Learning of medical pharmacology via innovation: a personal experience at McMaster and in Asia

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ABSTRACT

Pharmacology in the traditional medical curriculum has been treated as a discrete "preclinical" discipline identifying itself distinctly different from the other preclinical sciences or clinical subjects in knowledge base as well as learning/teaching instructions. It is usually run in series with other pre-clinical courses (eg, anatomy, biochemistry, physiology etc), but in parallel with other paraclinical courses such as pathology, microbiology and community medicine. Clinical pharmacology was only introduced relatively recently designed to overcome the perceived deficiency in "preclinical" pharmacology regarding its therapeutic relevance and application to medicine. In many universities, both preclinical and clinical pharmacology courses co-exist, usually independently offered by two separate, sometimes non-interacting Departments of Pharmacology and Clinical Pharmacology. In this model, pharmacology is generally taught in a teacher-centered, discipline-oriented, and knowledge-based curriculum. Furthermore, pharmacology courses are commonly taught by "expert" teachers, who usually engage in excessive-teaching, often adopt a knowledge-based approach in both instruction and assessment, and frequently evade or ignore clinical relevance. The clinical relevance of the pharmacological sciences is sometimes also taught in a didactic and problem-solving manner, although it is usually case-oriented. In recent years, problem-based medical curricula have emerged, in varying forms, as a platform in which pharmacology is viewed as an integrated component in a holistic approach to medical education. In this problem-based learning (PBL) model, pharmacology is learned in a student-centered environment, based on self-directed, clinically relevant and case-oriented approach, usually in a small-group tutorial format. In PBL, pharmacology is learned in concert with other subject issues relevant to the case-problem in question, such as anatomy, physiology, pathology, microbiology, population health, behavior science, etc. Students learn via problem-evoked curiosity and motivation, in an environment which encourages free inquiries and intensive discussions in a cooperative rather than competitive atmosphere. Teachers facilitate students' learning objectives rather than deliver pre-packed knowledge and dictate what they think students should learn. Based on the above two models, a change towards PBL curriculum appears to be beneficial in better preparing the medical students as life-long learners capable of coping with changes in knowledge and skills associated with the progressive and dynamic social/economic transformation in the Asia-Pacific regions. Evidence is presented that this is indeed happening.

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PHARMACOLOGY AS ADISTINCTIVE MEDICAL DISCIPLINE HAS COME A LONG WAY

Pharmacology is a biomedical science that deals with interactions between chemicals/drugs with living systems. As an important part of the interdisciplinary medical education in the conventional medicine, pharmacology courses are usually offered after the other core courses of medical sciences, such as anatomy and physiology. Interestingly, however, the roots of pharmacology go back before the establishment of anatomy and physiology as academic medical sciences. Our ancient civilization has long used plants and other natural products, and their extracts for both healing and poisoning. The understanding of interactions between drugs and living systems was acquired via generations of knowledge accumulation based on empirical observations. This form of healing evolved via a long historical experimentation in various cultures from an art into a scientific modality, now known as pharmacology. This recognition of a formal discipline of medicine occurred only about a century ago following the declaration of Flexner Report in 1910[1] that the practice of medicine should be based on scientific evidence rather than empiricism. The emergence of synthetic organic chemistry facilitating the discovery of new healing chemicals and the rapid development of physiological and biochemical sciences (often dependent on pharmacological tools) have further solidified pharmacology as a mainstream basic science in medicine.

Pharmacological sciences underscore the following multiplicity as reflected by many titles of specialization in any medical library. It includes pulmonary pharmacology, cardiovascular pharmacology, therapeutic pharmacology, neuropharmacology, psychopharmacology, clinical pharmacology and molecular pharmacology. The intimate relationship between pharmacology and other preclinical sciences is also evidently presented in journal as biochemical pharmacology, pharmacology and physiology, pharmacology & toxicology, pharmacy & pharmacology. Thus, it is safe to state that pharmacology is a distinct discipline which institutes itself with many disguises across a broad spectrum of basic and clinical sciences in medicine.

