

The Potential for Problem-Based Learning in Pharmacy Education: A Clinical Therapeutics Course in Diabetes

Richard C. Fisher¹

United States Public Health Service, Shawnee OK 74801

Problem-based Learning (PBL) is an alternate method of instruction that incorporates basic elements of cognitive learning theory. Colleges of pharmacy can utilize PBL to aid anticipated learning outcomes and practice competencies of entry level pharmacists. Traditionally, PBL is taught in a small group environment, by a facilitator or tutor, and requires active learning. A course in PBL relates basic knowledge to applied knowledge while building mental models in long-term memory that are easily retrieved. Learning, in this manner, enhances cognitive skills required during critical thinking, fundamental reasoning, sound decision making, and problem solving. The key elements to the interdisciplinary course in Diabetes Mellitus (DM) are objectives that prompt the students to develop or reformulate declarative and procedural knowledge in such a way that students' cognitive strategies are enhanced. This article provides a comprehensive review of the fundamentals of problem-based learning and describes a program design for teaching diabetes therapy using PBL.

INTRODUCTION

The recent debate over the change in the mission of pharmacy practice to pharmaceutical care has brought to focus the practice competence of entry level pharmacists(1). Pharmacists will be involved in expanded patient care responsibilities which require graduates to possess enhanced communication skills, greater problem-solving capabilities, ef-

fective critical thinking abilities, and sound decision making skills.

Pharmacy educators will play a significant role in developing the knowledge, skills, and abilities needed to practice pharmaceutical care. Curriculum modifications and various instructional strategies will have to be considered to facilitate the learning outcomes needed to practice pharmaceutical care. One such instructional strategy and/or curriculum model is Problem-based Learning (PBL). The purpose of

¹ *Corresponding address:* 14 Tyler Lane, Shawnee OK 74801

this paper is to show the potential for PBL in pharmacy curriculum and to provide a model design of a syllabus that contains course objectives and learning outcomes that promote the knowledge, skills, and abilities needed to practice pharmaceutical care in the management of diabetes.

PROBLEM BASED LEARNING—INSTRUCTIONAL STRATEGY OR CURRICULUM MODEL?

Current philosophy regarding Problem-Based Learning (PBL) in schools of medicine range along a continuum between instructional strategy and comprehensive curriculum model. Some medical schools have designed the entire curriculum to follow a PBL format (Harvard, McMasters), others have incorporated a dual track program (University of New Mexico), or have incorporated PBL as an instructional strategy for learning specific disciplines within the curriculum (Dartmouth).

Used in any setting, PBL offers teaching and learning methods that are based on cognitive science and pedagogy. Table I identifies the basic components of Problem-based learning. A report drafted from a symposium of the World Federation for Medical Education reviewed basic components of PBL(2). The authors state that PBL has the potential to integrate the basic sciences with clinical practice as the two are studied together. The interdisciplinary learning process can elaborate the cause and effect relationship of sound clinical decision-making.

The strengths and weaknesses of each position have been debated(3-5). A study by Patel, Groen, and Norman compared several learning outcomes of students in two medical schools, one using a conventional curriculum, and the other, a PBL curriculum(6). The paper presents results of a comparative study of two Canadian universities, McMasters University, which has an established problem-based learning medical school and McGill University, which has what is called a traditional curriculum. The results showed that basic sciences are best taught by conventional curriculum and the integration of clinical medicine should be taught in a PBL curriculum model. The results also lean towards PBL being an effective way to enhance cognitive strategies, a more efficient means of developing usable mental models or schema stored in long-term memory, and a more proficient facilitator of working memory (retrieval/response generator for long-term memory).

