Whether it is medicine or any field, the essential task in making decisions is to bring the whole world of knowledge in that field to our everyday actions. When we do problem solving in medicine, we are in essence trying to take all the relevant medical knowledge and apply it to each action we take on behalf of the person paying for it. The ultimate goal of this endeavor should be to satisfy each consumer that he or she consistently received in every medical encounter the best possible care that was available. The premise under which we have been operating to accomplish this goal is "education." We plan courses for students in which we stuff enormous amounts of medical knowledge into their heads. We examine them for recall of that knowledge as they seek admission to the world of practice. Recently, we have been adding courses in decision analysis, algorithms, and problem solving so that they might make better and wiser use of the knowledge. The patients expect that such a system of education enables the student to go out into the real world and do the right thing every time. The problem is that the "voltage drop" in information across this type of system is enormous.

Indeed, the entire premise that education can bring the world of knowledge to everyday actions is wrong and is a form of educational malpractice. The human mind simply cannot do what we have led the public to think it can do.

What is the basis for such a conclusion, and how did a new concept for education and practice called "problem-knowledge coupling" evolve out of it? The purposes of this presentation are to describe the evolution of the idea of problem-knowledge coupling and to explain the relevance of this concept to methods of education and the decision making inherent in everyday clinical practice.

Review of the Problem-Oriented System

Initial realization of the difficulties practitioners and those studying to be practitioners face in terms of making clinical decisions stemmed from experience with the problem-oriented system. From many years of using the problem-oriented medical record in daily patient care, we found that to understand the patient and his or her problems, a defined database and complete problem list were needed. Once the problems were discovered, a plan for each problem along with progress notes that were titled and numbered with respect to each problem were written. For each individual problem, the expectation was that there should be concise, clear statements of the following information: the goal of management, the basis for the problem statement, the disability from the problem, the status (getting better, worse, unchanging) of the patient in regard to the problem, the parameters for following and treating the problem, how the problem is to be investigated further (if that is consistent with the goal), and the potential complications to which we must be alert. It was expected that this process would occur in every patient encounter and that practitioners would recognize that a goal set for one problem had to be done so in the context of all the others. In essence, in using the POMR, we were using a system that allowed us to mobilize our common sense in treating the patient. In this way, we could meet the essential obligation of the medical professional—to solve the real-world, often interdisciplinary, problems of patients.
Evolution of the Problem-Knowledge Coupling Concept

In actual practice, it proved to be difficult for most medical providers in most settings to include all the elements of the POMR for each problem and to recall from memory in a rigorous manner all the knowledge necessary to implement all the components. Therefore, to aid the practitioner in this effort, the computerized POMR with thousands of screen displays of medical information and rapid response times was developed at the University of Vermont.\(^2\) We soon found, however, from use of the computerized POMR, that even though we had solved the memory problem, we had created a new one that was far worse—the inability of the human mind to process the increased volume of information that the computer provided. The information the computer could generate simply overloaded and overwhelmed the humans trying to process it. We discovered the mind could not handle all that information.

Psychologists Wason and Johnson-Laird note that although we would like to think the educated human mind is “capable of thinking in terms of propositions which take account of the possible and hypothetical” and that the mind will “be able to isolate the variables in a problem and subject them to a combinatorial analysis which nicely exhausts the possibilities,”\(^3(p189)\) it simply is unable to do so. In addition, the research of these psychologists\(^3\) and others who study medical decision making\(^4\text{-}6\) has told us that the mind copes with this problem of information overload by generating hypotheses in the earliest moments of encounters with patients, thereby prematurely biasing the remaining steps in the search for data. Out of necessity the mind limits the number of hypotheses to a number smaller than the problem requires. Furthermore, when the individual mind’s logical ability is restricted, it will “operate with heuristic or hit or miss procedures that do not guarantee solution.”\(^5(p170)\) In essence, the mind will underestimate the complexity of problems and will oversimplify them. The mind takes probabilities based on a few variables in many people and lets them supersede the reality of many, many more variables in one unique individual.

Therefore, it is a misconception we believe can think in the amount of detail needed to solve a complex task at the same time we are performing it. Educated individuals realize these limitations, know they cannot think about what they are doing at the time of action, and rely instead on simple but powerful tools. A good example is the engineer who does not take the time while building a bridge to derive complex formulas but rather relies on established mathematical tables for the information he or she needs to proceed with the task.