PHARMACOLOGISTS HAVE MANY FACES

What do pharmacologists do? Research pharmacologists often used experimental animals and cell culture, or even molecular systems to perform experiments and engage in biomedical research so that they can examine the way drugs interact with various living systems and define the mechanisms through which the drugs act. They are the driving force behind drug discovery. They clinical pharmacologists, on the other hand, deal directly with the study of interactions of drugs with human body. They are concerned with defining the effective routes and doses in drug administration and the assessment of side effects of drugs. Many of them are also involved in the evaluation of drugs under development by conducting clinical trials of drugs, usually in collaboration with pharmaceutical companies. Since these studies involve management of patients and volunteers, certified medical qualification is necessary. Since pharmaceutical manufacturers aim to make and distribute safe drugs for prescription by physicians to treat ill patients, the production of novel drugs usually work a research center manned by a team of multidisciplinary research scientists focusing on the initial screening, effective production, quality control and safety-testing of drugs. Some pharmacologists are more concerned with the public-safety issues dealing with regulatory laws in all phases of the development of drugs. Therefore, it is also safe to say that pharmacologists disguise themselves behind various masks of expertise and utilize their skills in many professional outlets.

Pharmacology recognizes two aspects of drug action: one is concerned with drugs actions on the living system (the pharmacodynamics) and the other with drugs being acted on by the living system (the pharmacokinetics). Not all medicines can restore the deviated physiological equilibrium in diseases to the normal status. In fact, some medicines may act like poisons, if they are administered excessively or when not needed. Some poisons may have therapeutic effects if used in a minute amount. When physicians prescribe drugs, the primary objective is to achieve the maximal therapeutic effects (Pharmacotherapy) and to minimize the toxic effects of drugs (Toxicology). The primary objective in learning pharmacology in the medical curriculum, therefore, would be to motivate medical students to learn the general pharmacological and therapeutic principles for effective management of diseases in patients within the context of perceived health determinants.

LEARNING PHARMACOLOGY IN MEDICINE HAS DIVERSE APPROACHES

Like all human acts, learning contains two

components: the *intrinsic substance* of the learning and the *process* by which the learning is achieved. Similarly, in the act of learning in pharmacology, the medical students are given the task of acquiring the knowledge of pharmacological principles and their application. The questions on the *contents* and *process* then follow: Should the medical students learn and retain the knowledge of all aspects of pharmacology just *in case* they might need them in their future practice? Perhaps, they should learn only how to find what is needed just *in time* for their clinical practice? Should there be a distinction in the scope of knowledge base for preparing the medical students and students who enter into other areas of specialization in pharmacology? Should the teachers be the center for delivering the knowledge base in a didactic format? What is the appropriate breadth and depth of the pharmacology knowledge base required for clinical practice? How does one ensure effective integration of basic science disciplines with the clinical skills? And, how do we assess the effectiveness of the integrative learning?

While the knowledge content of pharmacology required by medical students to achieve the objective of appropriate use of drugs in treating patients is theoretically similar in North America and in Asia, the learning behavior and process by which such an objective may be achieved could and does vary considerably among different medical schools. I offer below my observations and experience in university medical education in Hong Kong and Canada.

There are 14 Departments of Pharmacology amongst the 16 medical schools in Canada[2]. McMaster University (Hamilton), where I served for more than 2 decades, is one of the two medical schools that do not offer an undergraduate degree in Pharmacology and do not have an establishment of Pharmacology as a distinct academic structure (despite unsuccessful attempts to establish a Pharmacology Program at McMaster University – see the paper by Prof EE Daniel in this issue). In contrast, the University of Hong Kong, where I have previously served during 1992-1996, also does not offer an undergraduate degree in Pharmacology, but it does have a Department of Pharmacology established in 1965 with a 4-5 member teaching-staff and, in 1992, a 2-men Division of Clinical Pharmacology in the Department of Medicine.

