TEACHERS TOPICS

Increasing the PharmD Student’s Interest in a Required Neuropharmacology Course

Christopher K. Surratt, PhD
Mylan School of Pharmacy, Duquesne University
Submitted January 31, 2004; accepted March 1, 2004; published May 6, 2004.

A typical introductory neuropharmacology course required of PharmD students is likely to faithfully follow standard texts, with minimal coverage of basic or clinical neuroscience. This approach does not encourage class attendance or participation, as the students may be bored with predictable lectures or may realize that all information to be tested on is in the textbook. The instructor can increase student attendance and interest by occasionally including clinical case studies or anecdotes, cultural references, and references to current events that pertain to a drug or receptor discussed. Recent but well documented “cutting edge” research findings, which may include magnetic resonance images of a neurological disorder or of a drug occupying a brain site, intrigue the students and stimulate active learning. These “digressions” into basic and clinical neuroscience occupy only a few minutes of lecture time per week, yet visibly boost student learning and enjoyment of the course.

Keywords: pharmacology, neuropharmacology, neuroscience, receptor, benzodiazepine, imaging

INTRODUCTION

A 1-semester general pharmacology course in the doctor of pharmacy (PharmD) program with an emphasis on the central and autonomic nervous systems covers a staggering amount of material – at least 24 chapters and over 600 pages of the most recent edition of the Goodman and Gilman’s textbook. The pressure to effectively disseminate and teach so much information in so little time may understandably drive an instructor to “stick to the script” dictated by the course text. This strategy is unlikely to accommodate “active learning” or even allow time for student questions or comments during the lecture. This is especially unfortunate given the wealth of fascinating neuroscience that relates to the drugs and receptors covered by the course. The focus of this article is to promote the introduction of “cutting edge” basic and clinical neuroscience and course-relevant references to popular culture and current events, toward enhancing student learning in, and enjoyment of, this required course.

OBJECTIVES

The objectives of the course were as follows:
1. Characterize the problem with introductory neuropharmacology courses in maintaining student interest and performance;
2. Describe how lecture “digressions” that deal with clinical case studies or other anecdotes illustrating a drug’s effects can reinforce student learning;
3. Describe how incorporation of course-relevant references to cultural issues or current events enhances student interest and learning;
4. Describe how recent “cutting edge” neuroscience research findings enhance student interest and learning; and
5. Explain how instructor identification of “FYI” facts during the lecture may improve student performance.

INSTRUCTIONAL METHODS AND CONTENT

PHBMS 420 (Autonomic and Central Nervous System Pharmacology) is a required 4-credit course offered during the fall semester of the fourth year of the 6-year PharmD curriculum of the Duquesne University School of Pharmacy. The course is largely a lecture-based format with four 50-minute lectures per week.
Two pharmacy practice laboratory sessions with themes derived from the lectures are also a required component of the course. The required textbook is *Goodman and Gilman's*, but other commonly used pharmacology texts also are drawn from in writing the lectures. Several graduate-level neuroscience texts provide illustrations and advanced discussions of neuronal pathways, receptor structures, and schemes describing drug actions in the synaptic cleft between neurons. The instructor distilled information from these graduate-level texts to a point suitable for this course. The instructor choreographed the course to complement the required medicinal chemistry course taken concurrently by the fourth year students.

For the Fall 2003 semester, 127 students enrolled in the course. Students were given a handout of the same outline used on the overhead projector by the instructor; sufficient space was left on the outline for the student to enter the same notes provided by the instructor during the lecture. The balance between provided written text and that entered by the student was optimized so as not to “leave the student behind” during the lecture, while still requiring enough writing to maintain the student’s focus. Questions and comments from the students were encouraged by the instructor. Four noncumulative, multiple-choice examinations were administered, each covering 12 to 15 lectures. Before each examination, sample examination questions were provided, and an optional review session was led by the instructor. After each examination, an optional review session in which the instructor reviewed the answers to all examination questions was held outside of regular class hours.

The primary strength of this course was that it took advantage of the instructor (the author) being a neuroscientist who conducts basic research on drug receptors. Through this research experience and by attendance and presentations at scientific conferences, the author was in a position to elaborate on or provide information that superseded information found in the course textbooks. This allowed the instructor to present the neuropharmacology relevant to the course as a mystery that he and the class were in the process of unraveling and resolving, rather than as dry facts to be memorized. The author’s “war stories” of how drugs were discovered or receptors were cloned intrigued the students, who hungered for stories, anecdotes, and other interesting “inside information” not found in a textbook. Students ask that lectures be interesting, and not simply a narration of the textbook. They ask that the instructor go above and beyond the information in the textbook when necessary to fully explain the subject at hand. This article provides insights toward achieving those goals, and helpful hints that should render students well versed in neuropharmacology, while allowing them to enjoy the process.

