American Journal of Pharmaceutical Education **2005; 69 (2) Article 23.**

RESEARCH ARTICLES

Pharmacogenetics and Pharmacogenomics Instruction in Colleges and Schools of Pharmacy in the United States

David A. Latif, MBA, PhD, and Alan B. McKay, PhD

Bernard J. Dunn School of Pharmacy, Shenandoah University

Submitted June 8, 2004; accepted October 3, 2004; published March 22, 2005.

Objectives. To ascertain the extent and depth to which pharmacogenetics/pharmacogenomics is being taught in schools of pharmacy in the United States. To assess perceptions regarding future curricular emphasis dedicated to pharmacogenetics/pharmacogenomics instruction.

Methods. A survey was developed based on recommendations provided in a recent report on pharmacogenetics/pharmacogenomics by AACP's Academic Affairs Committee. It was mailed to 85 deans at colleges and schools of pharmacy in the United States.

Results. Forty-one usable surveys were returned to the authors (48% response rate). Seventy-eight percent of the sample provided some instruction in pharmacogenetics/pharmacogenomics. Items from the domains of the genetic basis of disease, ethical applications, and social and economic impact were used to assess depth of pharmacogenetics/pharmacogenomics instruction. Coverage of these domains varied significantly between schools.

Conclusion. Although the majority of surveyed schools provide some instruction in pharmacogenetics/pharmacogenomics and plan to increase it in the coming years, many presently do not provide the depth recommended by AACP's Academic Cabinet.

Keywords: pharmacogenetics, pharmacogenomics, curriculum, pharmacy education

INTRODUCTION

The National Coalition for Health Professional Education in Genetics (NCHPEG) recently distributed to the health professions education community *Core Competencies in Genetics Essential for All Health-Care Professionals*.[1] Their recommendation for implementation of these competencies stressed that there is a need for commitment on the part of all educators to incorporate genetic information into all levels of professional education.

The potential impact of the emerging knowledge of pharmacogenomics and pharmacogenetics on the future roles of pharmacists was addressed recently by the AACP Academic Affairs Committee.[2] The committee:

- discussed how pharmaceutical education might respond in light of this evolving knowledge base and meet the needs of the profession, health care system, and society;
- identified curricular outcomes, instructional strategies, faculty development needs and strategies, and resource implications; and
- developed a series of recommendations for the Association to guide academic institutions, educational programs, and faculty so they may prepare students with the necessary abilities for their future practice.

Using the AACP's Academic Affairs Committee recommendations for pharmacist competencies regarding pharmacogenomics and pharmacogenetics as a guide, the purpose of this investigation was threefold. The first goal was to ascertain the extent to which pharmacogentics and/or pharmacogenomics is being taught in colleges and schools of pharmacy in the United States. A second goal was to determine the depth in which the subject is being taught. The final goal was to assess school perceptions regarding future emphasis on pharmacogenetics and/or pharmacogenomics in the curricula, and if increased emphasis is planned, how that content will be delivered.

The Human Genome Project was initiated in 1990 with the stated goal of mapping the entire human genome.[3] The initial map was released in early 2001 amid much fanfare and high expectations that a new era of research and clinical practice had arrived.[1] While the road has been more difficult than some had predicted, significant growth in our understanding of the variations between individuals' responses to disease and drug therapy may soon lead to dramatic improvements in medical care. With these improvements will also come attendant

Corresponding Author: David A. Latif, MBA, PhD. Address: Associate Professor of Pharmacy Administration, Department of Biopharmaceutical Sciences, Bernard J. Dunn School of Pharmacy, Shenandoah University, Winchester, VA. 22601. E-mail: dlatif@su.edu

and rapid alterations in approaches to the education of health professionals.

Fueled by the Human Genome Project, pharmacogenomics is a broad, rapidly evolving field encompassing the analysis and application of the genetic basis of disease and the genetic determinants of drug efficacy and toxicity.[1] The term emanates from pharmacogenetics, which revolves around clinical observations of inherited differences in response to drugs.[4] Often, the terms pharmacogenetics and pharmacogenomics are used interchangeably. However, rather than focusing on single genes, pharmacogenomics uses genome-wide approaches to explain the inherited basis of differences between individuals and their response to drugs.[4] For purposes of this investigation, any instruction involving either pharmacogenomics or pharmacogenetics was deemed to be related to the same domain. The reason for this is potential confusion between the 2 terms. Therefore, this investigation did not seek to differentiate between pharmacogenomics and pharmacogenetics.

