

# What Clinical Teachers in Medicine Need to Know

**Abstract**—In order to identify the components of knowledge that effective clinical teachers of medicine need, the author carried out a qualitative study of six distinguished clinical teachers in general internal medicine in 1991. Using data from interviews, a structured task, and observations of each ward team, he identified six domains of knowledge essential to teaching excellence in the context of teaching rounds: clinical knowledge of medicine, patients, and the context of practice, as well as educational

knowledge of learners, general principles of teaching, and case-based teaching scripts. When combined, these domains of knowledge allow attending physicians to engage in clinical instructional reasoning and to target their teaching to the specific needs of their learners. The results of this investigation are discussed in relation to both prior research on teacher knowledge, reasoning, and action and faculty development in medicine. *Acad. Med.* 69(1994):333-342.

Attending physicians use many forms of knowledge as they listen to case presentations by medical students and residents. This knowledge base enables them to diagnose patients' problems, assess learners' needs, and provide targeted instruction.<sup>1</sup> What do clinical teachers in medicine need to know in order to teach effectively? Conventional wisdom suggests that knowledge of medicine is all that is necessary to be an excellent teacher. An alternative perspective, articulated most frequently by problem-based learning advocates, is that knowledge of teaching skills is fundamental and that teachers do not have to be content experts.

## RELEVANT KNOWLEDGE DOMAINS

In the context of clinical teaching, which of the perspectives just mentioned is accurate? Earlier research on physicians' and teachers' knowledge may provide clues to relevant domains of knowledge for teaching. These might include knowledge of subject matter, knowledge of learners, knowledge of general principles of teaching and learning, and knowledge of content-specific teaching.

### Knowledge of Subject Matter

"If you understand your discipline, then you should be able to teach it." This instructional assumption is translated into an often-cited dictum of clinical education: "See one, do one, teach one." This experiential learning model suggests the close relationship between learning, performing, and teaching. Physicians develop an extensive knowledge base of medicine and its related disciplines through experience with a broad array of clinical cases. As clinical experience increases, clinical knowledge becomes more tightly compiled and interconnected. Clinical knowledge is then retained in memory in the form of *illness scripts* (clinically relevant information on the enabling conditions, causes and consequences of an illness) and *instance scripts* (recollections of specific patients who suffered from a disease).<sup>2,3</sup> Alternative descriptions of this knowledge structure are *semantic structures*,<sup>4</sup> *knowledge representations*,<sup>5</sup> and *reciprocating networks*.<sup>6</sup> Patel and Groen argue that expertise in medicine involves the development of adequate knowledge representations combined with the ability to distinguish between relevant and irrelevant information in a problem—thereby filtering out irrelevant material.<sup>5</sup>

Educational researchers assert that knowledge for teaching requires an in-depth and flexible understanding of subject matter.<sup>7-12</sup> Teachers need to know their content well enough to make connections within the subject, across disciplines, and with their learners.<sup>13</sup> Alternative conceptions of

content help teachers switch back and forth between the student's, the discipline's, the textbook's, and their own conceptions.<sup>14</sup> Expert teachers also have richer, more tightly connected subject matter knowledge, and more detailed plans organized around content to be taught, than do novice teachers.<sup>12,15</sup>

### Knowledge of Learners

Beyond content expertise, teaching involves connecting learners with subject matter. Teachers need to understand their learners' prior knowledge as well as their conceptions and misconceptions of the subject matter. This includes knowledge of students' typical errors and the normal development path along which students progress in understanding content.<sup>9,16-18</sup> For example, expert math teachers employ this knowledge to elicit typical errors and then use those errors in lessons to teach the correct concepts.<sup>16</sup> Teachers' knowledge of learners' needs, motivations, and abilities also affects their teaching methods. Effective instruction emerges from the interaction between understanding learners and comprehending subject matter.<sup>12</sup>

### Knowledge of General Principles of Teaching and Learning

In addition to knowledge of subject matter and learners, teachers possess knowledge of general principles of teaching and learning. Teachers have general conceptions about how students learn and how instruction can enhance learning.<sup>19</sup> These personal

A slightly different version of this paper was presented at the annual meeting of the American Educational Research Association in Atlanta, Georgia, on April 22, 1993.

Dr. Irby is professor, Department of Medical Education, University of Washington School of Medicine, Seattle.

Correspondence should be addressed to Dr. Irby, Department of Medical Education, HQ-32, University of Washington, Seattle, WA 98195.

theories appear to develop from the apprenticeship of observation (seeing positive and negative examples of teaching) and from the reflective experience of teaching. Experienced teachers also have large repertoires of teaching strategies (e.g., lecturing, leading group discussions, asking questions) that can be combined to teach specific concepts. These are general principles of teaching and learning because they are not embedded in specific content, contexts, and learners.

#### Knowledge of Content-specific Instruction

When general content knowledge and general teaching methods are transformed into content-specific instruction for a particular group of students, a new form of knowledge results. This is termed *knowledge of content-specific pedagogy*<sup>19</sup> or *pedagogical content knowledge*.<sup>10,20,21</sup> This special form of knowledge unique to teachers develops through the repetitive experience of teaching specific content to specific students. The resulting knowledge becomes organized into teaching scripts. These scripts are analogous to play scripts that dictate the action on stage. Teaching scripts contain general goals of instruction, key teaching points, specific representations of content (explanations, analogies, examples, learning tasks),<sup>9,22</sup> an understanding of the conceptions and misconceptions of learners, and procedures for overcoming learning difficulties.<sup>8-10,13,23,24</sup> The essence of content-specific instruction is content knowledge organized for teaching purposes that makes it comprehensible to particular learners.<sup>20,21</sup> This special form of knowledge is what separates teachers from mere content experts.

Other potentially relevant domains of teachers' knowledge might include knowledge of instructional resources.<sup>14,19,25</sup>

While a host of observational studies have described the complexities and challenges of teaching in clinical settings,<sup>26-32</sup> none of them has at-

tempted to define the several knowledge bases needed for clinical teaching and to develop a model of clinical teachers' knowledge.

