Improving Pharmacology Teaching and Learning: Examination of a Medical Pharmacology Course

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ABSTRACT
The discipline of pharmacology is both expanding and changing; the number of medicinal drugs available is growing. In the Mexican pharmaceutical market there are over 7,500 medicinal products, yet physicians prescribe 50 to 60 of these. The purpose of this work is to analyze recent modifications to a program in pharmacology for 2nd year medical students at the School of Medicine at National University of Mexico (UNAM) and propose teaching strategies to enhance learning of the contents of the pharmacology curriculum. The previous version of the program included nearly 190 drugs from which 47 drugs have not been included in the present program. The “new” program includes the study of more than 260 drugs, of which 134 are new additions.

We suggest: a reduction in the number of entities to be reviewed, highlighting first choice drugs, making correlations with drugs included in the program and the National Essential Medicines List (Cuadro Básico de Medicamentos) and we propose exercises to make the information to be taught and learned more meaningful to medical students, including the search for information about “place in therapy”.

INTRODUCTION
In medical education, teaching pharmacology represents an evolving challenge. This young science has incorporated solid foundations from physiology into its knowledge base and grown complex with biochemistry, cellular biology, clinical medicine and more recently, genomics. Pharmacology provides the basis to reach the ultimate goal of delivering effective and safe therapeutic agents to the patient. The development of effective methods to instruct the medical student with principles of pharmacology that lead to adequate therapeutics has been a great concern for decades. The rapid and ever-expanding nature of pharmacology makes it difficult to keep up with the pace of an increasing body of knowledge that is not only enormous but also elaborate, due in part to the fast development of related sciences.

The 1970 edition of Goodman and Gilman’s, The Pharmacological Basis of Therapeutics, covered nearly 1000 drugs; the 1980 edition, 1300 [1] and in the latest edition, 2005, more than 2000 entities are covered [2]. Over 7500 medicinal products exist in the Mexican pharmaceutical market [3], yet it has been estimated that physicians prescribe 50 to 60 drugs [4]. It is, therefore, necessary that medical students be well informed and acquire the necessary tools to choose among the different alternatives of treatment, the one that suits best his/her patient in terms of efficacy, safety, convenience and cost, and that he or she develops the strategies to keep him/her updated. In the U.S., some of these responsibilities are now shared by pharmacists.

Some of the efforts made to improve the teaching of Pharmacology have included changes in the content of the courses, such as reduction in the number of drugs to be reviewed, modifying the orientation of the information, adding more courses related to pharmacology and therapeutics to the medical curriculum, implementing novel strategies to teach (such as problem based learning) and introducing concepts to promote rational use of drugs [1,2,4-6].

At UNAM medical students take the pharmacology course during the 2nd year as is the case in most U.S. schools. It is a year long course with a duration of 40 weeks, 160 hours devoted to lectures and 160 hours assigned to laboratory simulations and exercises. During the 3rd year, a complementary course is offered, centered mostly in therapeutics.

The objective of this work was to analyze recent modifications made to the pharmacology contents of the medical school curriculum at UNAM, with the following purposes: 1) to evaluate critically the modifications made to the curriculum both quantitatively and qualitatively, 2) to propose recommendations for exercises that could facilitate an approach to the information to be learned and 3) to generate suggestions for future modifications to the contents of the pharmacology course.

METHODS
The number of drugs listed in both programs, 2004/05 and 2005/06, were compared to detect differences. Drugs listed in the program 2005/06 were subject to analysis through Drugdex of Micromedex, specifically regarding its Place in Therapy. The Essential Drug List in Mexico or Cuadro Básico de Medicamentos del Sector Salud was reviewed to determine the number of drugs in the program 2005/06 which are included in the Cuadro Basico.
RESULTS AND DISCUSSION

The 2004/05 program listed 189 drugs, 266 drugs were listed in 2005/06. These differences include 134 drug additions to the present program and deletion of 47 (Fig.1).

In the 2005/06 program, the number of drugs to be reviewed each week ranges from 0 to 28. The weeks when no drugs were reviewed were those assigned to General Principles or Pharmacokinetics. The weeks with the highest number of drugs to be reviewed corresponded to the topics of Drugs acting on Pain and Inflammation (25 drugs) and Pharmacology of the Endocrine System and Metabolism (44 in total, 28 in a week).

Figure 1. The left bar shows the number of drugs listed in the program 2004/05; 189 is the total number of drugs listed, of these, 47 were not included in the 2005/06 program. The right bar shows the number of drugs to be reviewed in the program 2005/06; 134 are new additions.

Most of the drugs included in the program are intended for medicinal use, only a few are endogenous compounds and ~20 are toxic substances. The new program organizes the list of drugs to be learned under "Pharmacology of Systems" and "Toxicology Principles" instead of the previous organization that listed drugs and classified them by its Mechanisms of Action. The information is not arranged hierarchically, each drug appears equally as important as others.