Pharmacy educators and practitioners have become acutely aware of the potential that this field has for their respective fields of research, education, and practice, but they and the entire health care field are finding it difficult to stay abreast of developments.[3] For example, the pharmaceutical industry has used recombinant DNA strategies to develop new protein biopharmaceuticals that have altered and will continue to alter pharmacotherapy.[5] The field of pharmacogenomics is expected to have a dramatic impact by introducing new drugs that will significantly alter the course of disease, treating some diseases for the first time and altering our perspective on when and where to intervene in the course of disease. As a result of ongoing developments in pharmacogenomics and pharmacogenetics, a greater amount of useful information about specific regions of the human genome is available and genetic basis for disease and potential pharmacotherapy remedies are being investigated.[1,2] Nearly all disciplines within the pharmacy curriculum will be affected to a greater or lesser degree by clearer understanding of drug response through pharmacogenomics and pharmacogenetics.[2] For example, colleges and schools of pharmacy could play a pivotal role in educating health professionals on the optimal applications and treatment choices regarding the latest research in pharmacogenomics and pharmacogenetics.

In this paper, the methods used to assess the extent, depth, and perceptions regarding the future emphasis on pharmacogenomics in colleges and schools of pharmacy in the United States are described. Suggestions are offered on how colleges and schools of pharmacy may educate pharmacists to play a larger role in the dynamic fields of pharmacogenetics and pharmacogenomics.

METHODS

This investigation was descriptive and a request for exemption was approved by the authors' Institutional Review Board. The intent of this study was to describe the state of pharmacogenomic/pharmacogenetics instruction in schools of pharmacy in the United States. A survey was developed to assess the state of pharmacogenomics/pharmacogenetics instruction in the professional curricula of schools of pharmacy in the United States (available upon request from the authors). The authors concluded that conducting a survey was the best means of obtaining a comprehensive and accurate picture of curricular inclusion of pharmcogenomics/pharmacogenetics.

In March 2004, an initial letter was sent to 85 deans at member colleges and schools of pharmacy. The names and addresses of the deans were taken from the American Association of Colleges of Pharmacy 2003-04 Roster.[6] The letter described the intent of the study and thanked the deans in advance for their cooperation with the forthcoming survey. One week later, a cover letter was mailed to the 85 deans asking for their assistance in completing the survey by distributing it to pertinent faculty members responsible for teaching topics pertaining to pharmacogenomics/pharmacogenetics in the school's curriculum. The survey used for this investigation was developed by the authors based on a review of the relevant literature and on a requisite understanding of survey methodology. A major component in developing this survey was derived from the National Coalition for Health Professional Education in Genetics (NCHPEG) and the recommendations from the American Association of Colleges of Pharmacy's (AACP) Academic Affairs Committee regarding core competencies in phrmacogenetics and pharmacogenomics for pharmacists.[1,2] The pharmacy literature was searched to determine whether previous studies had examined pharmacogenomics/pharmacogenetics inclusion in pharmacy curricula. Unfortunately, the authors could find no previous studies assessing the extent and depth of pharmacogenomics/pharmacogenetics instruction in colleges and schools of pharmacy in the United States.

To maximize the response rate, the survey design employed a modified method developed by Salant and Dillman, whereby an initial pre-cover letter sent to the sample is followed by a cover letter and instrument.[7] The cover letter and instrument was then followed by 3 reminders sent 2 weeks apart to nonresponders. As a

Table 1. Demographics of Sample: Pharmacogenomics/ Pharmacogenetics School, N=41

	N	Percent
Is the subject taught at your school?		
Yes	32	78
No	9	22
At what level is the subject being taught?		
PharmD	16	39
Masters/PhD/Other	16	39
Where does the subject reside?		
Stand-alone required	4	9.8
Stand-alone elective	1	2.4
Part of another course	19	46.3
More than one above	8	19.5
Is there a single faculty member responsible for the subject?		
Yes	3	7.3
No	28	68.3
Are prerequisites required to take this subject?		
Yes	5	12.2
No	27	65.9
What is the present instruction state of this subject in schools of pharmacy?		
Very good	1	2.4
Good	4	9.8
Average	15	36.6
Poor	13	31.7
Very poor	3	7.6
Plans to hire additional faculty to teach subject?		
Fiscal year 2004-05	7	17.1
Fiscal year 2005-06	7	17.1
Fiscal year 2006-07	6	14.6

final effort to maximize response rates, the last reminder sent to nonresponders provided instructions for accessing and completing the survey online.