An instance where PBL is used as an instructional strategy is in a neurobiology course at the University of Colorado School of Medicine. The course was designed and implemented due to poor evaluations given the previous lecture/laboratory course(7). Clinical cases used for the basis of discussion and learning were videotaped examinations of real patients, presenting only subjective findings with no explicit information about the nature or location of the disorder. The student evaluations indicate that the neurobiology course went from the least liked to the most liked after the shift to the PBL format. Comparison of student performance on National Boards showed that test scores for neurobiology questions were lower than that of non-neurobiology questions prior to the shift to PBL. Following the change to PBL, test scores on neurobiology questions were higher than that of non-neurobiology questions. Although the findings were statistically significant in only one of four academic years involved in the study, the comparison of scores for years following the shift to PBL were appreciably

Table I. Elements of problem-based learning

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- Active learning organized around problems
 - The problem is solved without prior study or knowledge of the subject
 - Solving problems prompts the acquisition of knowledge
 - The problem is most often presented as a case study (real cases; simulated patients, video taped or on paper)
 - Uses minimum amount of lecture time, only to present the problem
 - Uses a “tutor” (expert or non-expert) as a facilitator of the discussion of the problem
 - Faculty members are used more as resources for investigation into the knowledge surrounding the problem
 - Learning declarative and procedural knowledge in a setting similar to where it is to be applied. Requires and/or develops cognitive skills as knowledge is being structured into long-term memory.
 - Creates better retention of knowledge, learned over time
 - Evaluation of students taught by PBL format is best accomplished by performance tests rather than traditional written examinations (true/false, multiple choice, or matching); Objective structured clinical examination (OSCE)
 - Hardin & Gleeson, Skills tests
 - Maastricht, Progress tests or Knowledge Test of Skills (KTS)
 - van der Vleuten
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higher when adjustments for changes in national performance were made using the national average as a threshold measure.

A recent article by Duncan-Hewitt describes a pharmaceuticals course delivered by PBL format(8). The course is designed to provide integration of fundamental knowledge and practice by introducing real problems of drug formulation into the classroom and laboratory. Students work on case problems in small groups. Resources consist of a reading list and reference notes for students to work with. The author reports that the critical portion of PBL course design is the development of the case problems. The author concludes that identification of the difficulties associated with the use of PBL in a pharmaceuticals course does not appear to outweigh the benefits afforded the learning process.

Other experiences with PBL in pharmacy education are documented in the literature(9, 10). One such instance is described by Pawlak, Popovich, Bland, and Russell, where the Guided Design technique is used to deliver PBL instruction in a Self Care Pharmacy Practice course. The method utilizes written case scenarios that are simulations of real life occurrence, distributed to the students in the class. The Guided Design technique contains the components of PBL, yet adds an additional element of control of the learning process. The instructor or facilitator of the course “guides” the students through the problem-solving sequence of each scenario by providing printed feedback to students at various steps in the problem(11). This method of active student learning offers an efficient means of meeting course goals and objectives due to the ability to limit the students tendencies to stray from the desired path towards the solution.

Table II. Problem-based learning educational outcomes

- Increases retention of knowledge over periods of up to several years yet, initially, may cause reduced levels of learning.
- Enhances both transfer of concepts to new problems and integration of basic science concepts into clinical problems
- Creates higher intrinsic interest in the subject matter by the students
- Enhances self-directed learning skills that can be maintained throughout ones professional life
- Problem-solving skills related to a content specific domain, are enhanced but PBL does not improve general, content-free, problem-solving skills.

^aCompiled from reference #17.

COMPONENTS OF PROBLEM-BASED LEARNING

The elements of PBL are designed to meet educational goals and objectives that extend beyond mere acquisition of declarative and procedural knowledge. The implications for such instruction are well documented in the medical literature(12-14). The need, and subsequent application for such an approach to learning for entry level pharmacists is discussed in several articles by Strand and colleagues(15, 16). Comparative studies of PBL versus traditional instructional methods to assess the ultimate validity of PBL are needed. An article by Norman and Schmidt discusses PBL and offers a synthesis of the advantages and disadvantages of PBL based on fundamental psychological constructs(17). The five basic elements of their synthesis are shown in Table II. These aspects of PBL instruction can provide educators with a guide to expectant educational outcomes when using a PBL instructional model.

To fully appreciate the power of PBL method of instruction, some fundamental distinctions of problem-solving skills, solving problems, and problem-based learning need to be made. These aspects are related to theory guiding expert performance(18). Solving problems incorporates a hypothetico-deductive reasoning where a series of hypotheses are tested mentally on unknown solutions to the problem. The process can be carried out with a minimum of content specific knowledge, yet is a more efficient process when the problem solver possesses a rich knowledge base.