Teacher-centered didactic lectures in large lecture theater supplemented with practicals have been the norm for teaching instructions for basic sciences under the governance of individual departments, including pharmacology, in the medical schools of Hong Kong. A similar pattern is observed in many other conventional Pharmacology Departments in most Asian medical schools. In many North American medical schools, there is more than a dozen staff in pharmacology departments and basic scientists dominate the teaching of pharmacology. However, at McMaster University where student-centered problem-based learning in small group settings is the norm, there have been only 4-5 pharmacologists by training, who serve as *resource persons* in pharmacology issues for medical students, but there are many Resource persons who are usually experts in specialized fields, affiliated with various clinical departments. These resource persons offer help to students only when students approach them for specific tasks over a short period of 15-min discussions or 2-4 week elective (so-called horizontal elective). The generalist tutors serve as facilitators in regularly scheduled tutorial small group sessions and they need not be and are usually not a specialist in pharmacology[3].

At McMaster University there is no basic science department in the Faculty of Health Sciences except for the Department of Biochemistry, which is also affiliated with the Faculty of Science. Medical education is dissociated from direct departmental administrative control and is under the central coordination of the MD Program, in which all Unit and Course planners, teaching staff and resource persons are volunteering faculty members from all departments (though sometimes "encouraged" by the Department Heads). Likely, this was a strategy of the founders of the McMaster Faculty of Health Sciences directed at breaking the stranglehold of the basic science departments, which tend to dominate teaching in many traditional medical schools and fail to bring out the clinical relevance from the basic sciences via cohesive integration.

BREAKING AWAY FROM TRADITION IS HARD

In 1997, when I returned to Canada, all preclinical departments of the Faculty of Medicine at the University of Hong Kong (HKU) were subject to an extensive review by an international team, which deliberated a strong recommendation suggesting amalgamation of preclinical departments, including the Department of Pharmacology. The conventional departmental system was considered ineffective and inefficient due to a high wastage in time and resources resulting from academic and administrative duplications among these departments

and the lack of interactions with clinical departments. The weak leadership in the preclinical departments at the Faculty of Medicine severely dampened the image of basic scientists within the faculty. This event also happened to coincide with the medical education reform initiated in 1995 by then new Dean, Prof SP CHOW, an orthopedic surgeon, who decided to operate on the "diseased" traditional medical curriculum and remodel it with a new-path curriculum in which problem-based learning (PBL) in small-group tutorials was implemented to replace a significant part of spoon-feeding didactic lectures and laboratory demonstrations. This was indeed the curriculum model I first introduced to and experimented with at the Department of Physiology shortly after I took on my duty as the Chair of Physiology in 1992. Also, awarded by a government educational grant in 1993 via the Action Learning Project[4], I was able to invite a teaching consultant from McMaster University and send a number of dedicated teachers to McMaster University and other North American medical schools that have successfully set up a PBL curriculum[5]. I also assisted other clinical departments to learn and appreciate the concept of PBL in medical education via seminars, discussion groups and workshops. However, due to various constraints under the pressure or insurmountable traditional influence, the resultant new-path curriculum can be considered at best a hybrid form of the traditional and PBL curricula still being dominated by lectures[6]. Five years following the new curriculum, the clinical teachers were satisfied with the outcome of the hybrid-PBL curriculum, but basic science teachers, based on the traditional examination results, felt that their medical students may be more conversant in clinical terms but became very much deficient in basic science knowledge[7]. However, this perception may reflect the setback of improper practice of hybrid-PBL, lack of training and proficiency in PBL concept or conceivably an expected outcome under the strong influence of the traditional content-oriented expectation in assessing student performance, or the combination of the above. Evidently, its effectiveness in achieving the intended educational objectives in terms of altered student learning behavior in relation to its University and Faculty mission has not yet been objectively evaluated, but preliminary positive outcomes have recently been reported[7,8].