#### DEFINING THE KNOWLEDGE BASE OF CLINICAL TEACHERS

I attempted to create such a model in 1991 by carrying out the study reported in the following pages. The method I used was to investigate the knowledge bases for teaching used by six distinguished clinical teachers in general internal medicine. These are the same six teachers described in my previous study about how physicians make instructional decisions during teaching rounds.<sup>1</sup> I chose a case-study design using these six carefully chosen teachers to illustrate the "wisdom of practice" among the best.<sup>21</sup> I selected outstanding clinical teachers rather than representative ones to identify the knowledge of the best educators, knowledge that is extraordinary, not ordinary. Studying the knowledge of representative teachers could have led to a description of "the unimaginative practices of the uninspired."<sup>33</sup> This research strategy focuses on what is possible rather than what is representative. Thus, my research question was "What is the knowledge base for teaching used by distinguished clinical teachers in medicine in the context of teaching rounds?"

The teachers I studied were all from the Department of Medicine at the University of Washington School of Medicine in Seattle. They had received excellent ratings of their teaching from students and residents,<sup>34</sup> and independent nominations by their department chairman and the program director of their department's residency. Further, I selected those who had distinctly different teaching styles and who were serving as attending physicians during spring quarter. This group of teachers comprised one professor, two associate professors, and three assistant professors (four men and two women).

The context of instruction was teaching rounds in general internal

medicine at two university hospitals. *Teaching rounds* is a case-oriented instructional session held predominantly in a hospital conference room with the ward team and is the teacher's primary opportunity to teach medical concepts in the context of patient care.

Data were derived from in-depth, semistructured interviews,<sup>35</sup> a structured task involving a think-aloud exercise,<sup>36</sup> observations of the ward team, and transcriptions of teaching rounds.<sup>37</sup> My interview questions related to the attending physician's knowledge, instructional reasoning, and actions. The two-hour interviews were audiotaped and transcribed.

The structured task involved a think-aloud exercise in response to a written case describing a medical student's presentation of a patient with diabetic ketoacidosis during teaching rounds. The attending physicians were asked to describe how they would respond to the case, what they would teach, and what problems medical students would typically have with this case. This exercise was designed to elicit their teaching scripts and knowledge of learners. Twelve medical students on the six teams were also given the case, minus the diagnosis and treatment, and asked to determine the problem, diagnosis, and recommended treatment. This was done to validate the teachers' knowledge of the learners.

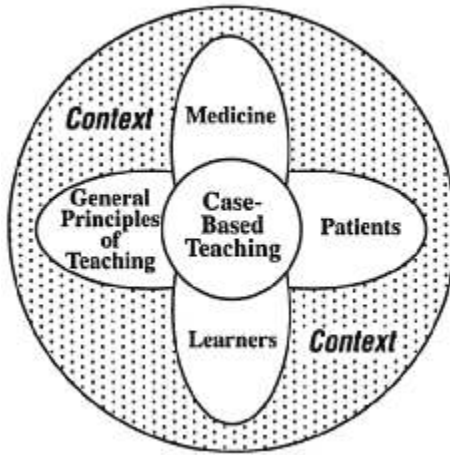
I observed each team for one week, recording my observations in field notes, and summarizing them immediately afterwards. In order to understand what was happening during teaching rounds, observations began with *work rounds* (when the team consisting of two third-year medical students, two interns, and one senior resident review all patients at the bedside) from 8 to 9 A.M., followed by an X-ray conference from 9:30 to 10:00 A.M., and concluded with teaching rounds with the attending physician from 10:30 to 12:00. In addition, all teaching rounds were audiotaped, and one session per attending physician was transcribed. The observations and transcripts of teaching rounds were used to corro-

borate the interview and think-aloud statements.

I coded the interview transcripts in order to identify the domains of knowledge needed for clinical teaching, and thus construct a model of such knowledge. Preliminary codes were developed based upon Shulman's theoretical model of teachers' knowledge<sup>20,21</sup> and Schmidt's model of physicians' knowledge.<sup>3</sup> My initial codes were knowledge of clinical medicine, knowledge of basic sciences, knowledge of patients, knowledge of learners, knowledge of general pedagogy, and pedagogical content knowledge. Intercoder agreement was 83% among two doctoral students in education and myself using a sample of the transcripts.<sup>38</sup> The codes were successively revised as analysis proceeded to account for all of the major themes in the data. The codes changed as categories were collapsed (knowledge of clinical medicine and knowledge of basic sciences became knowledge of medicine, because the informants said that these two categories were integrated), titles of codes were changed to make them more understandable (pedagogical content knowledge became content-specific teaching), and codes emerged from the data (knowledge of context and case-based teaching scripts). The final codes were validated by two general internists and myself using selective quotes from the transcripts. Intercoder agreement was 95% among the internists and myself. Final coding categories were knowledge of medicine, patients, context, learners, general principles of teaching, and case-based teaching scripts. The results were then checked against my observations of teaching rounds and the transcripts of rounds.

### A MODEL OF CLINICAL TEACHERS' KNOWLEDGE

The model of clinical teachers' knowledge identified by this study is depicted in Figure 1. Below, I discuss each type of knowledge shown in the figure, beginning with a description of the key features of the domain followed by illustrative quotes from the



**Figure 1.** The domains of knowledge needed for clinical teaching in medicine as identified by six distinguished attending physicians in the context of teaching rounds in general internal medicine. In the figure, these domains of knowledge are artificially differentiated for emphasis.

attending physicians. The teachers' names are pseudonyms and their comments have been edited slightly for readability.

#### Knowledge of Medicine

All of the attending physicians described the importance of general medical knowledge, referring to it as human biology, clinical experience, judgment and insight, clinical skills, pathophysiology, basic sciences, knowledge of psychosocial medicine, and epidemiology. Knowledge of medicine is drawn from a variety of disciplines and incorporates both basic sciences and clinical experience. Dr. Baker describes the medical knowledge base he uses for teaching purposes:

What I know about human biology that is affirmed by clinical experience is what I selectively use for teaching purposes. My clinical experience is drawn off human biology and allows me to teach people how to use human biology to take care of their patients. There are subsets of human biology — biochemistry, physiology, pathoanatomy — and larger social and environmental issues. There is also a relationship between these elements that determines how well a person with the disease is doing.

Dr. Davis uses a concentric-circle model of the discipline. He begins at the cellular level, then goes to the causes and manifestations of a disease, treatment options, and the psychosocial aspects of the case, and ends with the societal and epidemiologic context for the disease. "I try to get a sense of all these levels, from the cellular level up to the societal level. I use my skills to address the ones that haven't already been addressed."