The complexities of solving patients’ problems and the nature of limitations of the human mind show us that we need to use tools to help manage patient problems. The microcomputer-run Problem-Knowledge Coupler\(^\circ\) (PKC\(^\circ\)) was developed as a tool that could fulfill this need. Using the PKC\(^\circ\) software, we can record and store all findings in a patient about a problem and the relevant clinical knowledge from the literature about that problem. These two sets of information can then be coupled or linked together to determine the range of possible diagnostic or management options that the clinician should consider for the individual patient under consideration. The specifics of how PKC\(^\circ\) work and examples of how they may be applied in medicine and physical therapy practice have been outlined in detail elsewhere.\(^7\text{-}8\) In general, however, using the PKC\(^\circ\) as a tool, we can come closer to the goal of bringing the world of knowledge about a problem area to the everyday actions of the clinicians who manage the patients with those problems.

**Education**

The traditional premise that we can achieve this goal through an educational system that stresses memorization of facts and actions, regurgitation of information, and the acquisition of credentials is flawed. Rather than relying on this memory-based educational paradigm to ensure “quality” in subsequent clinical practice, educators should pursue quality in practice, defined as the excellence with which a well-defined function is fulfilled; that is, the person being evaluated knows exactly what the expectations are. In addition, the individual should have access to the tools needed to fulfill those expectations. It is only under these circumstances that others are able to assess whether expectations are achieved. The problem with medicine is that it has never defined quality in this way. Instead, medicine has traditionally defined quality as what people with credentials do, and only other people with credentials have a right to discuss it. Typically, for want of a better definition, medicine has labeled credentialed individuals with experience as “experts.” Ironically, we watch the actions of experts and instruct students to emulate their behavior instead of defining standards and providing students with the tools necessary to meet the complexities of decision making.

When rooted in a memory-based system of education and practice, students and educators have difficulty in appreciating that patients’ problems often cross specialty boundaries. This difficulty exists because as knowledge expands, medical professionals are forced to specialize and narrow their perspective simply to try to keep up with the knowledge explosion in their own field. This situation then forces clinical practice to be driven by an artificial division of the patient’s problems into specialty areas, and the most important decision that a patient makes in trying to solve his or her problems becomes which doctor’s door he or she walks through. In
physical therapy, where clinical specialization is a more recent phenomenon, the potential for a similar memory-driven artificial compartmentalization of patient problems in education and practice exists.

Finally, we have done a disservice to students when we, as teachers, do not acknowledge to students our learned ability to recognize patterns of patient symptomatology that suggest diagnoses. An educator or clinician with 20 years of experience is familiar with and can rapidly form patterns from patient findings. The student, who does not have the benefit of this experience, is unfairly tyrannized by the instructor when he or she is asked: “What should you think of next with this type of patient?” The educator and the clinical specialist are only good because they are familiar with and know selective patterns within their own limited domains. Confronted with problems outside of their domains, they, too, would be at a loss to see patterns in the patient’s symptoms that form diagnoses. However, unlike the student, the specialist and the educator are at the top of the clinical and educational pyramids. Therefore, they can be wrong and no one will question them.

Can the problems with using a memory-based system in medical care and education be solved? Yes. First, the concept inherent in the POMR of making the logic of our decisions explicit must be preserved. Second, we need to build and use tools that can help us manage the memory and processing limitations of the human mind.

**Clinical Decision Making**

Let us illustrate the need for an external tool such as a PKC® to aid us in diagnosing and managing patient problems. A busy practitioner in a single day may see a variety of patient problems including a case each of shoulder pain, knee pain, chest pain, and high blood pressure. The books may list 35 possible causes for each of the first two problems and 60 and 40 causes, respectively, for the latter two.

Another patient on the same day may have essential hypertension for which the books list 20 to 30 different management options if we include all the drugs, life-style changes, and holistic health approaches that apply. The patient believes that the medical provider not only knows all these things but also knows exactly what to seek in the history, physical examination, and simple inexpensive laboratory tests and how to systematically match the positive findings in the patient to the cause or management options that best fit each patient’s unique situation. Common sense, along with the results of psychological research, has told us that the unaided mind is not capable of doing this. If the unaided mind is not capable of this type of complex memorization and information processing and we are not currently using aids that help us, how are we managing now? Practitioners are able to manage because 95% of the time a patient’s problem is due to one of the “big movers,” that is, the five or six most common causes. The difficulty with this method of clinical decision making, however, is that the other causes may be more than 5% of the cost of medical care, and they often represent greater than 5% of the medical malpractice.

Another problem with a memory-based system of clinical decision making relates to the use of early hypothesis formation. The clinician identifies a few positive findings in the patient, and he or she immediately thinks of a favorite hypothesis to explain those symptoms. Further questions are then asked by the practitioner to support the already determined hypothesis. Although some clinicians believe that this is exactly the way clinical decision making should proceed and that this is how a data collection should be determined, there are significant problems with this type of approach.

