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ABSTRACT

Clinical problem solving exercises for preclinical medical education that were developed at Michigan State University School of Osteopathic Medicine are described. Two types of outcomes were set as priorities in the design and implementation of the problem solving sessions: small group peer interactions as instructional and evaluative resources; and issues relevant to the process of clinical problem solving. The small group discussions focus on three critical issues relevant to clinical problem solving: the multiple dimensions of a health problem (biopathological, psychological, and socioeconomic); the use of a systematic clinical problem solving strategy to resolve these problems; and the documentation of the clinical encounter. It is proposed that educational innovations in clinical problem solving should be grounded in as much theory as possible and that medical students should practice their clinical reasoning processes during their undergraduate years through group discussion of simulated clinical cases. (SW)

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Clinical Problem Solving Exercises  
for Pre-Clinical Medical Education:  
a Design, Implementation and  
Preliminary Evaluation.

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INTRODUCTION AND BACKGROUND

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Essentially, medicine is a profession whose overall goal is to prevent and solve people's health problems.

Recently, much curriculum development in medical education has concentrated upon early and extensive exposure of students to the process of clinical reasoning. In the interest of clarifying for the learner the connection between basic sciences and clinical methods, curriculum developers have devoted increasing attention to providing opportunities for students to observe, discuss and practice the strategies of clinical reasoning in the pre-clinical phase of the curriculum. This commitment is based on the premise that for a medical curriculum to be relevant to students and consequently to patients, it must emphasize both the content and process of clinical medicine, where content is defined by information, and process by strategies to resolve individual health problems.

In the past two years, the undergraduate program in the School of Osteopathic Medicine at Michigan State University addressed this issue by developing a series of instructional exercises in clinical problem solving, the Clinical Problem Solving Sessions (CPSS). Guided by pioneering efforts in the use of simulation techniques in pre-clinical medical education (Barrows, 1971 and 1975; Maatsch, 1974; Wags et al., 1973) and also by the outcomes of the Medical Inquiry Project (Elstein, Siekman and Sprafka, 1973; Elstein and Bordage, in press), two types of outcome were set as priorities in the design and implementation of these sessions: one dealing with the use of small group peer interactions as instructional and evaluative resources, the other emphasizing a few critical issues relevant to the process of clinical problem solving.

The clinical problem-solving sessions are small-group discussions of simulated clinical cases, presented on paper and designed to provide the undergraduate student with: 1) an opportunity to integrate the basic behavioral and clinical sciences as they relate to a person's health problems; 2) a systematic cognitive strategy for exploring and documenting various solutions to these problems; and 3) a non-threatening environment to practice these problem-solving capabilities according to a variety of clinical presentations.

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A typical case is composed of a number of information stems which the students, as a group, reflect upon according to a set of pre-determined questions. These inquiries guide the students in dealing with the critical issues judged relevant to clinical problem solving, such as early diagnostic hypothesis generation and systematic evaluation of clinical data. At different points in the case (such as after the history or the physical), the group is asked to summarize its findings by using such devices as writing up a section of the patient's medical record on the blackboard. At the end of each case a reference list is given that contains the major textbook references related to the case, a supplementary reading list of pertinent journal articles, and an inventory of available audiovisual or simulation materials. A session usually lasts between an hour and a half and two hours.

This presentation is divided into three sections. The first two briefly describe the conceptual framework used in the design of clinical problem-solving exercises. The last section discusses some preliminary results obtained in the implementation and evaluation of these exercises in three Organ Systems courses (genitourinary, gastrointestinal, and cardiovascular) over a two-year period.

### THE SMALL GROUP FORMAT

The implications of using a small group format are twofold: first, it implies a certain number of instructional advantages for the students, and second, it imposes a set of constraints or responsibilities on the faculty that participates as group facilitators.

The primary intent of the small group discussion format is to emphasize and foster experiences that lead to peer instruction and peer evaluation. The small groups provide the opportunity for each student to work with others in a learning situation toward the common goal of solving a clinical problem. Students can share their ideas and feelings with each other as they work together to develop a professional attitude and identity.

Students are encouraged to solve the clinical problems presented in the simulated cases to the best of their knowledge rather than to strive for an expert's solution: i.e., 'Given what you (the student) know, what can you do with your knowledge to work-up this case?' This kind of student independence dictates in turn the clinical instructor's role and responsibilities. These are to facilitate the inter-personal coherence of the group, to monitor the clinical problem-solving process being learned by the students (for example, to achieve a reasonable balance between discussing content and process materials), and lastly, to correct misinformation by stimulating the discussion rather than by providing direct responses.