These statements illustrate the broad scope of medical knowledge, the integrated nature of that knowledge, and the distinct conceptual schemas of these teachers. The teacher's conceptual framework of the discipline is an important determinant of the content that will be taught.<sup>23</sup>

#### Knowledge of Patients

In addition to medical knowledge, these attending physicians possess knowledge of specific patients that they have seen on their services. This knowledge is used to verify clinical diagnoses, to check on learners' progress, to stimulate the teaching of practical tips on patient care, and to motivate learning. This process ensures quality patient care and quality instruction, and was described as follows by Dr. Able:

Many of the patients I know because I have seen them before. They are my own patients, and I have a sense of what the story is . . . If I know my patients, then I can get at problems in my learners.

Dr. Ellis reported, "I get information about the patient through the trainee. When I go back to talk to the patient, I'm checking up on the trainee to a certain extent."

Knowledge of specific facts about each patient and knowledge of general principles of medicine are closely linked<sup>2</sup> and when combined create the attending physician's clinical credibility in the eyes of the ward team. This credibility is critical to the team members' acceptance of the attending physician's teaching.<sup>28</sup>

## Knowledge of Context

All the teachers mentioned that knowledge of context affected their teaching. Context includes the patient population served by the hospital, the social context of the patient, the historical context of therapeutic practices, and the context for encountering the patient's story (case presentation versus direct interaction with the patient). Dr. Charles described the impact of the patient population on teaching:

When you are at Harborview Hospital [a county teaching hospital] certain diagnoses are a lot more common than when you are at University Hospital. I know that a third of the patients that come in may have a history of IV drug use at Harborview and only 5% at Swedish [a private community hospital]. So even if the team doesn't tell me that, I am processing it.

Dr. Baker observed that students encounter patients in the context of an acute illness and frequently fail to appreciate what precipitates the illness and what follows it. Studies of teachers' knowledge in other settings have identified knowledge of context as important as well.<sup>8,10,20,21</sup>

## Knowledge of Learners

This domain comprises knowledge of specific learners, knowledge of the ward team as a group, and general assumptions about learners by level of training. Knowledge of learners emerges from teaching experience. Dr. Fagan reported, "It is a lot less work for you as a teacher if you can figure out where your student is— whoever the student happens to be . . . The longer you teach, the easier it is to see where they are." Dr. Ellis agreed: "Every month I attend I go through a period of trying to figure out where the team is, what their needs are, and what their personalities are like so that I can interdigitate with them the best." According to Dr. Davis,

Sometimes with a third-year student you have to go through a problem-ori-

ented approach to get them to tie it all together in a coherent picture. By the fourth year you expect them to be able to do that. By the time they're interns and residents, you should expect them not only to identify the problem but to understand the broader issues.

To investigate the accuracy of these teachers' knowledge of learners, I gave each of the attending physicians and each of the 12 medical students a hypothetical case presentation by a third-year medical student of a patient with diabetic ketoacidosis (DKA). All 12 students correctly defined the problem, identified DKA, and made appropriate treatment recommendations. Five of the six attending physicians accurately predicted the student's knowledge and performance; the least experienced attending physician underestimated the students' ability.<sup>1</sup> As is true of teachers in other disciplines, these teachers had an accurate knowledge of their learners' understanding.<sup>10,17,21,39</sup>

In addition to knowledge of learners by level of training, these attending physicians possessed knowledge of particular students. This knowledge is acquired through asking questions and observing performance. "I ask students questions constantly. I've asked the questions enough times that I know mostly what people can say as third-year medical students," said Dr. Baker. This general knowledge of learners combined with particular knowledge of specific learners enables the teachers to efficiently and effectively diagnose learners' difficulties.

## Knowledge of General Principles of Teaching

The most commonly articulated general principles of teaching and the numbers of the six attending physicians who described the principles were: actively involve learners and ask lots of questions (6/6), capture attention and have fun (6/6), connect the case to broader concepts (6/6), go to the bedside (5/6), meet individual needs (5/6), be practical and relevant (4/6), be selective and realistic (4/6),

and provide feedback and evaluation (3/6). These principles, discussed below, emerged from many readings of the interview transcripts.

1. *Actively involve learners (6/6)*. All of the attending physicians studied conduct highly interactive teaching sessions. "Keeping everyone involved is my ideal," said Dr. Fagan. One way to achieve active involvement and to diagnose learners' difficulties is to ask questions. "I use a lot of questions to get some assessment of the residents' and students' knowledge base," reported Dr. Charles. Similarly, Dr. Baker stated that "the kind of teaching I like to do is Socratic, or kind of probing question-and-answer. I ask them questions constantly."

2. *Capture attention and have fun (6/6)*. In order to make learning memorable, teaching must capture and retain attention. This is accomplished by using humor, dramatic case examples, suspense, and enthusiasm. Dr. Able said, "I always try to suck people into having as good a time as I am having." Dr. Ellis emphasizes the importance of drama in teaching: "I try to dramatize a point. In a sense, it is making teaching into theater— trying to present things in a way that captures people's attention." All six physicians studied seemed to enjoy teaching, and they all made learning fun and memorable.

3. *Connect the case to broader concepts (6/6)*. Clinical teaching connects learners' knowledge of the patient's particular problems to a broader understanding of the relevant disease. This helps learners generalize appropriately from their experience and offers them a conceptual scaffold for building new knowledge. Dr. Baker said: "You draw out something specific from that patient to say [such as] 'When you are taking care of people like this, you can expect that these will be problems.'" All the attending physicians related the case at hand to underlying constructs of the illness and/or to broader health issues.

4. *Go to the bedside (5/6)*. When students are unable to give a coherent case presentation, or the diagnosis does not adequately explain the patient's problems, the attending physi-

cians lead the team to the bedside. Dr. Baker, the only teacher who went to the bedside every day during this study, stated, "If I don't make a point of doing bedside teaching, it is real easy to just talk and the patient is left out." When a case presentation is unfocused, Dr. Charles goes to the bedside. "The easiest way to determine whether it is a patient or student problem is to go talk to the patient." Some of the other attending physicians went to the bedside to validate physical examination findings and to model and observe interactions with the patient. One attending physician stated that he was uncomfortable teaching in front of the patient, and another said that she perceived bedside teaching to be an unproductive experience for the team in most instances. Thus, neither of them routinely went to the bedside as part of teaching rounds—although both of them saw their patients independently from the team.