Algorithmic-type thinking means that you go down one path and not another. As you make this choice, you eliminate one or more possible routes. In contrast, if you ask all relevant questions and add up the positive findings, you come out instead with so many votes for this, so many votes for that. Using this type of system holds all options open until the end and confronts you with a range of possible patterns as well as any ambiguity inherent in the situation. Because patient problems cross disciplines and each patient is a unique universe unto himself or herself, tolerating ambiguity in the solution of difficult problems is essential.

Why is an approach that tolerates ambiguity and keeps open all diagnostic and management options not possible in a memory-based system? It is not possible because if you do not use algorithms in a memory-based system, if you do not form clusters in your mind, if you do not rely on probabilities, you will lose your sanity and be unable to run a clinic. In a memory-based system, you are forced to simplify in order to control the information overload. One of the problems with this approach, of course, is that no one protects the medical professional when he or she makes a wrong judgment based on the algorithm or probabilities method. Juries do not think statistically. The public expects individual uniqueness to be recognized. Professionals in medicine should be reminded that they use probabilities in decision making in direct proportion to their ignorance of the uniqueness of the situation.

More realistically, we need a clinical decision-making system that lets us see our options and that lets the patient and the clinician see the ambiguity. The question should not be “What’s the diagnosis?” but rather “I wonder how well our present state of knowledge, with all its attendant weaknesses, accommodates this individual?” All classification systems are arbitrary, textbook averages that do not “fit” any unique individual. Rather than blame the patient when the facts do not fit, we should seek methods of decision making that respect and help us deal with their uniqueness.

Some experts look at problem-knowledge coupling and say it is
weights, no calculations, just simple primitive because it includes no weights, no calculations, just simple matching. Calculations that would be meaningful to such critics often require that we know the "weights" of each manifestation of a given disease, not only in the overall course of the disease but also at each stage of the disease. In addition, we would need to know at the time the patient appears in the clinic with the problem the prevalence of the disease in the population from which the patient comes. The reality, however, is that these data are not available to feed into any computer system when the patient appears in the clinic for care. Furthermore, there are no "experts" who can given reliable estimates appropriate to the unique situation of each patient. Fortunately, based on the work of Robyn Dawes on linear models, we know we do not need to assign different weights to various findings because equal weighting performs as well as or better than unequal weighting in decision making.9

Finally, we should be reminded that in complex biological situations, there will always be much uncertainty and, under any circumstances, the initial choice of a diagnosis is just a hypothesis. Therefore, in managing any patient, we need to regularly ask, "How are we doing?" This initial uncertainty is why progress notes are the most important part of the POMR. In summary, to make good clinical decisions, we need to accept the initial ambiguity present in the patient's situation, learn to recognize errors in judgment, reevaluate when we are wrong, and proceed with management only if the evidence in the patient's response points us that way.

Summary

The information tool to aid us in making the clinical decisions discussed in this presentation is called the PKC®. Our goal with patients should be to couple the knowledge of the unique patient to the knowledge in the literature and get the best possible match. This approach requires combinatorial versus probabilistic thinking. In the real world, ideal matches are not found. Therefore, it is critical to exhaust the patient's uniqueness first and only then use probabilities to settle further uncertainties. It is an error to teach people how to deal with uncertainty instead of teaching them to clean up a great deal of the uncertainty first. Patients must be involved in this endeavor. In essence, they have a PhD in their own uniqueness, and it is this uniqueness that is very powerful in solving complex problems.

This method of patient evaluation and management cannot be used with the unaided mind. It requires new and powerful information tools like the PKC®. All information that is relevant to a problem should be included in the coupler. It should encompass differing points of view, and the rationale should be made explicit to clinician and patient alike. When complete, the coupler should represent an interdisciplinary compilation of questions and tests that are expected to be collected every time in the clinic for the type of problem the coupler represents. This method will provide a basis for quality control because the contents of the coupler now have defined what we expect to occur in every patient encounter.

Teaching clinical decision making within a memory-based educational paradigm is inadequate and even fraudulent because no one (not even the experts) could ever know what the patient thinks we do. Rather than use a system to tyrannize one another professionally, we should be judging how gracefully we can interact with the areas of our ignorance. In essence, what the everyday provider of medical care most needs are a few simple concepts, some powerful information tools, the manual skills of his or her specialty, well-developed interpersonal skills, and a dedication to the task at hand.

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