A contrast to the pure form of solving problems is when experts are confronted with a task that requires a solution or decision. An expert uses forward reasoning, or inductive mental strategies to develop a solution. Due to the contextual relationship of the problem to some previous experience, the expert practitioner quickly and effectively accesses memory stores to develop a solution (diagnosis, procedure, or therapy).

Problem-based learning's major premise lies in the development of an effective, readily accessible knowledge base stored in long-term memory, one that allows for easy retrieval of content knowledge through cognitive strategies found in working memory. Where general problem solving skills are developed over the entire educational experience of an individual, they are just one of several components of a person's cognitive skills (methods of accessing long-term memory). Cognitive skills are also essential for learning, inventive thought, decision making, and efficient mental management or metacognition. Problem-based learning also allows knowledge to be learned in the context in which it is

to be applied. The process is proven to create a knowledge base that is remembered or recalled better than information learned by more conventional, rote learning methods(19).

The use of PBL as an instructional strategy creates problems for students when they experience the two distinctly different methods of instruction (conventional or PBL) together in one curriculum. Students have reported confusion and frustration due to the different manner of information processing each method entails(7). One aspect that is difficult for students to accept is the amount of active learning they are required to engage in during a PBL course. Conventional courses and PBL courses that exist in the same curriculum should be accompanied by specific considerations that address the difficulties that may affect the learners, such as incorporating an orientation prior to PBL encounters(20, 21).

One must also differentiate between case study method of instruction and PBL methods. For example, a course that does not present the relationship of basic knowledge to applied knowledge in the solution of the case problem(s) is not following essentials of PBL instruction. In most instances of PBL, the problem is encountered initially without prior study of the subject. Case study method of instruction works through problems utilizing previously learned content specific knowledge. The pure form of PBL instruction is learning both basic knowledge and applied knowledge by active learning, solving a clinical case, and often by using simulated patients. One could easily reduce a PBL course to simple case study method of instruction if integration of basic science knowledge with applied knowledge is not included in the course objectives.

Ways to insure that fundamental concepts of PBL are directing the learning strategy are to: keep the students engaged in active learning, hold students responsible for the entire knowledge base that applies to diabetes, use a facilitator of knowledge (tutor) rather than presenter of knowledge, and design a variety of clinical scenarios that can be extended into chronic follow-up care and treatment. Whether PBL is used as an instructional strategy or guides the entire curriculum, students who participate in a PBL environment develop enhanced problem solving skills, sound reasoning, and critical thinking capabilities. Research is still needed to further assess the distinctions between the different applications of PBL.

TUTOR PARTICIPATION IN PROBLEM-BASED LEARNING

An essential component of "pure" PBL is the use of a tutor to lead and direct the course(22). Problem-based learning can place high demands on faculty members' time and support. For faculty members to take on the task of PBL course design and implementation, an enormous amount of time and commitment is required to see the entire learning process to the end stage. Faculty development programs have been designed to assist in the transition from a conventional curriculum(23). Tutor training is included in the orientation to PBL curriculum.

A tutor in a PBL course is not the provider of the knowledge but a facilitator of active learning by the student. Faculty members report difficulties in making the transition from lecturers to facilitators. Subject experts take the role of resource persons for students as they actively search for the knowledge to solve the problems. Facilitators need not be content subject experts. Subject experts are reported to be

less effective facilitators as they have a tendency to provide the knowledge and solutions to the problems, creating a passive learning environment for students(24). Subject experts speak more often and for longer periods, provide direct answers, and suggest more topics for discussion. The tutor to student exchange predominates when the tutor is a subject expert and the tutor predominate exchange is also identified as a deterrent to effective PBL.

One method used to assist instructors to function as facilitators is to engage in role playing(25). The instructor takes on the role of the patient and the instructor is interviewed by students in small groups. The students are allowed to direct the discussion, define and complete tasks, and generate the knowledge to be learned. Still another source for tutors or facilitators is by using graduate students. With proper orientation, they can function as facilitators in PBL courses in pharmacy schools. The faculty are then called upon to be resources for the students' inquiry of knowledge during designated office hours. Regardless of who is to be employed as the tutor, faculty development programs are strongly recommended when PBL is introduced into the curriculum.

