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ABSTRACT

This paper discusses two methods used in training allied health students to clarify patients' problems and develop treatment plans to resolve them. The traditional problem solving approach is presented as a means to introduce students to patient evaluation and treatment planning, while clinical reasoning is seen as a more expert way to approach this process. The incorporation of problem solving early in allied health curricula, followed by instruction and practice in clinical reasoning, is recommended. An instructional model for facilitating students' acquisition of clinical reasoning skill is presented. Flowcharts of the problem solving and clinical reasoning processes and a model for instruction in clinical reasoning are included. (9 references) (Author/GL)

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This paper discussess two methods used to clarify patients' problems and develop treatment plans to resolve them. The traditional problem solving approach is presented as a means to introduce students to patient evaluation and treatment planning, while clinical reasoning is seen as a more expert way to approach this process. The incorporation of problem solving early in allied health curricula, followed by instruction and practice in clinical reasoning is recommended. An instructional model for facilitating students' acquisition of clinical reasoning skill is presented.

The enhancement of students' ability to "problem solve" has received much attention in recent allied health literature. Concurrently, in the medical education literature there is a discussion of the "clinical reasoning process," a process used to think through patients' problems and formulate treatment plans. Both problem solving and clinical reasoning have as their goal the determination of a patient's problem and the development of treatment plans to resolve the problem. The purpose of this paper is to compare these two methods of resolving patients' problems, and to suggest a method of instruction that will facilitate students' acquisition of more expert reasoning.

BACKGROUND

Problem Solving Approaches

The discussion of problem solving in the allied health professions has centered around teaching strategies to enhance students' ability in this area (Burnett & Pierson, 1988; Olsen, 1983; May & Newman, 1980; Jenkins, 1985; Slaughter, Brown, Garner & Peritt, 1989) Although each of these models for teaching problem solving vary slightly, essentially the approach provides students with evaluation results which they analyze, synthesize into problem lists, and develop treatment programs to address the patient's problems. If patients were actually treated in this manner the practitioner would perform a general evaluation on a patient noting all normal and abnormal findings without judgement until the data collection process is complete. The practitioner would then review the evaluation findings, synthesize the results, break major problems down into subproblems, formulate goals for treatment, and finally develop a treatment plan. Figure 1 shows the format of this type of clinical problem solving. Although most commonly reported in the literature on teaching problem solving, apparently this method of addressing patients' problems is not utilized by expert practitioners (Norman, 1988).

Clinical Reasoning

Norman has noted that the majority of problems that are addressed in clinical medicine are solved by means that do not fit this typical definition of a problem solving model (Norman, 1988). Instead, physicians use what has become known as a "clinical reasoning process" (CRP) in addressing their patients' problems. Barrows described CRP as involving the use of hypotheses to guide the evaluation process, with diagnostic questions or tests used to confirm or refute the hypotheses (Barrows & Peltovitch, 1987).

According to Barrows the hypothesis-test method of clinical reasoning involves generating a hypothesis (or preferably, multiple hypotheses) regarding the patient's problems early in the evaluation process. Early hypotheses may be fairly general, not strongly tied to a specific diagnosis or problem source. These initial hypotheses are then mentally rank ordered in terms of their plausibility. The most likely hypothesized cause is then investigated, either with further questioning of the patient or with specific evaluative tests. As more information is gathered through the evaluation the practitioner continually re-orders the hypotheses in terms of their plausibility, deletes some, and gradually develops a more clear understanding of the patient's problem(s). Throughout the evaluation process the practitioner may revert to a more general evaluation format to gather more information on problems that should not be overlooked, eventually returning to the hypothesis-test method as the process continues. Figure 2 depicts the hypothesis-test, clinical reasoning process in flow chart format.

While Barrow's work focused on the clinical reasoning processes utilized by physicians, evidence exists that similar reasoning processes are used by experienced physical therapists (Payton, 1985), and presumably other allied health practitioners.

A comparison of clinical reasoning and problem solving shows is that there are two schools of thought regarding how to address patients' problems. The first (what we term "problem solving" approach) involves the collection of all evaluative information without judgement, followed by an analysis of the data collected. Clinical reasoning, on the other hand, involves an analyze-as-you-go approach. The results of each evaluative question or test is immediately interpreted and integrated with previously collected information to guide the practitioner to the next test to be performed or question to be asked. On one level the differences between these two approaches to patients' problems appears to be simply a difference in the sequence of patient evaluations. Examined more closely, clinical reasoning can be seen as requiring more complex cognitive processing of patient information which can result in a more efficient and effective identification of the cause of the patient's problem.