Collected data were analyzed using *SPSS* software version 11.0 (SPSS Inc., Chicago, Ill). Statistical tests included Student t tests and frequency distributions.

RESULTS

Of the 85 initial letters and instruments sent, 36 were returned by mail to the authors and 5 responses were sent by e-mail or fax (48% response rate). In order to assess the impact of nonresponse error on the questionnaire, a methodological procedure recommended by Churchill was used.[8] The procedure is based on the premise that late responders may be similar to nonresponders on variables of interest. By keeping track of those responding to the initial mailing and subsequent reminders, the means of the variables of interest can be calculated and then compared among the different subgroups to determine whether the subgroups are significantly different, based on the degree of difficulty experienced in making contact.[8] If no discernable trend is evident, nonresponders are assumed not to be systematically different from responders. Based on an analysis of responders, nonresponse bias did not appear to be a problem in this investigation.

Table 1 provides a summary of several pertinent items on the survey. The first goal of this investigation examined whether any component of pharmacogenomics/pharmacogenetics was being taught. Of the 41 responses, 32 colleges and schools stated that the subject was taught in their curriculum (78%). Of these 32 schools, 16 taught the subject exclusively to doctor of pharmacy students, while 16 taught pharmacogenomics/pharmacogenetics to postgraduate students (ie, masters and PhD) in addition to doctor of pharmacy students. Furthermore, only 3 of the 32 schools that provided instruction in pharmacogenomics/pharmacogenetics relegated this responsibility to a single faculty member, and 27 of the 32 schools did not require specific prerequisites (other than normal progression through the pharmacy curriculum). Table 1 depicts where pharmacogenomics/pharmacogenetics instruction was being taught in the curriculum.

The second goal of this investigation was to assess the depth of pharmacogenomics/pharmacogenetics instruction. To assess this, respondents were asked to check off salient topics and skills taught pertaining to pharmacogenomics/pharmacogenetics. These items were taken from AACP's Academic Affairs Committee recommendations of pharmacist competencies regarding pharmacogenomics and pharmacogenetics.[2] Items pertaining to the domains of genetic basis of disease (20 items) and ethical applications, social and economic implications (9 items) were selected. The percentage of the items in each domain addressed in the 32 schools that provided instruction in pharmacogenomics/pharmacogenetics were as follows: genetic basis of disease, 56% (11 of 20 items); ethical applications, social and economic implications, 33% (3 of 9 items).

The final goal of this investigation examined perceptions regarding future emphasis on pharmacogenomics/pharmacogenetics in the curricula. In response to the question regarding the present state of pharmacogenomics/pharmacogenetics instruction, the mean of the 41 colleges and schools was slightly above average (3.24 on a 5-point Likert scale anchored at 1 = "very good" and 5 = "very poor"). Interestingly, those schools that did not

provide pharmacogenomics/pharmacogenetics instruction perceived the present state of this instruction to be significantly poorer than those schools who did provide it ($\alpha = 0.018$).

Sixty-eight percent of sampled colleges and schools planned to increase their pharmacogenomics/pharmacogenetics instruction during the next 3 years. Table 1 includes a summary of the schools' plans for hiring additional full-time faculty members for pharmacogenomics/pharmacogenetics instruction.

DISCUSSION

As stated previously, this descriptive study sought to assess the extent and depth to which colleges or schools of pharmacy in the United States taught pharmacogenomics/pharmacogenetics. It also assessed schools' plans regarding providing future curricular space for the subject.