### THE CLINICAL PROBLEM-SOLVING TASK

The cases are selected according to the topics being presented in the Organ Systems courses, and consequently tailored to the students' current knowledge. The discussions focus on three critical issues relevant to clinical problem solving: 1) the multiple dimensions of a health problem (bio-pathological,

psychological, and socio-economic), 2) the use of a systematic clinical problem solving strategy to resolve these problems, and 3) the documentation of the clinical encounter. Each paper case used in the small group discussions addresses at some point each one of these issues.

Multiple dimensions of a health problem. While most of the problems dealt with by clinicians are of a bio-pathological nature, two other inherent dimensions are especially dear to the patient: the psychological and the socio-economic. A health problem is rarely uni-dimensional and is usually composed of an interaction among these three facets. Thus, clinical problem solving does not end with a problem being labeled or with a prescription being written. To reach resolution, the clinician is urged to consider the individual context in which the health problem occurred.

A systematic clinical problem solving strategy. In solving a health problem, the clinician exhibits three major types of capabilities: affective and communication methods, psychomotor skills, and clinical reasoning. This last category encompasses the clinician's problem-solving strategies and store of medical knowledge. The primary purpose of the exercises is to give the student the opportunity to learn and practice clinical problem solving at a strictly cognitive level, i.e., the thought processes involved.

In analyzing the clinician's thought process, it is often difficult to clearly separate the various components of this process since these are seldom sequential and often occur simultaneously. For our purpose, the process is broken down into a seven stage model derived from the outcomes of the Medical Inquiry Project (Elstein, Shulman and Sprafka, 1978): 1) cue acquisition, 2) hypothesis generation, 3) cue interpretation, 4) hypothesis evaluation, and diagnostic decision, 5) prognosis, problem priority, and complementary investigation decisions, 6) management decisions, and 7) follow-up.

Cue acquisition refers to the process of collecting clinical data. A cue is an element of information pertaining to the patient's bio-pathological or psycho-social condition: symptoms or signs. Hypothesis generation. From a set of cues, the practitioner generates a list of tentative diagnostic hypotheses as possible solutions to the problem. Early generation of diagnostic hypotheses is a major strategy used by the clinician to bound the regions of the potential problem space most likely to yield the solution. The subsequent workup is planned to permit testing and refinement of these early hypotheses. The open-ended, ill-defined medical problem 'What is wrong with this patient?' is thereby transformed into a set of closed, better-defined hypothetical problems, thereby simplifying the problem solving task. The clinician usually explores, at any one time, a maximum of four or five competing hypotheses, considered in some order of likelihood. Cue interpretation involves the retrieval from memory of lists of cues or features which characterize each diagnostic hypothesis. By subsequently and selectively eliciting these new clinical cues, the clinician will revise or further refine the set of diagnostic hypotheses. Hypothesis evaluation. If the cues presented by the patient are compatible with the clinician's characterization of the condition, the hypothesis is retained; if not, the hypothesis is dropped. After a certain number of iterations (depending on the complexity of the problem) the clinician finally selects the most appropriate diagnosis. Before establishing a treatment plan, the clinician

makes three interim decisions: the patient's prognosis, the problem priority in comparison to the patient's other problems, and the need for further data collection or complementary investigation. Then, management decisions are made: "What therapeutic program is best indicated for this problem in this particular patient?" Follow-up. The final step in the proposed strategy is to evaluate the results of the decisions made and the actions taken. If new data are collected or alterations in the patient's condition occur, these must be evaluated and may lead to reformulation of the problem and possibly a change in the diagnosis. Management decisions must also be monitored over time, with each evaluation leading to possible modifications of the treatment plan. The importance of observing the results of one's decisions, both diagnostic and therapeutic, cannot be over-emphasized.

This entire strategy of clinical problem solving continues until the problem is resolved. This may be over a short interval of time in an acute self-limiting illness, or may continue for years without definitive resolution in a chronic ailment.

Documenting the clinical encounter. Whereas the traditional medical record is organized according to the source from which the information originates, the 'Problem Oriented Medical Record' (POMR) utilizes the patient's health problems as its organizing structure (Hurst and Walker, 1972). The problem-oriented approach was recommended for the exercises. Two sections of the POMR are especially emphasized: the 'Master Problem list' and the 'Progress Notes' including the Subjective-Objective-Assessment-Plan subsections.

#### IMPLEMENTATION AND EVALUATION

The particular implementation of these process-oriented exercises into the second year Organ Systems courses at Michigan State was achieved in two phases: first, the faculty was trained to become group facilitators and cases were developed, and then the cases were given to the students.