5. *Meet individual needs (5/6)*. One of the great difficulties with clinical teaching is dealing with the diversity of learners' knowledge and skills. The teachers studied identify the interests of the team members during the first week of the rotation and attempt to meet those interests during the month. Dr. Davis stated: "I tell them my strengths and weaknesses, and I ask them how I can best help them. So up front I find out who they are, what they want to do, and what their needs are." Dr. Fagan indicated that she has the same approach: "My job is to figure out what they want to know this month. People don't learn unless they are ready for it." Identifying learners' interests and needs helps these teachers discover teachable moments.

To meet the diverse needs of learners, these attending physicians use a variety of instructional strategies. "The hardest thing about attending rounds is bridging all those different levels. I try to do it by hierarchizing knowledge," said Dr. Fagan. This involves asking students questions about pathophysiology, asking interns questions about day-to-day treatment, and asking the senior resident questions about broader medical

and health care issues. To meet the unique needs of students, she and the rest of the attending physicians periodically teach the students separately.

Teaching rounds are also adapted to the natural flow of patient care. During this study, four of the six attending physicians participated in work rounds (where the team visits the bedside of each patient and makes work assignments for the day) on post-call mornings and shortened or eliminated teaching rounds on those days. Post-call mornings occurred every four days following all-night work in the emergency room where the physicians treat and/or admit new patients to their service. During the next two days post-call, discussions in teaching rounds emerged out of the most teachable cases. The last day before on-call night was often spent dealing with broader topics and giving more formal presentations.

6. *Be practical and relevant (4/6)*. Clinical teaching must be both practical and relevant. Dr. Baker said that he frames his teaching with this question to himself: "What practical bits of knowledge have been necessary for me to know about taking care of patients like this? What are the real practical bits of knowledge that need to be brought out about a certain case to get the most learning from it?" Part of the process of being practical and relevant is teaching general concepts in the context of specific patients on the service.

7. *Be selective and realistic (4/6)*. These six teachers focused on a few important teaching points per case, prioritized time among cases to deal with a few cases in depth, and established realistic expectations for learning during the rotation. "Realizing that the more you say the less people learn, I try to hit two or three themes really heavily during an hour," reported Dr. Charles. "I try to find out where they are and give them the basic skills . . . to teach them four or five things" during the month", said Dr. Davis. Less is better to begin with.<sup>40</sup>

8. *Provide feedback and evaluation (3/6)*. "I think feedback is real important and labeling it as such is also,

because otherwise they don't know what they are getting," reported Dr. Fagan. "Evaluation is an important part of teaching. If you can find out whether somebody is learning, then you can increase how much teaching goes on," said Dr. Charles. The process of giving feedback should be both constructive and supportive, suggested Dr. Fagan: "You have to respect the needs of learners and their feelings as people. You should not teach by embarrassment, by pressure, or by berating them." Dr. Ellis concurred: "I take it as a principle that criticizing people in front of others is not appropriate."

All of these teachers gave large amounts of feedback to the learners. Since it was routinely embedded in teaching, the students frequently failed to perceive it as feedback. In one instance, I interviewed a medical student immediately following a one-hour meeting with Dr. Charles, who had worked with the two medical students on their case presentations. This had been an intensive teaching session with a great deal of coaching and feedback. When I asked the student whether he received feedback from Dr. Charles, he said that he didn't get much. Since I had just observed a great deal of feedback, I was puzzled. So I asked the student what feedback meant to him. He reported that it was the formal evaluation that he would get at the end of the rotation. Clearly there are differences in perceptions about feedback.

9. *Other general principles of teaching*. Individual teachers in this study identified other general principles of teaching, including using repetition, teaching anecdotally with cases, making things memorable and dramatic, role modeling, and teaching in a style that is right for the teacher. These general principles of teaching offered me initial insights into the next and most important domain of knowledge for teaching, case-based teaching.

#### Knowledge of Case-based Teaching Scripts

This domain of teachers knowledge, case-based teaching, is concerned with how attending physicians use

cases and case content to teach general principles of medicine. Understanding of this domain of knowledge emerged not so much from the interviews as from observations and transcripts of teaching rounds. This form of knowledge involves instructional methods that help learners interpret, reflect upon, and generalize from their cases. For a teacher, this requires knowledge of the patient's illness and life narrative, insight into the learner's representation of the case, and relevant teaching scripts. Through repetitive teaching of similar content and cases, teachers develop teaching scripts.<sup>1,9,22</sup> In this study, the teachers articulated three to five key points that they would teach related to a DKA case.<sup>1</sup> Knowledge of case-based teaching is at the center of teachers' understanding, where it connects all of the other domains.

In the clinical setting, learning begins with a specific patient. In Dr. Baker's words: "The patient is a representation of an illness and has unique features that are examples of a type. There are certain characteristics of the patient that cause you to bring out different points about a person and their reaction to illness." In the context of teaching rounds, several interpretive activities occur. Prior to teaching rounds, the learner elicits the patient's story. Next, the learner summarizes that story, recasts it into medical language, and presents it to the teacher and other team members. The attending physician listens to the case presentation and tries to make sense out of the patient's problem and the learner's representation of the case. Then teacher and learners together develop a coherent explanation for the case. Case-based teaching involves (1) helping learners construct coherent representations of the case, (2) filtering out irrelevant information, and (3) making connections between the specifics of the case and generalizations derived from the medical literature and experience with other patients.

I selected two very different examples of this form of knowledge in ac-

tion to present in this article. Both illustrate how attending physicians use cases for teaching purposes. The first example involves a Socratic or directed-questioning approach to the development of a diagnosis, while the second example was a more presentational style that demonstrates how to communicate with a patient's family. Both come from transcripts of teaching rounds.

In the first instance, Dr. Baker was responding to a medical student's case presentation at University Hospital. After the student gave an extended ten-minute case presentation of a 25-year-old man who had been admitted for persistent epigastric pain, Dr. Baker initiated the following instructional dialogue about this case:

*Dr. Baker:* Do you think he has acute pancreatitis or do you think he has acute recurrent pancreatitis? Is there a difference between the two?

*Student:* I think he has an acute recurrent pancreatitis. There are differences between the two . . . Number one is the indolent history of mild epigastric pain, which antacids don't help, and then later the acute and persistent onset.

*Dr. Baker:* Is that an important distinction?

*Student:* Yes. I think it is a very important distinction with his history.

*Dr. Baker:* If it is an important distinction, why?