Both the problem solving and clinical reasoning approach to patients problems have their advantages and disadvantages. Problem solving can be seen as a more structured approach, utilizing routine evaluation formats to collect information on patients. This method may be essential for persons with relatively little experience in a profession, as utilizing a structured approach leaves one less likely to "miss" key questions or tests. However, problem solving can also be more time consuming than clinical reasoning, and result in unnecessary evaluative procedures being performed. Clinical reasoning is a more expert-like way of approaching patient problems, which involves higher levels of cognitive processing of patient information, and more rapid and efficient determination of the patient's problem. One potential problem with using the clinical reasoning process to evaluate patients is that inexperienced practitioners (and students) may jump to conclusions about the patient's problem and forget or simply delete as unnecessary some key evaluative tests. However, as persons gain a more meaningful and broader understanding of pathologies and their appropriate treatments, and develop a repetoire of experience in their chosen field, it is less likely that such errors will occur.

The models for problem solving instruction advocate introducing the model early in the educational program (Burnett & Pierson, 1988; Olsen, 1983; May & Newman, 1980; Jenkins, 1985; Slaughter, Brown, Garner & Peritt, 1989). This inital instruction provides students with the structure needed to gain experience with patient evaluation and treatment planning. However, since one goal of allied health education is to produce competent clinicians, and apparently expert practitioners utilize a quite different approach to solving patient problems than that traditionally referred to as "problem solving," incorporation of the more complex reasoning process into existing allied health curricula seems advisable (Payton, 1985). Such instruction can be sequenced late in the educational program, after students have gained initial clinical experience using the problem solving approach. Instruction in the performance of the clinical reasoning process has the potential to accelerate learners' transitions from novice to expert clincian. The following describes a method of instruction in clinical reasoning that could be incorporated into educational programs, sequenced after students have gained experience with the more traditional problem solving approach.

INSTRUCTIONAL MODEL FOR CRP

While there have been several reports of teaching strategies for developing problem solving abilities, little has been written concerning the instructional strategies that will facilitate acquisition of clinical reasoning skill. Instruction in the clinical reasoning process is made more difficult because it does not involve a linear type of thought process, but rather uses an iterative approach to patient evaluation. Thus, instruction on this method of addressing patients' problems must convey the complexities of the clinical reasoning process while providing for practice of the skill, thereby enhancing students' ability to use the CRP in their patient care.

While the clinical reasoning process has been described as being distinctly different from traditional problem solving, it is not so different from the type of reasoning used when encountering everyday unknowns. Wright described "diagnostic induction" as being the kind of reasoning process that is basic to normal human functioning (Wright, 1989). This is a process by which, when confronted with a "problem" or question to which there is no blatantly apparent answer one generates multiple hypotheses which are ordered in terms of their relative plausability. The plausability rankings provide guidance on which "leads" to follow when searching for other relevant information which will help to clarify the question or problem under study.

`A common example of diagnostic inductive thinking is the way one would approach the problem of a car that won't start. Neither a mechanic nor an average car owner would try to determine the car's problem by completely evaluating all of its systems followed by a sorting out of this evaluation's results to identify the problem. Instead, both the expert mechanic and the average car owner would make some guesses (or hypotheses) as to what was wrong with the vehicle, such as the car being out of gas, the battery being dead because the lights were left on, or some general problem with the ignition system. Based upon these hypotheses one would perform some limited tests to determine which one is the real problem (looking at the gas gauge, checking the light switch, etc), and generate some plan to fix the problem. Showing students how the CRP is similar to the way they already think about common problems by using an example such as this may help to orient them to the usefulness of a hypothesis-test method of evaluating patients.

