. PT 3. Physiatry 4. Nursing 5. Speech	1. PT/OT 2. Speech 3. Social Work 4. Nursing 5. Physiatry

a) PT = Physical Therapy
b) OT = Occupational Therapy
c) Speech = Speech-Language Pathology
d) IM = Internal Medicine

Table 12. Top Five Rankings of Disciplines Represented on a Team Across All Settings

Diagnosis	Prognosis	Pharmacological Treatment	Non-Pharmacological Treatment	ADL's	Discharge Readiness
1. PT 2. OT 3. Physiatry 4. Speech 5. Psychology 5. NP	1. PT 2. OT 3. Physiatry 4. Speech 5. Neurology	1. Pharmacy 2. Physiatry 3. Neurology 4. IM 5. PT	1. PT 2. OT 3. Speech 4. Physiatry 5. Psychology 5. NP 5. Nursing	1. OT 2. PT 3. Physiatry 4. Nursing 5. Speech	1. PT 2. OT 3. Speech 4. Nursing 5. Physiatry

a) PT = Physical Therapy
b) OT = Occupational Therapy
c) Speech = Speech-Language Pathology
d) NP = Neuropsychology
e) IM = Internal Medicine

Table 13. Team Clinical Decision Making is More Accurate than Individual Decision Making

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
N	-	4	10	30	20
%	-	*6.3*	*15.6*	*46.9*	*31.3*

Table 14. Estimation of Publications on Team Clinical Decision Making and Accuracy

	1-25	25-50	50-75	75-100	100+
N	23	23	11	4	3
%	*35.9*	*35.9*	*17.2*	*6.3*	*4.7*

Table 15. Training in Team Clinical Decision Making

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
N	-	7	10	23	24
%	-	*10.9*	*15.6*	*36.0*	*37.5*

Appendix A: Sample Key Informant Interview Questions

1. In your experience with team-based care, what types of clinical decisions are most frequently made by teams?

2. Any there any clinical decisions that should not be made by a team? If so, what are they?

3. What constitutes a health care “team”? In other words, which disciplines are part of the health care team?

4. What, if any, are the benefits of team clinical decision making?

5. What, if any, are the challenges of team clinical decision making?

6. What decision strategies help facilitate accuracy amongst health care teams?

Appendix B:

Publications on Team Clinical Decision Making and Accuracy in Last 10 Years

1. Baxendale S, Thompson P, McEvoy A, Duncan, J. Epilepsy surgery: How accurate are multidisciplinary teams in predicting outcome? *Seizure*. 2012; 21(7):546-549.

2. Hautz WE, Kämmer JE, Schauber SK, Spies CD, Gaissmaier W. Diagnostic performance by medical students working individually or in teams. *Jama.* 2015;313(3):303-304.

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