LETTERS

India to Introduce Five-Year Doctor of Pharmacy Program

To the Editor. Recently, the Pharmacy Council of India (PCI) has proposed a plan to start a 5-year PharmD program in India. The PCI has selected 20 pharmacy institutions in India and submitted the proposal to the Indian Ministry of Health and Family Welfare for their review and approval. The idea is to educate and train pharmacy students in India to meet the shortage of pharmacists in Indian hospitals and also to match the entry-level PharmD curriculum in the United States. The National Association of Boards of Pharmacy (NABP) new requirement that a foreign pharmacy graduate have 5 years of pharmacy education before applying to take the Foreign Pharmacy Graduate Equivalency Examination (FPGEE) in order to then take the North American Pharmacist Licensure Examination (NAPLEX) and finally obtain a license to practice pharmacy in the United States is the key reason for this change in pharmacy education in India.[1-4] The movement towards a clinically oriented curriculum is already afoot and we believe more countries in the Indian subcontinent and around the world will soon follow the PCI decision.[5] In fact, many pharmacy institutions in India, like Jadavpur University have started offering a master of science (MS) course in clinical pharmacy to expand upon the basic pharmaceutical courses in the 4-year curriculum. Dr. Dutta, a Jadavpur University alum, was invited to his alma mater to provide a workshop for the faculty in teaching clinical courses to pharmacy students. We believe that students with advanced training in clinical courses meet the 5-year pharmacy requirement for taking the FPGE. Currently, Jadavpur University is identifying US universities to establish collaborative faculty and student exchange programs in pharmacy whereby faculty members from both institutions can visit the host institution to gain valuable experience in teaching and research. Jamia Hamdard (Hamdard University), Dr Ghilzai's alma mater, has also started an MS course in pharmacy practice at the Faculty of Pharmacy. The course is sponsored by Faculty of Pharmacy with Hamdard's Hospital and will be of 2 years duration, out of which 2 semesters will cover course work and another 2 semesters will be devoted to a research project and practice experiences to be undertaken in the Hospital. The new course has been established in Hamdard Hospital and the facility of Drug Information Services, which also publishes a bimonthly newsletter on the current drug information, has already been developed. Besides pharmacy faculty members, 2 clinicians from Hamdard's Hospital are associated with this course.

We really appreciate the PCI decision, which came after a visit by the Accreditation Council for Pharmacy Education (ACPE) delegation to India to meet with the PCI. Although this bold decision came very late, it is a positive step in the right direction to popularize pharmacy education and to graduate skilled and knowledgeable pharmacist who can work in clinical settings and counsel and manage drug therapy and improve patient's health care.

Until now, Indian pharmacy graduates have been mainly trained to work in the pharmaceutical industry as product and formulation scientists. Pharmacy education in India has mainly focused on pharmaceutical sciences courses, while clinical or pharmacotherapeutic courses have received far less coverage in the curriculum and no students have ever undergone pharmacy practice experiences. According to one article, there are over 600 pharmacy colleges and schools in India producing over 13,000 pharmacy graduates yearly.

In the last few years, the issue was hotly debated and discussed throughout India to get a consensus to revamp the pharmacy curriculum. It is suggested that the new pharmacy curriculum will entail courses in pharmacogenomics and biotechnology and a significant portion of the curriculum will focus on pathphysiology, pharmcotherpaeutics, and practice experiences.

The All India Council for Technical Education (AICTE) is a statutory regulatory body for technical education in the country that had been limited to overseeing technical education. However, in 2003, the AICTE announced that it will constitute a National Engineers Registration and Licensing Board (NERLB) to provide registration and licenses for practice of engineering in India. We would suggest that the PCI should work in close association with the AICTE to introduce and mandate a similar national board examination for pharmacy graduates to qualify to practice pharmacy in India.

We have contributed twice here in the past to raise the issue of pharmacy education in India and in those letters we suggested that pharmacy education in India needed to be more clinically oriented. We personally appreciate the PCI's decision to explore and involve an international accreditation agency and also congratulate the ACPE for supporting the PCI.

We would like to thank *AJPE* for promoting the cause of pharmacy education in foreign countries. Many foreign pharmacy graduates are employed as pharmacy educators in US colleges and schools of pharmacy. Also, foreign pharmacy graduates constitute a large and growing number of the total pharmacist workforce in some US states.