To help students understand the differences between the CRP and problem solving approaches it may be helpful to explicitly point out these differences. Following this introduction to the CRP, examples of its use in clinical practice should be provided to the learners. Since the CRP is actually performed mentally, without any overt sign of the information processing which occurs, presenting examples of it's use takes the form of the instructor "thinking aloud," by talking students through the steps involved in clinical reasoning. When presenting examples of clinical reasoning, a hypothetical patient case may be presented to the learners, with very little detail provided at the outset. The instructor would then talk through the steps being used (i.e. the steps shown in Figure 2) by generating lists of hypotheses about the patient, rank ordering the possibilities according to their plausibility, deciding upon information needs, selecting appropriate tests, receiving test results, modifying hypotheses, and so on. This method of instruction, based upon social learning theory, is referred to as modeling of the desired behavior.

An option to having the instructor simply talk through the reasoning process on a hypothetical patient is to use a videotape of an actual patient evaluation, with the instructor narrating the thought processes used to progress through the evaluation. Interactive videos, which would allow selective branching to different segments of an evaluation, provide an excellent, though expensive,

medium for depicting the clinical reasoning process in action. A less expensive alternative which still allows a greater touch of realism to this demonstration of CRP is the use of slides which depict the various evaluation steps, again narrated by the instructor.

In whatever medium the example is presented to the learners, the patient case study should be selected carefully. It should require all of the steps involved in CRP, yet be simple enough so as to avoid requiring a larger knowledge base than that possessed by the learners. One of the complexities of teaching the clinical reasoning process (or any of the problem solving approaches) is that the success of a student's reasoning is dependant upon prior knowledge upon which the reasoning is based. For example, one could not expect a student to demonstrate competent clinical reasoning when evaluating a patient with a head trauma if the student did not know the basics of neurology, and the necessary evaluation techniques. Therefore it is important that the examples and practice cases presented be based upon some clinical problem with which the learners are familiar.

Following this initial demonstration of clinical reasoning, students should be provided with opportunities to practice using the CRP on patient cases. Three levels of practice that can be used to promote acquisition of clinical reasoning skills include participative modelling, individual practice on case studies, and practice in clinical education settings.

Participative Modelling

In participative modelling the instructor presents a group of students with initial patient information and requests their input on potential causes of the patient's problem, ranking of the hypothesized causes, etc. Throughout this process the instructor may prompt students with questions, cueing them toward particular types of information that might be helpful in determining the patient's problem. In this way the students get immediate feedback about the use of CRP in a non-threatening, group environment. In participative modeling the instructor provides progressively less and less assistance in performing the desired skill, thus allowing learners to increase their competence and self-efficacy in using the newly learned skill. This type of practice can be used effectively in the early stages of learning a new skill.

Individual Practice

After students demonstrate an understanding of this "new" type of clinical reasoning they can progress to the second level of practice. Here the students should be provided with opportunities to practice and receive feedback on their own individual use of the process. Practice items for the clinical reasoning process should take the form of realistic patient case studies, much like those presented in the example. The type of case study to be used for practice of CRP should be designed so that practice closely parallels the use of the process in clinical settings. Thus, all information about a patient must not be provided to the learner at the outset. Instead, case studies snould begin with a small amount of information about the patient, such as the type of information that would be obtained when a patient is asked "Why did you schedule an appointment?" Additional information about the case study patient should be provided to the learner only upon request, as this allows mimicking the question-answer format of patient interviews and the test-results format of objective testing. Thus, if a student fails to remember to "ask" a key question, or "order" a vital test the student fails to receive crucial information that may affect the diagnostic/treatment process.

Given the iterative format of clinical reasoning, the format of practice items provides some challenges to the instructor. While it may seem awkward, written case studies can be used to provide this type of practice case. For example, two students could work together, one as the practitioner, and the other as the patient, or information source. The practioner would receive initial information regarding the patient, and based upon this information. would list possible causes of the patient problem, and rank order these causes in terms of their probability. The student would then request additional information from the patient to confirm or refute the most probable cause of the problem. The type of information requested could be answers to questions, or objective test results. The second student provides the practitioner with only the information requested, eventually culminating in the practitioner's selection of the patient's "diagnosis" and formulation of a treatment plan.

This method of working through case studies is certainly feasible, but is dependant upon the ability of learners to work together in teams. Computer programs written to provide patient information only upon request could be used to allow individual student practice. Interactive videos programmed to provide information to the learners in the same manner could also present an effective and powerful method for practicing CRP, this time allowing the learners to practice observation skills that are not afforded by the written or non-video computer-based practice methods.