In explaining how a drug elicits an effect in the patient, the instructor should detail cause and effect at each step of the drug mechanism. There are undoubtedly undergraduate pharmacology classes in which the adverse effects of Valium are covered in 2 sentences: “Benzodiazepines enhance the action of GABA, which is responsible for the sedative-hypnotic effect of these drugs. Chronic use and abrupt discontinuation may cause paradoxical anxiety, a phenomenon related to reduction of GABA action.” While some students may be content with this level of coverage, the approach carries 3 disadvantages: (1) little detail is offered on how Valium actually achieves its effects; (2) dry facts will not hold the students’ attention; (3) the students are merely memorizing, not learning.

Alternatively, Valium’s adverse effects could be addressed in the following way:

“The sedative-hypnotic properties of Valium and other benzodiazepines are due to potentiation of the action of the inhibitory neurotransmitter GABA at the GABA<sub>A</sub> receptor. Chronic use of the benzodiazepine leads to a reduction of GABA<sub>A</sub> receptor number at the cell surface via sequestration and/or downregulation mechanisms, a cytoprotective response to the unabated high levels of the drug. Fewer GABA<sub>A</sub> receptors mean fewer inhibitory postsynaptic potentials (IPSPs), in turn meaning that the postsynaptic neuron is more active than when the benzodiazepine was first administered. Consequently, less sedation is obtained. Thus, abrupt discontinuance of the benzodiazepine when an inadequate number of GABA<sub>A</sub> receptors is present results in even less inhibitory tone in the brain than before the brain ever experienced the drug. This translates into more excitatory tone than usual, manifested as anxiety, irritability, and even paranoia and psychosis in some cases.”

This information was given following or concurrently with a thorough presentation of the appropriate molecular mechanisms. These mechanisms included how inhibitory and excitatory neurotransmitters oppose each other in the central nervous system, how GABA elicits hyperpolarization of the postsynaptic cell, how one drug modulates the affinity of another at the same receptor via allosteric potentiation, and how cell surface receptors are desensitized, internalized, and recycled or proteolyzed.

Detailed coverage of such molecular mechanisms required a great deal of lecture time, but the investment was worthwhile. These mechanisms surfaced more than
once during the course; eg, during lectures involving excitotoxicity and stroke, barbiturate mechanism of action, and drug tolerance. More importantly, the student who understands these mechanisms will not have to rely solely on memorization in understanding a drug’s effect and will acclimate quickly to future drugs that employ the same receptor type.

Use clinical case studies or personal anecdotes to reinforce learning the specifics of a drug or a disease state. The course may be centered on neuropharmacology, but any student receiving a steady diet of only receptor structure and function as they pertain to the mechanism of action of a given drug will eventually lose interest in the class. This can be avoided by occasionally interjecting clinical aspects of the drug-receptor relationship, and especially by using a case study or personal anecdote that illustrates a drug effect. Consider the aforementioned example of “rebound anxiety” arising from chronic use and abrupt discontinuance of a benzodiazepine, such as Valium or Xanax. After fully explaining rebound anxiety at the molecular level, the attention of the fourth year students began to waver. At this point, the author told the story of a friend who suffered a psychiatric episode with severe paranoia resulting from sudden discontinuation of Xanax following long-term use of the drug. The story resembles the plot line of a dramatic novel, and the details of this episode clearly held the attention of the students. The class was especially interested to hear about the errors made by the physician and pharmacist involved, mistakes that could have resulted in a suicide or homicide. The author occasionally incorporated other anecdotes into the course that involved drugs of abuse or anesthetics, for example. These stories also appeared to help the students remember details about these drugs, such as whether opiates constrict or dilate the pupils, or whether nitrous oxide is an effective surgical anesthetic. Instead of instructors relying solely on their own anecdotes, setting aside a day or 2 during the course for guest lecturers is another option. Hosting a clinical psychologist or a forensic toxicologist should ensure that the class hears interesting case studies that complement the “molecular” aspects of the course.

It may be argued that telling stories is beyond the scope of the course and a waste of valuable lecture time, but student feedback on teaching evaluations indicated that such anecdotes facilitated learning and increased lecture attendance. The Xanax anecdote described above alerted the students to their responsibilities in advising the customer on product use, and rendered more vividly their understanding of why one must gradually decrease the dosage of a benzodiazepine when discontinuing long-term use of the drug.