*Student:* I looked at the differential diagnosis for epigastric pain . . . For this person with his surgical history, one of the major causes of pancreatitis is pancreatic insult—which he clearly had twice with an insulinoma resection and a later laparotomy.

*Dr. Baker:* Take a step back to the question: What are two common causes of pancreatitis?

*Student:* Alcohol.

*Resident:* Gallstones.

*Dr. Baker:* Then there is actually a third, which is idiopathic. For the vast majority of cases of acute pancreatitis, it is one of these three. The older the person, the more likely it is obstructive, and the younger the person, the more likely it is alcohol. The minute you get recurrent pancreatitis, though, the differential changes dramatically. Everything in this case points to pancreatitis due to surgical complications. The second possibility is that he may have a tumor. Why is that important in this case?

Dr. Baker continued this interactive teaching process for another 13 minutes. He asked more focused questions, provided brief teaching points, quickly summarized what is known in the literature, and assigned readings on recurrent pancreatitis. Through the questioning process, Dr. Baker drew out of the student the key features of a diagnosis of recurrent pancreatitis, elicited the underlying reasoning of the student, and targeted information from the literature to the learner's point of need.

A second example of knowledge of case-based teaching occurred during Dr. Charles's teaching rounds at Harborview Medical Center (a country hospital managed as a teaching hospital by the University of Washington). An intern presented a case of a 30-year-old man infected with human immunodeficiency virus (HIV), both his mother and his woman companion were asking how long he would live. The following sequence occurred in the midst of a 13-minute discussion of this case:

*Intern:* His girlfriend wanted to know if he would live to be 60 . . . I'm always tempted to say something like, "Well, he may die tomorrow, but may not." It is hard to know how to respond to that.

*Dr. Charles:* Sometimes, if they are patients that I know well, I'll be pretty frank with them and just give them the statistics. He has AIDS with probable PCP, so that means life expectancy for him on AZT is

probably somewhere between 18 and 22 months. Fifty percent are dead at 18 months.

*Intern:* . . . Being vague is not bad . . .

*Dr. Charles:* I think that while he is processing a lot of information, that is very appropriate. But when patients are trying to make life plans on what to do in a couple of years, I basically say that we have patients that are living four or five years with AZT and we don't know what their endpoint will be. They may live eight, nine, or ten years. We don't know. So that gives them hope. But, I add that the average is about two years.

*Intern:* Actually, I may tell him that. I didn't know those numbers . . .

The conversation continued, with Dr. Charles offering practical and formal knowledge in the context of dealing with this specific patient. The team was relieved to receive this practical advice, supporting data, and a model of how to share this sensitive information with the patient and his family. This style directly addressed the learners' questions.

In case-based teaching, the teacher discerns both the patient's illness and the learner's representation of the case, and then helps the learner make sense out of the experience. Depending on the circumstances, teachers accomplish this task using Socratic and/or directive styles. The six distinguished teachers made this a highly interactive, engaging, and memorable process.

Researchers of classroom teaching describe this form of knowledge as *content-specific pedagogy*,<sup>19</sup> *pedagogical content knowledge*,<sup>10,20</sup> *curriculum scripts*,<sup>9</sup> and case-based instruction.<sup>41-43</sup> A somewhat similar approach, although oriented towards clinical practice, is the *patient-centered clinical method*, which aims at understanding the unique story of each individual patient.<sup>44,45</sup> While recognizing the uniqueness of each patient, case-based teaching scripts

focus on the question: What is this particular patient a case of? How does this person's unique story relate to stories of other patients with similar diseases and to broader biomedical knowledge?

### Other Domains of Knowledge

Individual attending physicians in this study identified communication skills (compassion, sensitivity, intuition) and knowledge of the curriculum (medical school, clerkship, and residency program) as types of knowledge essential to clinical teaching. While knowledge of curriculum is part of classroom teachers' knowledge base,<sup>8,10,20,21,24</sup> this is not generally true for the attending physicians studied.

### Sources of Knowledge for Teaching

How did these six clinical educators learn how to teach so well? They acquired their knowledge of teaching primarily from the experience of being a learner (the apprenticeship of observation of good and bad examples) and a teacher (reflecting on what worked and did not work). Dr. Able reported that he had taken no formal courses, in teaching methods: "No, none of us have. It's like sex education and parenting, you just do it . . . I think it is an art, and I think you learn it in an apprenticeship sort of way." They all stated that experience was the biggest determinant of their overall teaching styles, and that they taught in ways that they themselves like to be taught and that fostered their own learning. Dr. Davis said, "I draw on my experiences of having been a student and a resident, and try to pick out the things I liked." Several of them said that it took six to seven years to discover a teaching style that they felt comfortable with. Only two of them had read books and articles on teaching and had attended faculty development workshops. Dr. Fagan was unusual in having participated in numerous faculty development workshops, seminars, and short courses.

### IMPLICATIONS

Throughout this research, I was impressed with the congruence of what I learned about the six teachers' knowledge, reasoning, and action: what those attending physicians told me in the interviews closely matched what they did in practice. This congruence in turn agreed with what their students reported and what the transcripts of teaching rounds verified. The attending physicians had a rich knowledge base for teaching that accurately reflected their own teaching styles and strategies. They were articulate in expressing their insights into teaching and their struggles to continuously improve. These expert teachers used their knowledge in an encapsulated mode—namely, they could give a concise teaching point but when needed or asked could elaborate on the deeper structure of the knowledge underlying that point. This is similar to the encapsulated knowledge structures of medical experts studied by Schmidt and Boshuizen<sup>46</sup> and the compiled knowledge structures described by Bordage and colleagues.<sup>4,47</sup>

The collective knowledge base for teaching identified in this study has implications for (1) general conceptions of knowledge for teaching, (2) facilitating learning in clinical settings, and (3) knowledge growth and teaching improvement.

### Knowledge for Teaching

The knowledge base for teaching the six physicians studied incorporates six domains of knowledge that are tightly connected through the integrative domain of case-based teaching scripts. While knowledge of medicine is foundational, it is inadequate for effective clinical teaching. Over time, knowledge of medicine becomes reorganized for teaching purposes and interconnected with other forms of knowledge.

While all of the domains of knowledge identified in this study are conceptually distinct, they functionally overlap. As Dr. Able commented when asked to diagram the knowledge



he uses during teaching rounds: "The domains of knowledge don't exist in my mind when I am teaching . . . For me it is a fairly cohesive mix."