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Science-based Pharmacy Education

To the Editor. Dr. Kenneth Skau's recent Viewpoint[1] is "on target" concerning the reduction of pharmaceutical sciences as a negative outcome of increased experiential education required in the ACPE standards.[2] Dr. Skau and I share being 1960s pharmacy students, multi-decade "pharm sci" teachers, and this concern.

Pharm sci teachers like us recognize(d) that the 1979 and 1995 *American Journal of Hospital Pharmacy* editorials titled "The Decline and Fall of Secundum Artem [inaccurate pharmaceutical compounding]," [3] and "Interpreting, Rather Than Reciting the Literature on Drug Compatibilities," [4] were "clinically remarkable warning signs" of the de-scientization of pharmacy education and thus the skills and expertise to protect and heal patients. The following 3 examples dramatize the professional embarrassment and patient harm that can result from decreased content and perceived importance of basic pharm sci in pharmacy curricula.

Example 1: Biochemistry of Proton Pump Inhibitor Drugs (PPIs)

Nearly all pharmacy students learn that PPIs suppress hydrochloric acid synthesis by irreversibly inhibiting H^+, K^+-ATPase enzyme, or "proton pumps." However, not nearly all learn that (1) irreversible means covalent bonding, and (2) orally administered PPIs are enteric coated to prevent their being protonated in gastrointestinal contents at pH$<$5, which precludes their bonding with intestinal $-$SH groups before systemic absorption. Neither do all pharmacy students learn that hydrogen must be bonded with the S$=$O group on PPI molecules, in gastric parietal cells, to enable their disulfide bonding with H^+, K^+-ATPase. Thanks to our colleague, Dr. Vicki Roche, for articulating this so lucidly and thoroughly, ie, so scientifically.[5] It should trouble all pharmacy educators that all pharmacy students who will be called "doctor" and "the drug experts" after graduation do not learn all of this science about one of the most frequently swallowed, therapeutically valuable, and biggest money-making drug classes in US history.

Example 2: Oral Absorption of Organic Weak Electrolyte Drugs

Here is the question from a 2007 first-professional year PharmD student: "If a drug diffuses most readily through cell membranes in its non-ionized form, but it must be ionized for its best solubility in small intestinal contents, then what exactly takes place so that the drug gets absorbed?"

My answer:

(1) Outstanding question!
(2) From the Henderson-Hasselbalch equation (H-H), there is a constant ratio of the dissolved concentrations of non-ionized to ionized forms, ie, because there is a practically constant pH at any local small intestinal site where a drug is dissolved, dissolving, and diffusing.
(3) Assume that 15% of the swallowed drug dose is dissolved at any moment in the contents of the jejunum, and of that 15% dissolved, 3% is non-ionized and 97% is ionized, ie, the H-H ratio.
(4) As the dissolved non-ionized drug progressively diffuses from jejunal contents into membrane capillaries, the dissolved ionized drug simultaneously converts to the non-ionized form to maintain the 3% to 97% ratio. It is the *ratio* of the concentrations, not the concentrations, that the H-H holds constant.
(5) Conversion of dissolved ionized to dissolved and diffusible non-ionized drug creates a "thermodynamic void" relative to the saturated drug solubility, which "pulls" more undissolved drug into solution.
(6) Comprehending and explaining drug science such as this distinguishes pharmacists from pharmacy technicians, and earns respect for the pharmacy doctor title and persons who bear it from patients and health care professional colleagues, especially physicians.

Example 3: Compatibility of Intravenous Calcium and Phosphates

Besides the lost pharmacognosy that Dr. Skau cited,[1] 4-year and 5-year bachelor of science (BS) in pharmacy curricula also required courses in qualitative and quantitative chemical analysis, and inorganic pharmaceutical chemistry. Those began disappearing in the 1970s as the BS to PharmD degree transition gained national momentum. Those chemistry courses taught us with which anions calcium was soluble and with which it precipitated, which, admittedly, was not all that important until the emergence of total parenteral nutrition, TPN, *ca* 1970.