Some drugs newly listed and which possess therapeutic indications are not drugs of choice or do not offer advantages over other drugs listed in previous versions of the program. In a few cases, i.e., acarbose, pioglitazone, etc., drugs are only alternatives or complements to other preferred drugs in the treatment of common diseases. Although their mechanism may be of interest, a complete pharmacological description may not be needed to begin the third year of study. In other cases, such as clofibrate, methicillin, etc., drugs have been replaced by safer and more effective drugs.

More than 50 drugs (to be used in therapeutics) listed in the program 2005/06 do not appear in the Essential Drug List (Cuadro Básico de Medicamentos del Sector Salud) for the three levels of medical attention (1st through 3rd) [11].

Several authors have proposed a reduction in the number of drugs to be taught in medical pharmacology courses to enhance learning and retention of information. Riley [1] decreased the number of drugs from 500 to 200 in a medical pharmacology course and proved that this reduction did not adversely affect the performance of graduates on nationwide, standardized examinations. Previously, Chernick [7] had shown that emphasizing structured guidance throughout the four-year curriculum of a list of 50 drugs that students needed to master, improved their scores on examinations related to those 50 drugs. The "Core Curriculum" in some British medical schools includes about 120 drugs that are considered the most important to learn [5,6]. Many schools around the world have adopted Problem-Based Learning in the teaching of Pharmacology, avoiding teaching and learning long lists of drugs, which has proven to be effective not only in terms of problem solving skills but also in learning of factual knowledge [11].

The organization of the drug list in the new program at UNAM is more medically oriented than its previous version since it arranges the list of drugs to be learned under "Pharmacology of Systems" and "Toxicology Principles". However, changing the classification of drugs, though more appropriate and didactic for a medical curriculum, includes the addition of more than 130 drugs to the version that had been taught until 2005.

Some sections of the program are more representative of the information overload. The section on Pharmacology of Systems requires the information of nearly 250 drugs to be taught in a period of twenty one weeks. Some topics are particularly heavy on the amount and complexity of the information to be reviewed, not to mention their diversity. Pharmacology of the Endocrine System and Metabolism covers 7 different sub-topics and 44 drugs to be reviewed in 10 hours, which means about 9 drugs per 2 hour session, and if taught as suggested in the printed program, in a particular week of the course, 28 drugs would have to be reviewed in four hours.

Another topic which is relatively large is drugs acting on pain, inflammation and immune response with 33
different drugs, distributed in five subtopics to deal with in six hours. The present form of listing the drugs makes them appear equally important; there is no distinction among them to highlight those which are more important. The fact that the information is not hierarchically presented constitutes a potential obstacle to the full comprehension of its importance in therapeutics and the further utilization of the pharmacological knowledge in the proper choice of drugs to be prescribed for the treatment of patients.

We considered that designing an exercise to determine “Place in Therapy” and “Therapeutic Uses, FDA approved” by looking up the Drugdex of Micromedex [9] during the time left after laboratory sessions could help students to satisfy the “Clinical uses” requirement. The section on “Place in Therapy” describes the value of the drug from a therapeutic point of view. In most of the cases it clarifies if a pharmacological agent is the drug of choice for a certain disease or if it is an alternative agent, or second or third line drug, or if it has no advantages over other prototypical drugs. This information may not be explicitly approached in a text book of pharmacology or during lectures but we consider that it is important in order to make the student prioritize the information received and give it further meaning that could improve recall of important drugs.

Also, we considered that by reviewing the section on Therapeutic Uses, students would become aware of those with FDA approval for intended use and become familiar with the categorization of the level of evidence and the strength of the recommendation for the use of a particular drug in a given clinical situation. Hopefully, when a student or physician is acquainted with a new or unknown drug he/she may want to learn what evidence exists regarding the drug’s clinical utility. The impact of this exercise on the learning of contents of this new program has not been evaluated since this is the first time that this strategy has been utilized. However, students responded with interest to this approach to drug information. This exercise also attempted to reduce or change the number of drugs to be included in the program of pharmacology, or to help distinguish one from another (i.e. writing in bold or capital letters those considered more important and whose complete pharmacology should be learned). Some of the drugs included in the present program are not prototypical nor are they drugs of choice. These are bumetanide, clofibrate, methicillin, minoxidil, norfloxacin, neomycin, nimesulide, pirenzepine, oxitetacycline, and yohimbine among others.

Curricular planners should make an effort to avoid “coveritis” (a propensity leading to the overwhelming desire to cover a teaching subject exhaustively). This has to be well balanced with the need for adequate breadth and depth in course content. The clinical orientation that is relevant to professional requirements must be considered critical in the pharmacology curriculum [10].

*We recommend*: A. Reducing the number of drugs as much as possible by eliminating drugs: 1) with no advantages over other drugs included in the program, 2) that are not prototypical, 3) with no evidence of being therapeutically useful or representing a means to teach a relevant pharmacological concept or action. B. To use bold or capital letters to highlight those drugs most important from a therapeutic or pharmacological point of view. C. The introduction of computer laboratory sessions where the student is more familiar with information tools that allow him/her to evaluate drugs by searching for the evidence supporting their use. D. Establishing a correlation between the drug list in the teaching program and the National Essential Medicines List (Cuadro Básico de Medicamentos) [11] or its equivalent.

**REFERENCES**