In addition to the format of practice items it is also important to consider the sequence in which they are presented to students. Easy to difficult sequencing is recommended so that learners may first practice on problems on which they have a relatively high probability of successfully completing, thus allowing them to practice a new skill in low stress situations. Easy cases might describe patients whose problem is easily identifiable, has a fairly obvious source, or is commonly seen in clinical settings. More difficult cases might include patients with multiple problems, or seemingly contradictory evaluation results. The use of divergent practice items is also recommended, to allow students to practice applying the CRP with different types of patient problems.

During this level of practice it is essential that students receive corrective feedback regarding the effectiveness of their clinical reasoning. Feedback from the instructor should concentrate not only on the outcomes of the learner's use of CRP (i.e. the identified patient problem and treatment plan), but also on the process itself, perhaps by pointing out specific steps on which the learner needs to focus. When using the CRP two types of errors can be made. First, students may use the CRP itself incorrectly, referred to as a process error. For example, when presented with initial patient information a student may "collect" data randomly, without using hypothesized causes of the patient's problem to guide the data collection process. This type of error might be identified by asking the student why they elected to "perform" a specific test, and what kind of information they hoped to gain from it.

The second type of error that can occur when using the CRP is making incorrect assumptions about the meaning of test results, or the symptoms exhibited by a patient with a certain problem. These errors can be classified as knowledge errors. Students working with this type of error might appear to be randomly collecting data on a patient, but actually be working with a deficient knowledge base, and thus be generating implausible hypotheses. This type of error requires identification of the student's incorrect assumptions, and perhaps referral to text books or other references for remedial work.

When providing feedback about students' clinical reasoning skill, it is important to remember that no two individuals can be expected to take the same paths through the reasoning process on any given patient. The CRP is

individualistic in that many of the steps require judgements based upon prior knowledge and experience. For example, when presented with a patient with low back pain, one physical therapist may rank as the most probable hypothesized cause of the pain as being a generated from a disc. An equally competent therapist with different prior experiences may believe that the most probable cause is a muscle sprain, and still another might hypothesize facet involvement. From these diverse starting points each therapist will progress by asking questions and performing tests to confirm their own hypothesis, and eventually revising their hypothesis to keep it in line with the information gathered from the evaluation.

Since one can not expect two experts to follow the same paths in thinking through a patient's problem it is important that one does not expect all students to perform the reasoning in exactly the same manner. The important point is that students do not make critical errors in their clinical judgement, such as forgetting key tests that might differentiate one type of patient problem from another. To help students recognize how important it is both to consider all possible causes of a patient's problem, and to not jump to conclusions about the problem source early in the evaluation process, contrasting patient cases should be included in the practice of CRP. This involves the development of cases in which the patients have similar presenting symptoms which result from different causes. A physical therapy example of these type of cases would be to present students with a case of a patient with shoulder bursitis, and one with a cervical radiculopathy. Both patients could have similar (though not identical) histories of the onset of the problem, identical pain distributions, and very similar range of motion and muscle strength. However, a few key tests could be performed on such patients to differentiate between the two problems. Failing to perform the tests might result in the incorrect identification of the patient problem, and development of an inappropriate treatment plan.

Clinical Education Practice

The final level of practice of the clinical reasoning process should occur in the most realistic setting possible. Clinical education experiences are ideal forums for practice of clinical reasoning, for it is in the clinic that the process takes on real meaning for the students and their patients. Under the supervision of clinical preceptors students can further refine their clinical reasoning skills, and experience first hand the results of their reasoning. Following a student conducted patient evaluation the clinical preceptor can use in depth questioning of the student to determine why certain tests were or were not performed. This will assist the preceptor in understanding the student's clinical reasoning, and will help to identify weaknesses in process or knowledge that might lead to ineffective determination of the patient's problem. The preceptor might then suggest potential causes of the patient's problem that the student did not consider, and correct any faulty assumptions that the student might have made during the evaluation.

DISCUSSION

The reasoning process utilized by health professionals is a complex one, which requires integration of information from numerous sources. The clinical reasoning process presented here can be seen as distinctly different from traditional problem solving models. The model presented for CRP instruction is intended to clarify the clinical reasoning process itself, and to identify instructional strategies to assist students in acquiring this critical skill. Figure 3 depicts the steps described for instruction on clinical reasoning.