Use cultural references and references to current events whenever possible. The most popular television shows and movies in this country often deal with neuroscience, forensic science, or emergency medicine. It stands to reason that entertainment involving these subjects would be especially popular among pharmacy students. Associating a drug with an episode of ER, a historical figure or event, or a warfare strategy is a powerful learning tool. Students who are not particularly interested in the mechanisms of action of antipsychotics for the sake of their pharmacy education are suddenly eager to understand how haloperidol and ziprasidone exert their effects after the drugs are referred to in an episode of Law and Order. Students who are otherwise indifferent as to how an individual becomes addicted to narcotics or psychostimulants want to understand exactly why the lead singer of their favorite band died of a heroin overdose. Taking the time to incorporate a cultural reference to a drug or receptor into the lecture effectively holds students’ attention and provides a short break from the monotony of focusing on course material eligible for the examination. When covering the mechanism of action of hallucinogens, the author described Albert Hoffman’s accidental discovery of LSD’s psychoactive properties, Timothy Leary’s experiments with LSD and psilocybin and the resulting social movements, and the debate on whether LSD contributed to the creativity of the Beatles’ Magical Mystery Tour album. Lectures on schizophrenia and its treatment included references to celebrated schizophrenics such as John Nash, as portrayed in the movie A Beautiful Mind, and David Helfgott, as portrayed in the movie Shine. In fact, a running list of neuropharmacology-related books and movies that the author has deemed “good” or “bad” was provided to the students and received much positive feedback. When teaching on anticholinesterase agents, the author mentioned the 1988 sarin gas attack by Saddam Hussein on the Kurdish people, the 1995 sarin gas attack by the Aum Shinrikyo cult on a Tokyo subway train, and the prophylactic use of pyridostigmine by American soldiers to combat a possible Iraqi sarin gas attack during the 1991 Gulf War. References to pop culture or world events took no more than 10 minutes of lecture time per week, and were invaluable in keeping the students in class and awake.

Address relevant, “cutting edge” research findings too recent or controversial to be included in the textbook. Pharmacy students appear to be uniformly concerned that their education will be “dated” in the near future. There may be some truth to this concern if the
neuropharmacology course consists of the instructor faithfully following the textbook and ignoring recent peer-reviewed research publications. Students browse the Web sites of CNN and other news agencies, and see reports on breakthroughs in neuroscience or development of an investigational drug relating to a disease state covered in the course. The instructor should be the first to see these reports, and should take the initiative to present a summary of the new findings to the class. Optimally, the instructor should also be prepared to critique the scientific article. It is important to instill in the student a critical eye for what is reported in the scientific literature, and especially what is reported in the “abridged” version that appears in the popular press. From his research on opioid receptors and neurotransmitter transporter proteins, the author could comment on new findings from these fields. Interesting findings presented at the annual Society for Neuroscience conference or other scientific conferences were also related and explained when relevant to the subject of the lecture. If the recent finding extended beyond the field of the author (involving muscarinic acetylcholine receptors, for example), a colleague (within or beyond Duquesne University) with this expertise was consulted. When the findings were not documented well enough to merit inclusion in the next edition of the textbook, this caveat was brought to the attention of the class and the students were not tested on the information. The students clearly valued “cutting edge” information that updated, or elaborated on, information found in the textbook, partly because they expect their staggering tuition payments to provide professors who do more than read from the textbook. By discussing drugs currently in clinical trials, the students should acclimate more quickly to newly FDA-approved drugs during their subsequent professional practice.

Providing the “inside story” behind an advance in neuroscience or development of a drug was also appreciated by the class. The author has collected a fair number of these stories in over 20 years as a researcher in the biomedical sciences. These include recounts of the races to clone the monoamine transporter proteins and opioid receptors in the early 1990s, and a conversation with Dr. Oliver Sacks about the parkinsonian patients in Awakenings. Pharmacy students are intrigued but uninitiated regarding the scientific method, and many want to know how the information in their textbook was acquired. They enjoy occasionally hearing a sketch of the experimental design that answered a longstanding question in neuropharmacology. If nothing else, they are reassured in knowing the instructor is well qualified. This type of teaching preparation is not reserved for those involved in basic or clinical research. For instructors who are not actively involved in research, the information could be obtained from their colleagues who are, and from reading the scientific literature.