Having acquired the experience of implementing PBL at HKU in 2000, I have had the opportunity to spend a 6-month sabbatical leave, at the invitation of the Faculty of Medicine of the National University of Singapore (NUS), to assist with the implementation of PBL in a new pathway curriculum initiated in 1999. Compared to PBL at HKU, PBL at NUS represented even a smaller component (about 20 % of student-contact hours) totally immersed in a fundamentally traditional curriculum, in which the bulk teaching of pharmacology has remained department-based, lecture-oriented, Laboratory-supplemented, teacher-centered and examination-driven. PBL was placed merely to allow students for a brief exposure to self-directed learning and to appreciate clinical relevance of the taught materials via limited trigger problems. Despite this hybrid nature, improvement in students' learning behavior has been noted[9].

INNOVATION IN LEARNING OF PHARMACOLOGY IS MORE THAN A FACE VALUE

As mentioned earlier, at McMaster University, the sharp conventional demarcation between preclinical and the subsequent clinical discipline-based subjects was intentionally discarded in order to foster effective integration of learning and practice of medical knowledge and clinical skills. In McMaster PBL curriculum[10], to speak of learning pharmacology is the same as to speak of learning anatomy or physiology, or biochemistry or microbiology, *etc*. Learning of medical knowledge and clinical skills are problem-based (or case-oriented) rather than discipline-based (or subject-oriented). Both the health-care problems and biological systems in question are integrative rather than composite in nature. The management of knowledge acquisition is self-directed (or student-centered) rather than teacher-centered. The forum for effective learning is achieved via small-group tutorial rather than large-class lectures. I often heard of pro-claimed "integrative" courses, which are merely "composite" lectures delivered in series to the same class of students by a basic scientist and a clinician (or by a physiologist and an anatomist or a pharmacologist) of the subject specialty in question. I have also heard of "self-directed" learning by students who are in fact given regular periods for "self-study". It is also not surprising to note that "small group tutorial" has been wrongly perceived by some teachers who actually practice "small class teaching". A group of 15-20 students has been conveniently labeled "small group". While it may be a relatively small group indeed as compared to large lecture class having 150-200 students, this group size still posts significant deficiency characteristically observed in "large class". PBL is an innovative educational phi-

losophy/concept, but is frequently mistakenly regarded by many as a pedagogic methodology, probably due to its loose definition. There are many "clones" or "subtypes" of PBL; some are deviated intentionally because of constraints in expertise and resources and some are compromised due to weak leadership and internal resistance against change and some are modified for refinement and improvement. For more than 3 decades since its inception at McMaster University, PBL remains as the central philosophy in medical education, but it did not remain stagnant and continue to evolve in structuring, instruction, assessment, problem design, and faculty development.

LEARNING MEDICAL PHARMACOLOGY IS MORE EFFECTIVE UNDER CLINICAL SETTING

In traditional medical curriculum, basic sciences knowledge, packaged as discrete disciplinary compartments, is acquired over a particular sequence, often after Anatomy, Physiology, and Biochemistry. At McMaster University, pharmacology issues are blended within a clinically oriented health care problem (HCP), which emerges as early as in Unit 1, a foundation unit designed to acclimate the students, who come from a broad scope of social/economic/academic/cultural backgrounds, for group learning in PBL format via horizontal and longitudinal integration. Students are grouped, 5-6 students in each group, according to gender, academic/professional training/knowledge and ethnic origins in order to maximize the group dynamics. This initial Unit is divided into 3 subunits, dealing with normal tissues and injuries, growth and development, and homeostasis and regulation. Students are encouraged to use these HCPs as a platform for hypotheses formulation and knowledge acquisition rather than using them for the purpose of problem-solving. It is more of a reasoning-oriented and inquiry-drive rather than a memorizing-oriented and answer-driven learning experience. Therefore, some problems may not have standard solutions and thus cannot be "solved".