IMPLICATIONS FOR PBL IN PHARMACY SCHOOLS

To what extent would PBL be best incorporated into a pharmacy curriculum? Initial investigation begins with a review of the content knowledge that is taught in colleges of pharmacy. Pharmacists in practice are required to know an extensive amount of declarative knowledge and are often called upon as resources. Physicians, nurses, patients, and other health care professionals rely heavily upon pharmacists for quick, precise information concerning drug products, drug strengths, dosage forms, and specific doses. Instructional strategies, such as lecturing, can cover a great amount of declarative knowledge and deliver it to a large quantity of students during class periods.

As pharmacy practice incorporates a greater patient care component, pharmacists will be held responsible for identifying and solving higher order clinical problems or encounter patient care problems that will require critical thinking skills and precise decision making abilities. Pharmacists will be involved in the clinical treatment of patients (pharmaceutical care) that requires more detailed communication with patients and health care providers. This expanded professional interaction will require pharmacists to utilize effective problem solving skills. Implementation of PBL into colleges of pharmacy has potential for preparing entry level practitioners to be successful in the future changes of pharmacy practice. The potential for a course in clinical diabetes therapy following PBL format in a college of pharmacy will be outlined.

Unlike physicians, whose major professional functions are to solve problems of a clinical nature, pharmacists practicing in traditional retail pharmacy settings do not have an extensive role in clinical problem solving. The future of pharmacy practice is bound to change the pharmacists' role. A declarative and procedural knowledge base that includes extensive drug product information is critical to the pharmacy practitioner. Colleges of pharmacy can meet the learning outcomes of the declarative knowledge component that pharmaceutical care demands, by incorporating variations of lecture methods and other active learning strategies into pharmacy curriculum courses. However, traditional phar-

macy courses that lend themselves to PBL instruction include over-the-counter products, pharmacotherapeutics, pharmacy administration, toxicology, pharmacy practice, and clinical pharmacy. A PBL course in basic or pharmaceutical sciences, such as biochemistry, pharmacology, pathology, medicinal chemistry, would be difficult to design without incorporating basic knowledge into a problem-solving model of applied pharmacy practice.

Restricting the use of PBL to upper level professional degrees and graduate level courses will not meet the needs of educators, the learning outcomes for entry level students (regardless of degree designation), and the patients served by pharmaceutical care. A somewhat unique approach for the use of PBL is to design a course in pharmacotherapeutics that would focus on a specific disease state (hypertension, congestive heart failure, diabetes). A course structured in this manner is a novel concept for undergraduate education, as pharmacists currently learn about drug therapy of a disease condition as portions of different courses (pharmaceutics, pathophysiology, toxicology, and therapeutics) often taught by lecture or case study methods of instruction. Learning about each scientific discipline of Diabetes Mellitus in one course presented in the framework of problem-based learning format offers enormous potential for teaching specific learning outcomes required of pharmaceutical care. Some medical schools have offered a similar approach towards PBL in basic science subjects like pharmacology(26) and neurobiology(6) as well as clinical practice courses, health promotion disease prevention(27) and surgery clerkship(28), but have yet to develop courses that focus specifically on a disease state.

A course following a PBL format, where the outcome is a working knowledge of a disease state and its treatment, would allow for in depth investigation of how basic sciences and pharmaceutical sciences contribute to the study of diabetes. The issues that surface from an approach such as this are: (i) where is the course placed in the curriculum; (ii) can students learn content specific knowledge of all the basic sciences (pathology, physiology, pharmacology, and biochemistry) from a course in Diabetes Mellitus; and (iii) what becomes of the courses in the basic biomedical sciences, are they deleted from the curriculum or is the material on diabetes deleted from the basic science course. These curricular issues need to be addressed prior to implementation of PBL into colleges of pharmacy.