Occasionally include “cool” neuroscience even though it may not involve therapeutic drugs. Students are fascinated by the neuroscience underlying brain disorders. Because some of the more interesting neuroscience may be unrelated to the action of a drug, a typical neuropharmacology course might omit this information. As an example, autism is an intriguing neurological case that students are quite curious to learn about, but the lack of a corresponding effective pharmacotherapy excludes this topic from most pharmacy curricula. Nevertheless, autism fit nicely within a lecture introducing the CNS in which the associationist cortex of the brain and mechanisms of integrating information were discussed. A comparison of functional magnetic resonance imaging (fMRI) brain scans on autistic and “normal” children is a compelling method for illustrating communication within the brain. Indeed, fMRI “real time” scans always capture the audience. Lectures for this course include scans of a time-lapse sequence of cocaine entering and leaving the nucleus accumbens (the “reward” area of the brain), and images documenting abnormally low frontal cortex activity in individuals with antisocial personality disorders. These data are easily incorporated into lectures involving drugs of abuse and schizophrenia, respectively. Multimedia presentations, including videotape of patients afflicted with neurological disorders related to the condition, receptor, or neurotransmitter currently being studied, should also be effective teaching tools. Other fascinating aspects of neuroscience are found in alternative approaches to treating a neurological disorder. After covering the pharmacology of anticonvulsants used to treat epileptic seizures, the more drastic surgical approaches for preventing tonic-clonic seizures, including hemispherectomy and corpus callosotomy, were discussed. The students were entertained by a brief discussion of the bizarre decoupling of the brain’s vision and language areas upon bisecting the corpus callosum, thus preventing communication between the hemispheres of the brain. The students were also amazed to hear of the curative powers of surgical implantation of striatal brain tissue, dopamine cells, or neurotrophic growth factors into the brain of an individual suffering from Parkinson’s disease. Again, these digressions from the standard pharmacology covered in the text are powerful tools for engaging the student audience.
Let the students know what is “fair game” for the examination, and what is “FYI.” Every instructor knows the pain of hearing the question, “Do we have to know this for the exam?” but perhaps a bit of sympathy for the students is in order. A pharmacy student in the professional phase of the curriculum typically endures 18 credit hours per semester of 100% pharmacy classes for 4 years. Mastering the career-relevant information alone from these courses requires a daunting amount of learning and memorization. Additionally, committing to memory the considerable amount of minutiae found in each lecture, information neither suitable nor intended for an undergraduate examination, can be backbreaking for the student of average ability. The overloaded student will not be able to discriminate which information is important, leading to demoralization, poor attendance, and the goal of merely passing rather than excelling in the course. By indicating when an item covered in class is “for your information” (FYI) only, the instructor can avoid these problems and enjoy an attentive, interactive audience.

This is not to suggest that the instructor should tell the students what information will be tested with the examination; rather, the instructor should indicate which information is too advanced for, or beyond the scope of, the course. Extraneous information in a figure or table may be FYI, as is a graduate-school-level explanation of receptor-mediated signal transduction. The stories and anecdotes described above are always FYI in the author’s lectures. Identifying which portions of the lecture are FYI “after the fact” is only helpful to the student when preparing for the examination. The student is writing furiously, too busy to comprehend this part of the lecture because (s)he is preoccupied with not missing anything that might be on the examination. Instead, coverage of “FYI” material is prefaced by identifying it as such. The students relax, put down their pens, and listen, learn, and enjoy the course. This brief respite energizes the class and the students are attentive for the remainder of the hour.

OUTCOMES

The success of the approaches described above to teaching a neuropharmacology course that students both like and learn from was largely assessed using the quantitative and qualitative portions of the instructor’s Teaching Effectiveness Questionnaire (TEQ). Ninety-nine of the 127 students completed the TEQ administered for the PHBMS 420 neuropharmacology course, scoring a mean of 4.76 out of a possible 5.00 points, a very high score for such a large group of respondents. The qualitative responses were also very positive; many students declared that it was the best course they had ever taken. The clinical cases, stories, and anecdotes were frequently singled out as a favorite part of the course, and most students said they never missed a class because they could count on it being interesting. As one student put it, “You make the boring stuff not boring!”

SUMMARY

It is possible, and even essential, to incorporate cutting-edge neuroscience, clinical case studies, anecdotal stories, cultural references, and relevant references to current events into an undergraduate neuropharmacology course. These additions complement and augment understanding of the material found in the textbook. Occasional snippets of the countless fascinating findings about the brain invigorate the student sitting through 4 consecutive pharmacy classes, increasing the student’s learning, participation, attendance, and satisfaction with their choice of career path.

REFERENCES