Pharmacology issues are embedded in many HCP over all units. Students are to identify these issues, if they consider them to have sufficient relevance, priority and importance pertaining to the given problem. The students need to collectively decide whether they will pursue these pharmacology issues in the face of other relevant issues as their learning objectives. If they wish to take these pharmacology issues collectively as a group learning objective, they also need to decide what to learn, how to acquire information, how broad and how deep should the issues be explored? Due to different interests and background preparations, individual student may also face the choice between personal learning objectives and group learning objectives and learn to convince, respect, support, negotiate, and compromise with other members. The above process is in line with the spirit of so-called self-directed learning in PBL which addresses to the nature of self-management in group-learning, cultivation of team spirit and demonstration of communication skills and professional behavior. The advantages are based on real life situation, clinical setting and professional environment as demonstrated below.

LEARNING VIA HEALTH CARE PROBLEMS

One HCPs used for assessment purpose in Unit 1, "Georrgina Nesbitt"[11], offers a commonly encountered household scenario, which I modified somewhat for simplicity.

A 3-yeart-old Georgina, who attends day care, was brought to her family doctor by her mother, who is a single parent relying on social welfare for living. Georgina looked lethargic, had a running nose and a mild fever. Her mother demanded antibiotics because she believed that antibiotic is a magic cure-all medicine. The family doctor gave Georgina "Tylenol" for the fever and prescribed antibiotics (4 times a day for one week). Georgina returns again, and again during the next few weeks. In the recent visit, the doctor found white patches in Georgina's throat. Her mother got very frustrated and asked why the medicine prescribed by the doctor was not working for Georgina.

The medical students are expected to use this problem as a forum to explore, learn and understand a number of principles, which manifest themselves as questions under the following three major categories:

Biological Sciences issues What kind of tissue injuries is responsible for Georgina's symptoms? What pathogens are involved? How different are virus, bacteria and fungus? What is the normal flora in the mouth? Why is there "running nose"? How is fever caused by some pathogens? What is Tylenol? How does it work? and how is it different from other anti-pyrogens, like Aspirin? What is the indication for using antibiotics? What is antibiotic resistance?

Population Health issues Why was Georgina

not brought to the Emergency Department of the hospital? What is the - role of a family doctor? Is the Day Care Center a source for the spread of flu/cold in preschool children? How often are antibiotics prescribed by doctors or asked for by patients in the treatment of flu? What is the impact of antibiotic resistance on the current health care system?

Behavior issues Why did the mother insist on the prescription of antibiotics? Why do some doctors prescribe antibiotics upon patients' request? Was the mother compliant in supervising the use of the antibiotics by Georgina? Is better understanding the burden of child sickness on mother useful for a physician's approach in treatment?

Another HCP, "Donald Wong", which I often use in tutor training exercise during my consultancy activities, presents a different scenario, but is also quite familiar to students:

An agitated 1st year graduate student from Hong Kong is brought to the Student Health Service in the morning by his room-mate. The night before, Donald had his first taste of Gin Tonic in a welcoming party held in a local bar by Student Union. For years, Donald has been helping out in his family grocery business in Hong Kong during his secondary school education. He also studied hard and did not spent time for much extra-curricular social activities with friends after school. Although he was somewhat shy, he did enjoy the company with his party-going classmates, who eventually challenged him into drinking 4 glasses of Gin Tonic. Things deteriorated from there with each engulfing of one glass of alcohol. As Daniel became restlessly excited near the end of the party, the bar-tender advised his companions to drive him home, but Daniel insisted that he was fine and could drive home by himself. Upon arriving at his domitory, Daniel vomited a few times and lost consciousness. He felt sick and week the next morning.