One consideration is where the course will be placed in the curriculum. Pharmacy students could benefit from a course of this type in the first or second professional year yet PBL would cause problems for students if offered during conventional pathophysiology, pharmacotherapeutics, or pharmacology courses. Medical schools that incorporate PBL have the luxury of teaching first year students that possess a comprehensive knowledge of the basic sciences, as most students enter medical school with a bachelors degree in a basic science. Medical students approach the clinical case problems in the PBL course with a greater degree of prior knowledge of the basic sciences than pharmacy students, yet still require reformulation of basic science knowledge into a problem-oriented mental model. The presence of prior knowledge of the basic sciences diminishes the strengths of PBL. As mentioned earlier, one of the basic components of PBL is the ability to structure a working knowledge of the basic sciences within the context of clinical

case problems. Where the students possess a lesser amount of prior knowledge of the basic and biomedical sciences, a more fundamentally pure model of PBL could be implemented. This does not mean that traditional lectures are inadequate at conveying knowledge, but traditional lectures are not as effective in the formulation of working knowledge (mental model stored in long-term memory) that is structured in the context of a pharmaceutical problem.

A pharmacotherapeutics course in diabetes could not be expected to substitute for the basic biomedical science knowledge currently being offered in colleges of pharmacy. The elements of entry level pharmacy practice and pharmaceutical care(1), as well as theory guiding the acquisition of practice competence and expert performance(29) supports the premise that professional practice requires content specific knowledge as well as problem-solving skills. However, biomedical science courses expose students to what is commonly referred to as information overload as the subject content of these sciences is ever expanding(4). The amount of information required to be presented in these courses is best suited for lectures. Yet the attempt to offer the most information in the shortest time so to be able to "cover the ground", limits students' capacity to absorb, retain, and use the information in professional practice arenas. Can PBL provide a sufficient level of content specific knowledge of the basic and biomedical sciences to allow the entry level pharmacist to meet the demands of pharmaceutical care? Problem-based learning curriculum would have to include a number of disease states, not just diabetes, to encompass a greater scope of basic and biomedical sciences.

Lipman discusses some curricular issue of educating pharmacists for clinical training and distributive services(30). He points out that as early as 1971, a workshop on clinical pharmacy practice and education addressed the educational concerns of pharmacy practice. At the meeting, Dean Linwood Tice of the Philadelphia College of Pharmacy offered a perspective that addressed the curricular issue between pharmaceutical sciences and pharmacy practice. He stated: "over the years and under well meaning influence of pharmaceutical scientists, the curriculum has become considerably removed from the needs of pharmacists in practice and far too much an undergraduate preparation for graduate study." Today's clinical pharmacy practice faculties have made a significant impact on this issue. Does PBL have a place in the debate? Problem-based learning would appear to be able to meet the demands of pharmaceutical care with regards to pharmacy practice concepts, but has yet to be specifically evaluated in pharmacy education. In those medical schools that offer an entire curriculum following a PBL format, the basic sciences are not presented in traditional lectures. Faculty members function as resources for students in their quest for solutions to the clinical case problems. What PBL offers pharmacy education is the ability to free biomedical science faculty members from the demands of lectures and traditional instruction, allow more needed time for research programs, as well as provide the opportunity for interdisciplinary approach to pharmacy education. Compared to traditional curriculum models, the literature indicates that the students knowledge of the basic sciences are not as comprehensive when learned in a PBL curriculum but the knowledge learned is retained to a greater degree(4, 6). Whether a PBL clinical diabetes course, and other courses structured similarly (hypertension, congestive

heart failure, cardiology, infectious diseases, etc.) could replace conventional curriculum courses in colleges of pharmacy remains to be seen. However, implementation of PBL models into pharmacy education should be accompanied by properly designed educational research.

EVALUATION OF STUDENTS FOR COURSE GRADE

Testing of students in a PBL format uses a somewhat different approach as the recall of knowledge from PBL versus conventional courses follows different elaborate mental models and schema. Examinations that require recall of knowledge from long-term memory using the enhanced cognitive strategies developed by PBL is the goal of many testing procedures employed by PBL courses. Many examinations of this type are performance tests(31) or progress tests(32). Clinical educators offer drawbacks to tests that follow these formats. Performance tests in a clinical environment are often lab simulations with hands on performance which are awkward, cumbersome, and time consuming to implement. Van Der Vleuten, Van Luyk, and Beckers designed and validated a written test, Knowledge Test of Skills (KTS), that provides course evaluation of procedural knowledge and requires students to apply upper level cognitive strategies to answer questions in much the same manner that they would use to perform clinical evaluations, diagnosis, and treatments(33).