Since 1982, there have been several reports of patient morbidity and mortality resulting from dibasic calcium phosphate, $CaHPO_4$, precipitating in intravenous (IV) infusions, especially TPN. Related reports have reviewed the $H_2PO_4^{-1} \leftrightarrow HPO_4^{-2}$ equilibrium and other chemical factors that are clinically crucial to avoid $CaHPO_4$ precipitation. It is probable that the pharmacists who compounded IV infusions in which $CaHPO_4$ harmed and killed patients had little formal inorganic chemistry instruction, especially not intensive labs.

After the year 2001, I consulted on the case of baby who died from intravenously infused $CaHPO_4$ precipitate, ie, more than 19 years after publication of the first of 18 pertinent and prominent information sources, the last of which was in 2001. The pharmacist(s) who prepared that mixture of calcium gluconate and potassium phosphates injections either misinterpreted or ignored that information, which included a 1994 nationwide FDA Safety Alert to hospital pharmacists and other health care professionals. No matter how much practical experience all the pharmacists had in all the patient harm cases, they did not know enough about calcium and phosphates compatibility/solubility chemistry. [The author will forward a list of 18 literature citations on intravenous calcium and phosphates compatibility, which are extraneous to this Viewpoint, upon email request to dnewton@su.edu.]

So what may be expected from increased experiential credits? Some readers may suspect that Dr. Skau, me, and our likes, are merely reminiscing or "turf battling" over the expansion of experiential at the partial expense of basic pharm sci credits. The case of the baby dying from $CaHPO_4$ emboli epitomizes our true campaign, ie, some instructional losses can lose patients.

In a recent survey, only 51% of chain store pharmacists identified the important interaction between concurrent consumption of St. John's wort and oral contraceptives.[6] I'll bet that more than 51% of "ER" viewers who watched the February 19, 2004, episode of the popular television show know it (St. John's wort and oral contraceptives were the theme of that episode).

Will more experiential rotations ensure that all of "the drug experts" better learn the *what* and *how* symbiosis of drug therapy, eg, that there *is* an SJw-OCs interaction, and that it *results* from SJw inducing P-glycoprotein chemical transporters and hepatic CYP3A4?

There is no better example of the necessity of basic sciences knowledge to advancing clinical practice than DNA. A mountain of unheralded good basic science by dozens of unheralded good scientists stemming from the 1930s was necessary for Watson and Crick to produce their mole hill size 1953 letter in *Nature* that forever changed the world.[7] Moreover, all of that enabled the birth of many new fields of basic science research and clinical treatment, including the currently dear to pharmacy wave of pharmacogenomics.

There are 12 tertiary level Competency Statements in the North American Pharmacist Licensure Examination (NAPLEX) Blueprint[8] focused on basic pharm sci and calculations, which comprise 34% of each 150-question NAPLEX.[9] [The 12 tertiary levels are 1.2.2, 1.2.5, 1.2.6, 1.2.7, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.2.4, 2.3.1, 2.3.3, and 3.1.2. Contact the author at dnewton@su.edu for instructions on calculating the theoretical percentage weight of each of the 35 tertiary level NAPLEX Competencies toward the total NAPLEX score.]

Pharmacy students are likely to learn little or nothing during clinical and dispensing practice experience to answer items assigned to those Competencies. Therefore, more experiential and less pharm sci education could be a detriment rather than a benefit to graduates' NAPLEX performance.

If increased experiential credits occur as 1- to 4-week blocks dispersed over the early upper division years of PharmD curricula, then it could resemble the apprenticeship "rite of passage" training of the pre-1940s. It took decades to construct a strong pharm sci base in pharmacy curricula,[1] but the demolition of nearly anything can occur much faster than its construction.

The recent report of a taskforce of primarily state pharmacy board members seemed to discredit science-based pharmacy education with such excerpts as the following[10]:

- "Experience is the best teacher. . . practical training, under the supervision and guidance of an experience professional, has long been the cornerstone of pharmacy education."
- ". . . graduates have to know more than chemical structures; they need to be able to think on their feet. . ."

AACP's Dr. Arlene Flynn responded that "To prepare someone to enter practice is clearly the schools' role." Wasn't it Mark Twain (Samuel Clemens) who mused

in the late 1800s that "The problem with experience as a teacher is that first it gives the test, then it gives the lesson."? It would be a sad day for pharmacy and for patients if, for example, education regressed to students learning pharmacology from product package inserts and observing patients' responses to drugs. . .and there is no guarantee against the arrival of that day.

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