This HCP clearly allows the students to easily identify the pharmacological issues around alcohol as a drug. It also contains many psychosocial and behavior issues that are familiar to them. Drinking and driving among young people being one. How much drinking is considered unsafe? How is alcohol absorbed, metabolized, distributed and eliminated? What is the biological basis for drug addiction, dependence and abuse in addition to alcohol? If Daniel is an obese person, will the outcome be different under the similar situation? Does the fact that Arthur being an oriental has anything to do with his reaction to alcohol? How does alcohol intake affect the behavior? Pharmacology issues related to biochemistry can also be raised as learning objectives. For example, what are the enzymes involved in the transformation of alcohol? How does alcohol affect cellular membranes (eg, lipid composition and membrane fluidity) and protein ie, receptors, enzymes and ion channels) conformation? What is alcohol dehydrogenase? Is the expression of alcohol dehydrogenase different across the human population? Is there a genetic basis for different sensitivities to alcohol intake? Are the cellular toxicities caused by alcohol or the end products of alcohol? The *population issues* include the regulatory control of public consumption of alcohol. Alcohol related trauma incidence. Alcohol related body harm in University environment. Alcoholisms as a burden for the society including the health care system. Awareness of alcohol-drug interactions. Legal issues on dealing with drinking and driving, the role of physicians and the role of staff working in the bar. The behavior issues could include the change of behavior following drinking. Why do people drink? Peer pressure in initiation of drinking (or taking drugs) among youngsters.

The major thrust of the PBL curriculum as exemplified by the above HCPs is the characteristics in the integration of learning. Physiology issues are definitely there. Pharmacology is clearly implicated. The need to learn some biochemictry is evident. Although in-depth anatomy is not necessarily applicable in these two examples, other HCPs dealing with different systems will certainly have anatomical issues (gross anatomy as well as histology combined with pathology). Clearly, there is no need to go through 200 hours of anatomy lectures, 200 hours of physiology, 80 hours of pharmacology lectures and 100 hours of biochemistry in order to handle these HCPs. Students learn whatever is needed to understand these carefully designed HCPs. They acquire the knowledge when it is needed rather than in case it is needed. Even in dealing with pharmacological issues, the students not only learn about the pharmacological principles and the mechanisms of drug action, they also learn about the social/economic impacts and population/ behavior perspectives in alcohol use in the society/community. Depending on the level of the educational needs and the purpose of the HCP at a given stage, this problem can be easily modified to include the newly emerged disciplines in pharmacology, such as pharmacoleconomics and pharmacogenomics.

I have given only two HCP examples (out of 16 HCPs) from Unit 1 handbook. There are 3 more Units that are system-based (*ie*, cardiovascular, respiratory, renal, hematologic, gastroenterologic, endocrinologic, neurologic, *etc*), each with 12-15 HCPs before the medical students enter the clinical clerkship. Each of the Units also contains pharmacology issues. Therefore, the learning of pharmacology is a continuing process throughout the entire medical curriculum rather than a fragmental process as in the conventional curriculum, in which clinical applications of the basic pharmacological concept are treated separately (in time and space) by clinical pharmacologists in some medical schools, often as a futile attempt to bridge the inevitable gap[12, 13].

ALL IS NOT WELL IN THE PRACTICE OF PBL

Conceivably, when PBL is practiced as a teaching methodology in a single disciplinary area, especially along side with other conventional teaching methods, such as didactic lectures, PBL may not extend to its full pedagogic potential. Thus, the practice of PBL in teaching pharmacology independent of other related disciplinary areas in medicine may not be as prominently beneficial or cost-effective, as compared to using PBL as a conceptual framework (as opposed to teaching methodological specialty) in a more integrative curriculum. Implementation of an innovative and integrated curriculum based on the spirits of PBL may be administratively challenging or even risky in the face of powerful resistance in favor for the traditional comfort zone. If successfully implemented and sustained, it is likely to be academically refreshing and pedagogically enjoyable for both faculty and students. It can also be cost-effect based on pooled multi-departmental resources and contributions. Realization of such optimism about PBL lies in the wisdom and the foresight of the academic leadership and the underlying academic culture.

In many medical schools, PBL is used as a teaching method (for being student-centered, students teach students via presentations in this PBL model), some times for individual preclinical or clinical discipline. For example, at the University of Hong Kong, the territorial separation between basic pharmacology and clinical pharmacology was evident and the hybrid PBL curriculum apparently was not perceived to have successfully integrated the pharmacological knowledge in preclinical and clinical years[13].