A written test for use in the above described PBL course in clinical diabetes is preferred over performance tests as little to no patient simulation has been employed during instruction. A test that follows the KTS model should be implemented as the major method of student evaluation of the course. A course that requires student participation in active learning and class discussion will require some subjective evaluation of the student. A combined formula of a written test along with a subjective component can result in a valid letter grade for students in a PBL course of this type.

PBL APPLICATION TO A COURSE IN CLINICAL DIABETES THERAPY

The course outlined below has yet to be presented in a college of pharmacy and offers a somewhat different approach towards the use of PBL that requires consideration of the curricular concerns mentioned above. The course goals and objectives will be met through procedural problem solving of four cases and follow-up evaluation of long-term management of each case (see Appendix A). Students will document the responses to course goals and objectives as they develop the solutions. The class will report on the findings by small group presentation followed by class discussion. Class will meet at its scheduled time for those students who need assistance. Case reports will be held until the last class periods of the semester.

The actual problems the students will confront consists of the management of patients' clinical cases (see Appendix C). Information will be limited to the initial clinical findings (subjective and objective data). As the case develops, the student will be required to respond to the solutions that they, themselves provide during the course of managing the patient's problem and treatment. In meeting the course objectives, the students should focus on the specific topics identified in Appendix B. Below are seven procedure guides to be followed for each case. The student should work through each case in search of the solutions to the tasks

listed below. Relate each concept below to each case and include related findings significant to each particular case.

1. Identify the elements leading to a diagnosis of Diabetes Mellitus for the patient, and how the diagnosis was determined (laboratory, symptomology). Discuss the diagnosis and present pertinent, objective clinical evidence of the diagnosis. State and elaborate on the clinical assessment of the patient's condition.
2. Relate the patient's clinical situation to fundamentals of carbohydrate metabolism—this should be done for each follow-up patient scenario and complications that occur.
3. Identify all possible treatment regimens available for the patient. For each treatment plan; relate the mechanism of action for each agent to carbohydrate metabolism; identify and compare the properties of each type of insulin and each type of oral agent; generate possible drug interactions that might occur during treatment, provide an alternative to the interaction, and offer the pharmacological mechanism of the interaction. Identify potential side effects of therapy for each agent and elaborate on the strategy used to combat problems that might occur during therapy.
4. Determine the most effective approach to therapy for the patient and offer the justification for your determination. Formulate a treatment plan for patient at initial visit, and discuss follow-up treatment plan for future visits.
5. Explain the rationale of therapy for the patient throughout the follow-up scenarios and provide a clinical assessment of patient at each follow-up. Identify complications of therapy or treatment failures and the biochemical mechanism for such conditions as they arise. Formulate adjustments in therapy as indicated and provide basis for such adjustments with clinical data.
6. Discuss the pertinent dispensing information, patient education, and extent of counseling that should be provided to the patient as a portion of the pharmacotherapy.
7. For each case, elaborate on various socio-economical implications of the disease that may exist for the patients; *i.e.* side effects of medication, physical and behavioral limitations associated with the disease, impact on quality of life the patient may experience for both controlled and uncontrolled diabetes.

Each distinct course objective (see Appendix B) requires the student to develop a procedural knowledge of diabetes. Certain declarative facts and data concerning diabetes will be obtained during the completion of the course objectives. The acquisition of declarative and procedural knowledge in a problem-based format will provide the student with a comprehensive working knowledge of diabetes. Student will develop enhanced access to and retrieval of specific knowledge concerning diabetes that is stored in long-term memory. Problem-based learning facilitates the use of contextual reasoning and elaboration that enhances the richness of representations in long-term memory, that are identified to be efficient cognitive strategies for problem solving.