While practical for implementation in most allied health educational programs, this method for teaching the clinical reasoning process has not been

subjected to testing with students to determine it's effectiveness in achieving the goal of acquisition of more expert-like CRP skills. One difficulty in testing any instructional method for clinical reasoning is the difficulty in measuring performance outcomes. The authors know of no tool which allows for assessment of students' ability to reason in clinical settings, save clinical preceptor's subjective assessment of student performance. A recent effort to determine the effectiveness of a clinical problem solving model through the use of a standard critical thinking scale was unsuccessful, perhaps not so much because of the ineffectiveness of the model, but because the testing instrument used might not be an effective measure of the problem solving used in allied health practice.[5] The identification of an effective evaluative instrument for measuring learners' clinical reasoning skill would be of great assistance in determining the value of any clinical reasoning instructional model.

As mentioned previously, the use of the clinical reasoning process is dependant upon the student's prior knowledge, and their ability to recall and integrate information from prior coursework that might assist in the CRP. Current work in instructional design related to schema theory may help to identify ways to design instruction so that this information is more easily retreivable for use in the clinical setting. One problem that we have observed in students beginning to evaluate patients in clinical settings is their inability to distinguish between relevant and irrelevant evaluation findings. Using the clinical reasoning process may help to reduce the amount of irrelevant information that students obtain from patient evaluations, as each test or question is related to their hypothesis regarding the cause of the patient's problem. Again, instructional strategies that will facilitate identification of relevant cues would be of assistance in preparing students for competent clinical practice.

Additional research into the area of clinical reasoning may be directed toward the identification of critical characteristics of case studies to be used in the practice of CRP. Investigation into the attributes of media through which CRP practice is provided may also provide guidance in the design of effective learning experiences in this area.

Another area of interest is the issue of sequencing clinical reasoning instruction. We have recommended introduction of "problem solving" early in the health care professionals' curricula as a means of providing learner motivation and initial structuring of knowledge for use in health care settings. This initial instruction would be followed by later instruction in the hypothesis-test method of CRP. The question of whether it is necessary or advisable to teach problem solving before hypothesis-test has not been tested empirically. Some learners may be able to generate sufficient numbers of hypotheses regarding patient problems early in the curriculum so that simple problems may be addressed through this more expert-like method. On the other hand, other learners may not be able to utilize the hypothesis-test method until they have completed extensive clinical experience in their chosen fields, and may not use this method until they have completed their formal schooling. Studies of individual differences in ability to generate and test hypotheses may provide insight into the optimal sequencing of CRP instruction (i.e. problem solving prior to the CRP; focusing solely on CRP, or using some other method not yet addressed) for individual learners.

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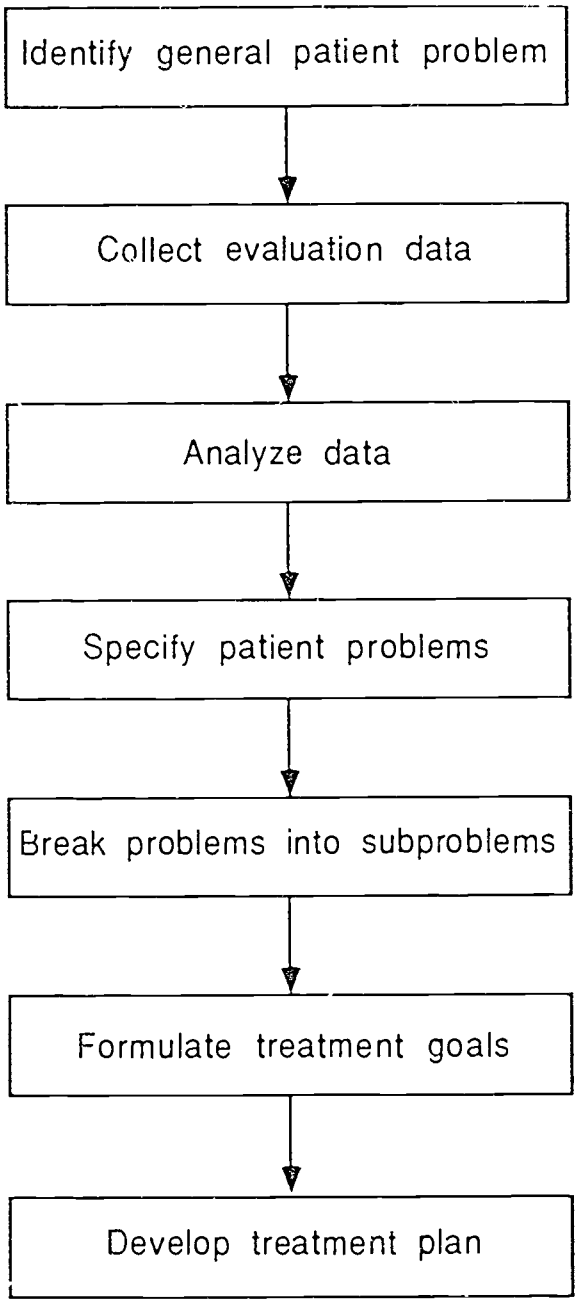