The faculty training and case development phase was greatly facilitated by the fact that the conceptual framework for these clinical problem-solving exercises had been clearly defined beforehand. The instructional objectives were specific, the student and faculty roles were well delineated, and most of all, the cases reflected the three issues previously described as critically relevant to clinical problem solving. The cases include such diverse conditions as acute cholecystitis, myocardial infarction, hypertension and cystitis. Two classes of second year medical students have now participated in the sessions: groups of ten students were formed each under the supervision of one clinical faculty. A weekly ratio of one or two session(s) proved to be a reasonable balance between content and process materials.

These clinical problem-solving exercises, although not graded, were evaluated as to their educational relevance, their instructional effectiveness, and their influence on small group dynamics. These evaluations, although preliminary, yielded useful information concerning the three main goals of the exercises. The evaluation procedure was based on a twenty-five item attitudinal questionnaire administered to the students after each Organ

systems sequence, debriefing periods at the end of each session, and interviews with the participating clinical faculty.

The overall rating of the project was positive. The single most salient factor best appreciated by the participants was the feeling of having learned a generic reasoning process as opposed to a unique once-and-for-all solution to a particular clinical situation. The analysis of each one of the three goals will better clarify the strengths and weaknesses of the exercises.

Educational relevancy. The paper-simulated cases were perceived as a suitable, and long needed, link between the basic and the clinical sciences. Furthermore, the students, and occasionally the faculty, were motivated to do additional readings or seek other clinical advice. All expressed the need and wish to design more cases for both the second and first years of the undergraduate curriculum.

Instructional effectiveness. Three issues were judged critically relevant to clinical problem solving: the multiple dimensions of a health problem, the documentation of the clinical encounter, and the use of a systematic problem-solving strategy. While the first two issues were judged adequately represented in the cases, there were questions about the third, and most critical issue. These are twofold: the representativeness of all the elements of the problem-solving model in each case, and secondly, the need for a valid and reliable instrument to measure clinical problem-solving capabilities. It was felt that the diagnostic portion of the cases (stages 1 to 4 of the model) was adequate, but that the remaining stages (i.e., prognosis, management and follow-up) were not dealt with in sufficient detail. This latter point was remedied by properly emphasizing these elements in the case questions. Regarding the second concern, the measurement of clinical problem-solving capabilities, the faculty expressed a need to know the extent to which these exercises were actually helping the students to develop their cognitive clinical acumen. This kind of measurement was not systematically explored in the preliminary evaluation of the project because no thorough and easily scorable instrument was readily available to measure the elements of the process depicted in the model. For pre-clinical students, the evaluation should emphasize early generation of multiple competing hypotheses and a focused search for relevant clinical cues (Sprafka and Istein, 1977). While machine scorable formats, including patient-management problems and multiple-choice questions, provide rapid and reliable scores with low demand on faculty time, the feedback to students is too often unsatisfactory. On the other hand, while essay-type or short-answer formats can provide meaningful feedbacks to students and faculty, the scoring is slow and often inconsistent, and the demand on faculty time is often excessive.

Small group format. The non-threatening atmosphere of the small group discussions were highly rated and received positive comments. The participants appreciated the peer learning process fostered in the group format, but expressed concerns about the smoothness of peer evaluation, i.e., the process of debating one's opinion against an opposing one. This latter point further underlines the need to deal with peer professional review at an early phase of the educational process. Finally, although judged positively, both students and faculty had to adapt their instructional expectations to the unaccustomed role of the clinical faculty as a group facilitator, rather than the more traditional lecturer function.

With this preliminary evaluation in hand, four future trends emerged. First, the experience was judged positively enough by the students, the faculty and the administration to warrant the continuation and the further development of similar exercises for the Organ Systems courses. Second, and because of the faculty's expressed needs to improve their competence in preparing cases and facilitating small group dynamics, a faculty training and updating program is being planned. Third, concerns regarding the measurement of clinical problem-solving capabilities led to greater awareness of this measurement problem and is the object of further research. Lastly, this pilot project and its preliminary evaluation has convinced the participating faculty of the need for systematically evaluating the effects of an instructional innovation. This early assessment will not only benefit the overall outcomes being sought, but will also help to monitor, on a continuing basis, the progressive evolution of the project.

#### SUMMARY AND CONCLUSION

Three pedagogical themes were developed throughout this presentation. First, educational innovations in clinical problem solving should be grounded in as much theory as possible. When the mechanics are well understood, the controls are made easier and remediations are often more specific. Second, the medical students should have an opportunity to practice their clinical reasoning processes during their undergraduate years. And third, group discussions of paper-simulated clinical cases can help give the students that opportunity.

Preliminary results in the design, implementation, and evaluation of such clinical problem-solving exercises with a group of second year medical students at Michigan State University have demonstrated effectiveness in achieving such clinical goals at the undergraduate level of medical education.

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