The most elusive and important form of knowledge stored in memory is case-based teaching scripts. While none of the attending physicians spoke directly to this form of knowledge, they demonstrated it during teaching rounds and acknowledged the accuracy of its description in this article. The importance of this component of knowledge is clearly stated by Hunter:

In the clinical context, teaching and learning begin with the patient.

As an interpretive activity . . . undertaken for the care of a sick person, it (medicine) takes the patient as its text and seeks to understand his or her malady in the light of current biological, epidemiological, and psychological knowledge.<sup>48</sup>

The patient as text is both a unique person and a memorable representation of a general class of disease. After listening to the learner's case presentation of the patient's story, the teacher's task is to diagnose the patient's problem, diagnose the learner's representation of the case, and connect the learner's understanding with broader conceptions of medicine and with other cases. This process aids the learner's development of illness scripts and builds stronger connections among medical concepts. In such an ill-structured domain as medicine, Spiro argues:

The best way to learn . . . cognitive flexibility . . . for future application is by . . . case-based presentations which treat a content domain as a landscape that is explored by "criss-crossing" it in many directions, by reexamining each case "site" in the varying contexts of different neighboring cases, and by using a variety of abstract dimensions for comparing cases.<sup>49</sup>

### Facilitating Learning

Case-based teaching strategies support experiential learning processes

of students and residents by encouraging their abilities to reflect upon experience, develop appropriate generalizations, and predict future effects.<sup>50-53</sup> This involves three instructional tasks. First, teachers need to assess learners' knowledge (including errors, misconceptions, or gaps in knowledge) by asking questions. Other research has found deficits in the content of case presentations<sup>54</sup> and the tendencies of residents to slant the presentation to what they think the preceptor expects to hear.<sup>55</sup> Inquiry is essential to overcoming these difficulties. Asking questions also has the side benefit of activating the learners' prior knowledge, which improves subsequent learning.<sup>51,56-58</sup> During this inquiry process, teachers need to have a flexible knowledge base, since learners vary in the ways in which they structure their knowledge.

Second, teachers need to organize and present medical knowledge so that learners can comprehend it and use it to satisfy their learning objectives. This requires knowledge of case-based teaching scripts to present medical knowledge in an understandable and memorable manner. This often takes the form of short teaching points, modeling interactions and reasoning processes, and encouraging learners to elaborate and reflect upon their knowledge. When the latter occurs, subsequent retrieval of the knowledge is enhanced.<sup>57</sup>

Third, teachers can help learners challenge and expand their existing knowledge. In this instance, teachers need knowledge of medicine, patients, learners, general principles of teaching, and case-based teaching scripts. Creative methods may be needed to challenge learners' understanding in a constructive and supportive manner.

The eight general principles of teaching articulated by the teachers studied (e.g., actively involve learners, capture attention, have fun, etc.) facilitate learning, and are congruent with prior research on clinical teaching<sup>59,60</sup> and with constructivist theories of learning.<sup>61-64</sup> The emphasis upon active involvement and the

joint construction of meaning in the context of knowledge use capture essential features of constructivism. However, the limited number of teachers mentioning feedback is troubling although not surprising. While these teachers provided a great deal of feedback to their learners, most attending physicians do not. The lack of feedback during clinical rotations appears to be a rather intractable problem in medical education.<sup>34</sup>

### Knowledge Growth and Teaching Improvement

Through the apprenticeship of observation and reflective teaching practice, attending physicians and residents may eventually develop a reasonable knowledge base for teaching. However, this process could perhaps be expedited through systematic teaching-improvement programs for residents and faculty members. In studies of residents' teaching, residents frequently fail to take advantage of teaching opportunities during work rounds and tend to favor lecturing over asking questions and actively involving the team in clinical decision making.<sup>31,65,66</sup> Teaching-improvement workshops are effective mechanisms for developing general teaching skills and for increasing teachers' and residents' understanding of learners.<sup>67-70</sup> Knowledge of case-based teaching is best learned in the context of departmental teaching-improvement and mentoring programs where content-specific, case-based teaching scripts and strategies can be shared.<sup>1</sup>

The present study illuminates the wisdom of practice among distinguished teachers in general internal medicine in the context of teaching rounds. Generalizations from this study should be made to theoretical conceptions of teachers' knowledge rather than to the knowledge base of clinical teachers in medicine generally.<sup>38,72,73</sup> To test this framework of professional knowledge for teaching, further research is needed among less distinguished and more novice clinical teachers, in other medical specialties and in other clinical settings.



## SUMMARY

The professional knowledge base of clinical teaching in medicine is multi-dimensional. Excellence in clinical teaching requires clinical knowledge of medicine, of specific patients, and of context plus an educational knowledge of learners, general principles of teaching, and case-based teaching scripts. When combined, these domains of knowledge allow attending physicians to engage in clinical instructional reasoning and to target their teaching to the specific needs of their learners.<sup>1</sup>

The author gratefully acknowledges the contributions of many colleagues to the development of this study, in particular, Dr. Lee Shulman of Stanford University for his underlying theoretical work on pedagogical content knowledge, Drs. Pamela Grossman and Samuel Wineburg of the University of Washington for their guidance in qualitative research methods, and Dr. LuAnn Wilkerson of University of California, Los Angeles, for encouraging him to dig deeper into the data. While affirming their contributions, the author accepts sole responsibility for the limitations of this paper.