Figure 1. The problem-solving process. Problem solving is presented as a linear process.

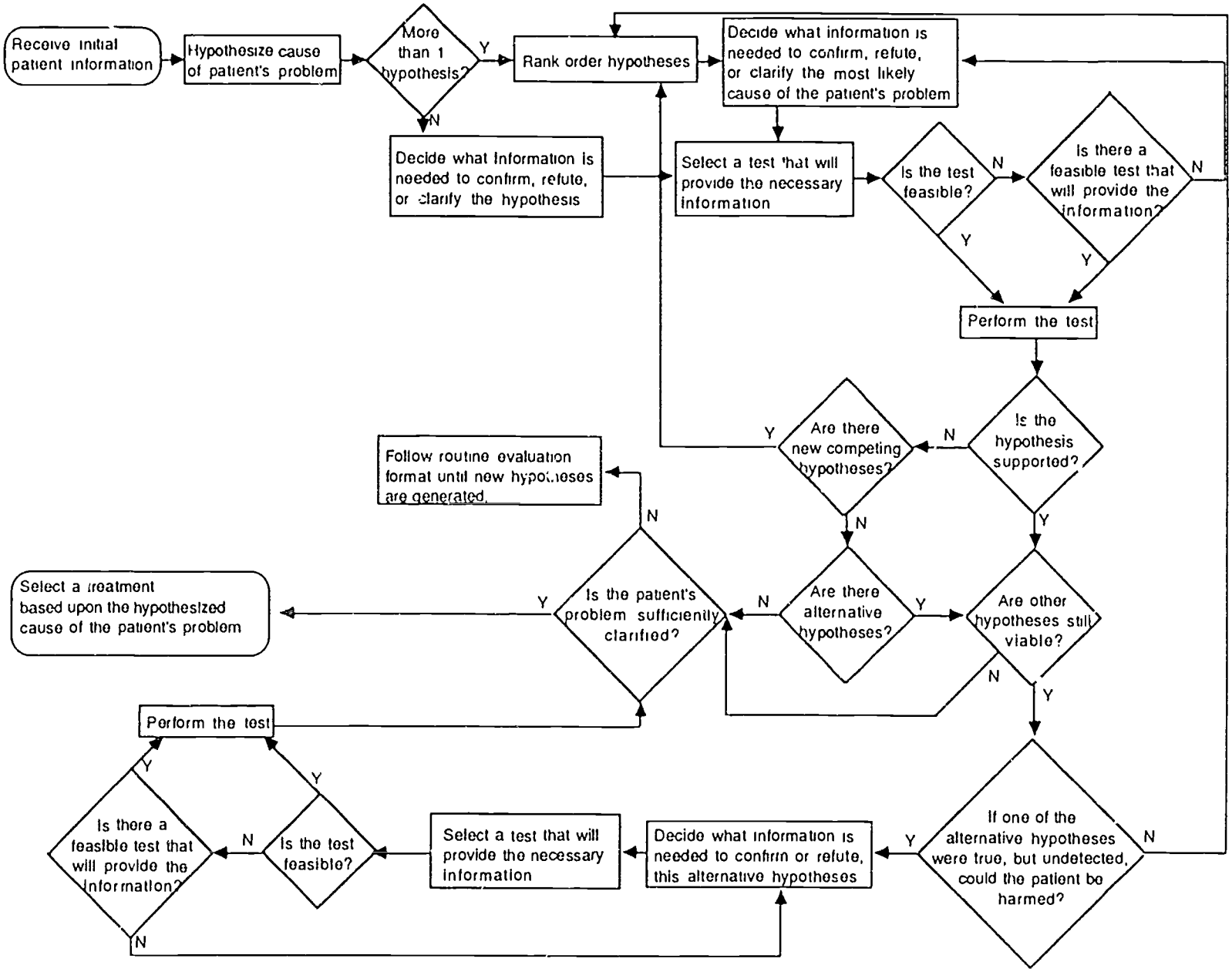

Figure 2 The clinical reasoning process Clinical reasoning is an iterative process in which information from each evaluative