Am. J. Pharm. Educ., 58:183-189(1994); received 11/24/92, accepted 3/18/94.

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APPENDIX A. COURSE TOPICS

1. Biochemical mechanisms relate to the treatment of diabetes; Krebs cycle, gluconeogenesis, glycogenolysis, glycolysis, gluconeogenesis, ketogenesis, lipid metabolism, protein metabolism.
2. Classification of Diabetes. Type I and Type II, Maturity onset diabetes, diabetes in pregnancy non-obese and obese Type II
3. Diagnosis and prognosis. Signs and symptoms, laboratory evaluation, long-term complications and management.
4. Treatment and Monitoring. Goals of therapy, diet, insulin use, exercise, oral anti-diabetic drugs,

APPENDIX B. COURSE GOALS AND OBJECTIVES

The course goals and objectives will be met through procedural problem solving of four cases and follow-up evaluation of long-term management of each case.

1. Understand the role of carbohydrate metabolism and diabetes; identify the biochemical aspects of diabetes in relation to specific case problems and complications of treatment management. Identify the basic mechanism of action of insulin and oral hypoglycemic agents and where in the biochemical process of carbohydrate metabolism does each pharmacological agent interact.
2. Classify the different types of diabetes based on diagnostic criteria.
3. Identify the pharmacological and non-pharmacological treatments for diabetes.
4. Discriminate between the types of insulin available and the therapeutic indications, contraindications, potency, precautions, onset and duration of action, adverse reactions, for each case.
5. Differentiate between the different oral hypoglycemic agents, their potency, onset and duration of action, side effects, contraindications, and precautions in therapy of diabetes cases.
6. Generate a specific treatment plan for each different clinical case of diabetes.
7. Adopt clinical strategies for treatment and long-term man

agement of diabetes cases.

8. Identify various methods of patient monitoring of diabetes and administration of treatment.

APPENDIX C. CLINICAL CASE SCENARIOS FOR PBL OF DIABETES

Case #1

A well nourished 19 year old female is seen in the clinic complaining of fatigue and weight loss for a period of 6 weeks. Patient also complains of some anxiety since her recent enrollment in college. The patients past medical history is unremarkable. Family medical history is negative for diabetes, hypertension, stroke, and cancer. Physical examination is within normal limits. Her weight is 54 kg, and is 5'6" tall.

Follow-up visit two weeks later—The patient presents at the clinic with urine test results from home monitoring and states she feels a bit better but still complains of nocturia 1-2 times a night.

Follow-up visit two weeks later—The patient presents at the clinic with urine test results from home monitoring and states a decrease in nocturia and energy level has begun to return to normal. The morning and mid-morning urine tests are elevated.

Case #2

A 14 year old patient is hospitalized with symptoms of fever, weight loss, polydipsia, polyuria, easy fatigued, and documented upper respiratory infections times 3 over last two months. Physical exam show some chest congestion and SOB. Temperature of 101.5 F.

The patient returns to diabetic clinic on a 6 months follow-up and has only rare hypoglycemic reactions that are associated with skipping meals. He wishes to participate in organized athletic events in school and needs physical exam and permission to participate. Current doses of insulin are 9U Reg/16U NPH in the morning and 6U Reg/6U NPH in the evening. FBS before meals range from 140-160 mg/dl.

Case #3

A 57 year old moderately obese male was referred to diabetic clinic after routine urinalysis showed presence of glucose. Patient denies polyphagia, polyuria, or polydipsia. Medical history documents recurrent bouts of monilial infections and hypertension treated with medication. Family history of obesity and a brother who died of heart problems at the age of 60.

The patient presents at the clinic 6 months later with complaints of extreme fatigue, admits to not following the diet prescribed. Patient complains of nocturia and increase intake of fluids. Blood pressure reading is 140/100 and has been slightly elevated by home blood pressure readings recently.

Case #4

A 28 year old white female presents at the clinic for annual gynecological exam and lab determines glucosuria upon urinalysis. Patient's medical history is unremarkable, family history indicates her father has been a diabetic "as long as she can remember". Patient weighs 130 pounds, is not on birth control, and is looking to start a family soon.