Despite PBL in medical education being originated at McMaster University with a sustained faith lasting for the past 37 years with a proven educational value and significant outcome, deficiency in the learning of pharmacological sciences in medical education has been a continuous plague in the system. As I have been tutoring in both unit-1 and unit-2 and maintained long-term relationship with many of my students, I heard of students' complaints over years about their gap in pharmacology, relative to other basic science subjects. As pointed out in the paper by Prof EE Daniel in this issue, despite the fact that the design of many HCPs had indeed included various, pharmacological perspectives, students and/or tutors tended to make superficial attempts or shied away from dealing with those issues. The reasons were not clear and limited investigations had been unsuccessfully attempted, probably due to the complexity in the academic politics.

OTHER CONTEMPORARY PHARMACOLOGICAL KNOWLEDGE IS NEEDED TO SATISFY HEALTH CARE NEEDS

As mentioned earlier in the introduction, modern pharmacology came a long way from the empirical experimentation with the natural products. It is well known that Aspirin is derived from the willow tree bark and digoxin is derived from the foxglove leaf. The theory in the use of "drugs" in some folk medicine is apparently very different from the use of allopathic medicinal drugs as we learn in the modern pharmacology. As the understanding of drug actions in modern pharmacology is based on a constant set of cellular and molecular events, herbal therapies in many cultures are tailored with the individual temperaments and the surrounding environment, although in recent years the study of pharmacological individuality of drug responses under the new discipline of pharmacogenetics.

In some cultures, pharmacological issues related to herbal therapies or Chinese traditional medicine, which has had a much longer history and empirical basis compared to allopathic medicine during the span of human civilization, have been largely ignored by the main stream medicine, due to the purported lack of scientific evidence based on studies in population, and due to professional bias and political pressure. In the recent decade, the socioeconomic demand has helped revisit this area and re-emerge as complementary or alternative therapies. Despite the increasing globe-wide popularity of alterna-

tive medicine/therapies, training of main-stream medical students in this area is generally so poor such that they cannot offer any intelligent advice to their patients, or even blindly oppose to the use of complementary therapies by their patients. As a result, patients may place themselves in health hazards by concurrently using herbal medicine or synthetic drugs or by self-medication without consultation with the physician. Many preventable medical errors or mishaps involving the use of alternative medicine may be preventable, if the medical students and practicing physician are properly educated or trained.

In the Orient, the traditional Chinese medicine coexist with, and are practiced in parallel with, the allopathic medicine. In China, medical students are educated in both streams of medicine. There are no compelling reasons to exclude the study of pharmacological issues of alternative or complementary medicine from the main-stream medicine and both can be studied together using problem-based learning approach, which by nature is a comprehensive, integrative and holistic approach to medical education within the context of socioeconomic demand.

CONCLUSION

It is increasingly clear to many medical educators in the Asia-Pacific region that PBL curriculum does set the stage for a truly integrative learning experience using socially/clinically oriented scenarios as the learning platform (not just for problem-solving) to apply basic science knowledge to concept-building and clinical reasoning[4,10,14]. For medical students, pharmacology is only one of the many scientifically related and intertwined disciplines, which they must learn and apply effectively. Not ALL medical students are able or need to know EVERYTHING about pharmacology (even this would be difficult or unreasonable to expect from research students specializing in one or few of the disciplines in pharmacological sciences). Those who desire to learn more or wish to specialize in areas requiring more pharmacology knowledge beyond the scope set for the learning units, they have the choice of taking 4-5-week elective with a specialist in pharmacology to enrich their knowledge base. For research students, the same PBL approach can also be used, and has been used at McMaster University in the undergraduate Biology/Pharmacology Honors Co-operative Program[15,16], and in undergraduate Health Sciences Program. In this instance, the acquisition of the knowledge base may be geared more towards biological sciences at an advanced level involving more critical appraisal using up-to-the-date scientific publications in specialized journals.

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