procedure affects the selection of the next procedure

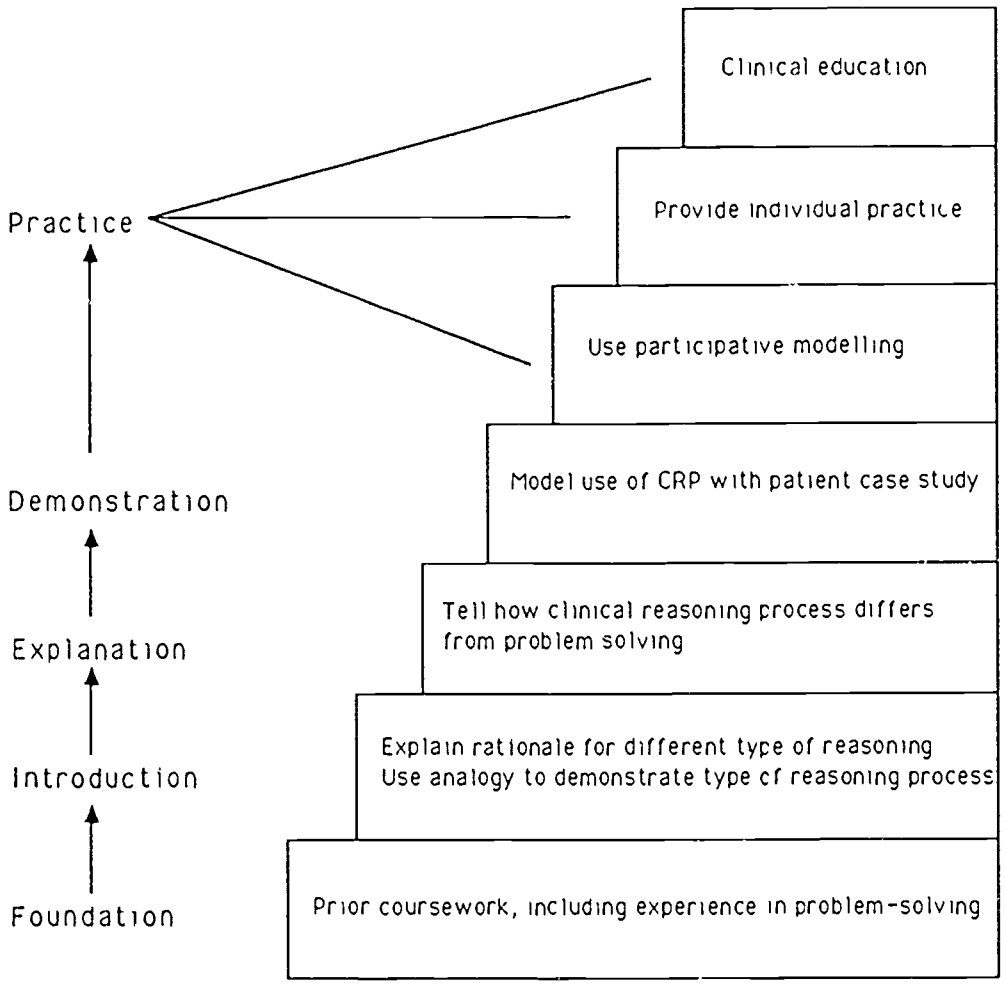

Figure 3 A model for instruction in clinical reasoning Note that this instruction builds upon a foundation of both coursework and prior experience with problem solving