## References

1. Irby, D. M. How Attending Physicians Make Instructional Decisions when Conducting Teaching Rounds. *Acad. Med.* 67(1992):630-638.
2. Norman, G. R., Brooks, L. R., Allen, S. W., and Rosenthal, D. The Development of Expertise in Dermatology. *Arch. Dermatol.* 125(1989):1063-1068.
3. Schmidt, H., Norman, G., and Boshuizen, H. A Cognitive Perspective on Medical Expertise: Theory and Implications. *Acad. Med.* 65(1990):611-621.
4. Bordage, G., and Lemieux, M. Semantic Structures and Diagnostic Thinking of Experts and Novices. In Proceedings of the Thirtieth Annual Conference on Research in Medical Education. *Acad. Med.* 66, Supplement (September 1991):S70-S72.
5. Patel, V. L., and Groen, G. J. The General and Specific Nature of Medical Expertise: A Critical Look. In *Toward a General Theory of Expertise: Prospects and Limits*, K. A. Ericsson, and J. Smith, eds., pp. 93-125. New York: Cambridge University Press, 1991.
6. Feltovich, P. J., Spiro, R. J., and Coulson, R. L. The Nature of Conceptual Understanding in Biomedicine: The Deep Structure of Complex Ideas and the Development of Misconceptions. In *Cognitive Science in Medicine: Biomedical Modeling*, D. Evans, and V. Patel, eds., pp. 113-172. Cambridge, Massachusetts: MIT Press, 1989.
7. Brophy, J., ed. *Teachers' Knowledge of Subject Matter as it Relates to Their Teaching Practice*. Greenwich, Connecticut: JAI Press, 1991.
8. Grossman, P. L., Wilson, S. M., and Shulman, L. S. Teachers of Substance: Subject Matter Knowledge for Teaching. In *Knowledge Base for the Beginning Teacher*, M. C. Reynolds, ed., pp. 245-264. New York: Pergamon Press, 1989.
9. Putnam, R. T. Structuring and Adjusting Content for Students: A Study of Live and Simulated Tutoring of Addition. *Am. Educ. Res. J.* 24(1987):13-48.
10. Wilson, S., Shulman, L., and Richert, A. 150 Different Ways of Knowing: Representations of Knowledge in Teaching. In *Exploring Teacher's Thinking*, J. Calderhead, ed., pp. 104-124. London, England: Cassell, 1987.
11. Wilson, S. M., and Wineburg, S. S. Peering at History through Different Lenses: The Role of Disciplinary Perspectives in Teaching History. *Teachers College Record* 89(1988):522-539.
12. Wineburg, S. S., and Wilson, S. M. Subject-Matter Knowledge in the Teaching of History. In *Teachers' Knowledge of Subject Matter as it Relates to Their Teaching Practice*, J. Brophy, ed., pp. 305-347. Greenwich, Connecticut: JAI Press, 1991.
13. McDiarmid, G. W., Ball, D. L., and Anderson, C. W. Why Staying One Chapter Ahead Doesn't Really Work: Subject-Specific Pedagogy. In *Knowledge Base for the Beginning Teacher*, M. C. Reynolds, ed., pp. 193-205. New York: Pergamon Press, 1989.
14. Carlsen, W. S. Subject-Matter Knowledge and Science Teaching: A Pragmatic Perspective. In *Teachers' Knowledge of Subject Matter as it Relates to Their Teaching Practices*, J. Brophy, ed., pp. 115-143. Greenwich, Connecticut: JAI Press, 1991.
15. Leinhardt, G. Math Lessons: A Contrast of Novice and Expert Competence. *J. Res. Math. Educ.* 20(1989):52-75.
16. Leinhardt, G. Development of an Expert Explanation: An Analysis of a Sequence of Subtraction Lessons. *Cognition and Instruction*. 4(1987):203-223.
17. Peterson, P. L., Fennema, E., and Carpenter, T. P. Teachers' Knowledge of Students' Mathematics Problem Solving Knowledge. In *Teachers' Subject Matter Knowledge as it Relates to Their Teaching Practice*, J. E. Brophy, ed., pp. 49-86. Greenwich, Connecticut: JAI Press, 1991.
18. Smith, D. C., and Neale, D. C. The Construction of Subject-Matter Knowledge in Primary Science Teaching. In *Teacher's Knowledge of Subject Matter as it Relates to Their Teaching Practice*, J. E. Brophy, ed., pp. 187-244. Greenwich, Connecticut: JAI Press, 1991.
19. Reynolds, A. What is Competent Beginning Teaching? A Review of the Literature. *Rev. Educ. Res.* 62(1992):1-35.
20. Shulman, L. Those Who Understand: Knowledge Growth in Teaching. *Educ. Res.* 15(1986):4-14.
21. Shulman, L. Knowledge and Teaching: Foundations of the New Reform. *Harvard Educ. Rev.* 57(1987):1-22.
22. Leinhardt, G., Putnam, R. T., Stein, M. K., and Baxter, J. Where Subject Knowledge Matters. In *Teachers' Knowledge of Subject Matter as it Relates to Their Teaching Practice*, J. E. Brophy, ed., pp. 87-114. Greenwich, Connecticut: JAI Press, 1991.
23. Gudmundsdottir, S. Pedagogical Models of Subject Matter. In *Teachers' Knowledge of Subject Matter as it Relates to Their Teaching Practice*, J. E. Brophy, ed., pp. 265-304. Greenwich, Connecticut: JAI Press, 1991.
24. Marks, R. Pedagogical Content Knowledge: From a Mathematical Case to a Modified Conception. *J. Teach. Educ.* 41(1990):3-11.
25. Grossman, P. L. *The Making of a Teacher: Teacher Knowledge and Teacher Education*. New York: Teachers College Press, 1990.
26. Adams, W. R., et al. A Naturalistic Study of Teaching in a Clinical Clerkship. *J. Med. Educ.* 39(1964):164-166.
27. Becker, H., Geer, B., Hughes, E., and Strauss, A. *Boys in White*. Chicago, Illinois: University of Chicago Press, 1961.
28. Mattern, W. D., Weinholtz, D., and Friedman, C. P. The Attending Physician as Teacher. *N. Engl. J. Med.* 308(1983):1129-1132.
29. Reichsman, F., Browning, F. E., and Hinshaw, J. R. Observations of Undergraduate Clinical Teaching in Action. *J. Med. Educ.* 39(1964):147-153.
30. Shulman, R. Wilkerson, L., and Goldman, D. Multiple Realities: Teaching Rounds in an Inpatient Pediatric Service. *Am. J. Child.* 146(1992):55-60.
31. Tremonti, L. P., and Biddle, W. B. Teaching Behaviors of Residents and Faculty Members. *J. Med. Educ.* 57(1982):854-859.
32. Weinholtz, D. The Socialization of Physicians During Attending Rounds: A Study of Team Learning among Medical Students. *Qualitative Health Research* 1(1991):152-177.
33. Shulman, L. S. Toward a Pedagogy of Cases. In *Case Methods in Teacher Education*, J. H. Shulman, ed., pp. 1-30. New York: Teachers College Press, 1992.
34. Irby, D. M., and Rakestraw, P. Evaluating Clinical Teaching in Medicine. *J. Med. Educ.* 56(1981):181-186.
35. Spradley, J. P. *The Ethnographic Interview*. Chicago, Illinois: Holt, Rinehart and Winston, 1979.
36. Ericsson, K. A., and Simon, H. A. Verbal Reports as Data. *Psychological Rev.* 87(1980):215-251.
37. Spradley, J. P. *Participant Observation*. New York: Holt, Rinehart and Winston, 1980.
38. Miles, M. B., and Huberman, A. M. *Qualitative Data Analysis: A Sourcebook of New Methods*. Newbury Park, California: Sage

- Publications, 1984
39. Sabers, D., Cushing, K., and Berliner, D. Differences among Teachers in a Task Characterized by Simultaneity, Multidimensionality, and Immediacy. *Am. Educ. Res. J.* 28(1991):63-88.
  40. Bordage, G. The Curriculum: Overloaded and Too General? *Med. Educ.* 21(1987):183-188.
  41. Christensen, C. R., Garvin, D. A., and Sweet, A. *Education for Judgment: The Artistry of Discussion Leadership*. Boston, Massachusetts: Harvard Business School Press, 1991.
  42. Schon, D., ed. *The Reflective Turn: Case Studies in and on Educational Practice*. New York: Teachers College Press, 1991.
  43. Shulman, J. H. *Case Methods in Teacher Education*. New York: Teachers College Press, 1992.
  44. Levenstein, J. H., et al. The Patient-Centered Clinical Method: I. A Model for the Doctor/Patient Interaction in Family Medicine. *Fam. Pract.* 3(1986):24-30.
  45. McWhinney, I. R. *A Textbook of Family Medicine*. Oxford, England: Oxford University Press, 1989.
  46. Schmidt, H. G., and Boshuizen, H. P. On the Origin of Intermediate Effects in Clinical Case Recall. *Memory and Cognition* 21(1993):338-351.
  47. Bordage, G., and Zacks, R. The Structure of Medical Knowledge in the Memories of Medical Students and General Practitioners: Categories and Prototypes. *Med. Educ.* 18(1984):406-416.
  48. Hunter, K. M. *Doctors' Stories: The Narrative Structure of Medical Knowledge*. Princeton, New Jersey: Princeton University Press, 1991, p. 25.
  49. Spiro, R. J., et al. Knowledge Acquisition for Application: Cognitive Flexibility and Transfer in Complex Content Domains. In *Executive Control Processes*, B. C. Britton, and S. Glynn, eds., pp. 177-200. Hillsdale, New Jersey: Erlbaum, 1987.
  50. Hewson, M. G. Reflection in Clinical Teaching: An Analysis of Reflection-on-Action and its Implications for Staffing Residents. *Med. Teach.* 13(1991):227-231.
  51. Hewson, M. Clinical Teaching in the Ambulatory Setting. *J. Gen. Intern. Med.* 7(1992):76-82.
  52. Kolb, D. A. *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, New Jersey: Prentice-Hall, 1984.
  53. Schon, D. *The Reflective Practitioner: How Professionals Think in Action*. New York: Basic Books, 1983.
  54. Kihm, J. T., Brown, J. T., Divine, G. W., and Linzer, M. Quantitative Analysis of the Outpatient Oral Case Presentation: Piloting a Method. *J. Gen. Intern. Med.* 6(1991):233-236.
  55. Bucher, R., and Stelling, J. G. *Becoming Professional*. Beverly Hills, California: Sage Publications, 1977.
  56. Franks, J. J., Bransford, J. D., and Auble, P. M. The Activation and Utilization of Knowledge. In *Handbook of Research Methods in Human Memory and Cognition*, C. R. Puff, ed., pp. 395-425. New York: Academic Press, 1982.
  57. Norman, G. R., and Schmidt, H. G. The Psychological Basis of Problem-based Learning: A Review of the Evidence. *Acad. Med.* 67(1992):557-565.
  58. Steward, D. E., and Feltovich, P. J. Why Residents Should Teach: The Parallel Processes of Teaching and Learning. In *Clinical Teaching for Medical Residents: Role, Techniques, and Programs*, J. C. Edwards, and R. L. Marier, eds., pp. 3-14. New York: Springer Publishing Company, 1988.
  59. Irby, D. M. Clinical Teacher Effectiveness in Medicine. *J. Med. Educ.* 53(1978):808-815.
  60. Stritter, F. T., Hain, J. D., and Grimes, D. A. Clinical Teaching Reexamined. *J. Med. Educ.* 50(1975):877-882.
  61. Bruner, J. *Acts of Meaning*. Cambridge, Massachusetts: Harvard University Press, 1990.
  62. Dewey, J. *Experience and Education*. New York: Collier Books, 1938.
  63. Lave, J. *Cognition in Practice: Mind, Mathematics and Culture in Everyday Life*. Cambridge, U.K.: Cambridge University Press, 1991.
  64. Resnick, L. B. *Education and Learning to Think*. Washington, D.C.: National Academy Press, 1987.
  65. Lewis, J. M., and Kappelman, M. M. Teaching Styles: An Introductory Program for Residents. *J. Med. Educ.* 59(1984):355.
  66. Wilkerson, L., Lesky, L., and Medio, F. J. The Resident as Teacher During Work Rounds. *J. Med. Educ.* 61(1986):823-829.
  67. Edwards, J. C., Kissling, G. E., Plache, W. C., and Marier, R. L. Long-Term Evaluation of Training Residents in Clinical Teaching Skills. *J. Med. Educ.* 61(1986):967-970.
  68. Edwards, J. C., and Marier, R. L. *Clinical Teaching for Medical Residents: Roles, Techniques, and Programs*. New York: Springer Publishing Company, 1988.
  69. Skeff, K. M., et al. Assessment by Attending Physicians of a Seminar Method to Improve Clinical Teaching. *J. Med. Educ.* 59(1984):944-950.
  70. Skeff, K. M., Stratos, G. A., Berman, J., and Bergen, M. R. Improving Clinical Teaching: Evaluation of a National Dissemination Program. *Arch. Intern. Med.* 152(1992):1156-1161.
  71. Shulman, L. S. Autonomy and Obligation: The Remote Control of Teaching. In *Handbook of Teaching and Policy*, L. S. Shulman, and G. Sykes, eds., pp. 485-504. New York: Longman, 1983.
  72. Bromley, D. B. *The Case-Study Method in Psychology and Related Disciplines*. New York: John Wiley & Sons, 1986.
  73. Glaser, B., and Strauss, A. L. *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Chicago, Illinois: Aldine, 1967.