That 78% of the schools sampled provide some instruction in pharmacogenomics/pharmacogenetics is laudable. This demonstrates an awareness among pharmacy schools of the importance of the topic to pharmacy. However, somewhat discouraging is the depth to which the subject is being taught in schools of pharmacy. Specifically, using the AACP Academic Affairs Committee's recommendations on pharmacist competencies/skills as a guide, the average pharmacy school that provides pharmacogenomics/pharmacogenetics instruction is only addressing about half of the recommendations pertaining to the genetic basis of disease and about one third of the recommendations related to ethical applications and social and economic implications. Therefore, a great deal of work needs to be done to expand pharmacogenomics/pharmacogenetics instruction in schools of pharmacy. Two suggestions are offered to address this. The first relates to faculty development. Specifically, interested faculty members with backgrounds in areas such as biology, biochemistry, biotechnology, cell biology, chemistry, genetics, and immunology should be encouraged by their institutions to obtain the requisite skills to provide didactic instruction in pharmacogenomics/pharmacogenetics. This may be accomplished through formal training, attending workshops, or completing tutorials such as *Pharmacogenomics: Applications to Patient Care*, which is offered by the American College of Clinical Pharmacy (http://www.accp.com/strphgen.php). A second suggestion is to encourage faculty members who teach this subject matter to more closely follow the core competencies suggested by the AACP's Academic Affairs Committee in designing pharmacogenomics/pharmacogenetics instruction.

Although the cumulative sample (41 schools) perceived the state of pharmacogenomics/pharmacogenetics instruction in schools of pharmacy as adequate, further examination revealed that the schools that provided it (32 schools) perceived the instruction to be significantly better than those who did not (9 schools). Perhaps the achievement orientation prevalent in the United States is playing a role in that they have the mindset, "if I teach pharmacogenomics/pharmacogenetics, the state of this instruction cannot be poor."[9] It is very encouraging that 68% of the sample plan to increase pharmacogenomics/pharmacogenetics instruction during the next 3 years. Many plan to hire faculty members specifically dedicated to this instruction. A suggestion for optimally delivering pharmacogenomics/pharmacogenetics instruction is to bring in more expertise.

If hiring PharmDs and/or PhDs with expertise in pharmacogenomics/pharmacogenetics proves too difficult for colleges and schools of pharmacy, then training faculty members who already have the requisite backgrounds discussed above (eg, biology, biochemistry, etc) might be a reasonable strategy for gaining greater expertise in this important domain. In addition, schools of pharmacy must develop outcome measures by demonstrating that students are more competent in pharmacogenomics/pharmacogenetics upon entering their experiential rotations and upon graduation.

Limitations

This investigation has several inherent limitations. Since it was descriptive in nature, no cause and effect relationships can be established. In addition, although the response rate was 48% and nonresponse bias was assessed, the 52% of the schools who did not respond might have responded significantly differently than this sample. Thus, generalizing this investigation to all colleges and schools of pharmacy may not be reasonable.

A third limitation relates to the methodology and the survey instrument itself. Specifically, the instrument was sent to the deans and they were asked to forward the instrument to the most appropriate faculty members. To the extent that the deans erred in forwarding the survey to the most appropriate faculty members, the results may be suspect. Likewise, the survey was based on AACP's Academic Affairs Committee recommendations for core competencies deemed essential for pharmacists.[2] However, it is possible that the different components of pharmacogenetics/pharmacogenomics instruction presently being taught by the schools surveyed may be as important as those recommended by the Committee.

Finally, an item on the survey asked the number of full-time faculty members' that schools of pharmacy

anticipated hiring to deliver pharmacogenetics/pharmacogenomics instruction in the subsequent 3 fiscal years. The responses to this item may be understated to the extent that schools plan to hire faculty members from other science disciplines (eg, biology, biochemistry) who have (or plan to gain) expertise in this subject matter.

Despite these caveats, this investigation provides the first glimpse of the extent and depth of and future plans for pharmacogenetics/pharmacogenomics instruction in schools of pharmacy in the United States.

CONCLUSIONS

This descriptive study of the state of pharmacogenetics/pharmacogenomics instruction in curricula of schools of pharmacy in the United States demonstrates that an awareness of the need for this instruction exists, but that a much greater effort is needed to align this instruction with the recommendations advanced by the AACP Academic Affairs Committee on core pharmacist competencies/skills. The results of the present study call for a more in-depth approach to pharmacogenetics/pharmacogenomics curricula within colleges and schools of pharmacy in United States. If pharmacists are to take a leadership role in pharmacogenetics/pharmacogenomics, then schools of pharmacy need to offer a more structured, formalized process of teaching this important topic. Outcomes data demonstrating that students are more prepared upon entering their experiential rotations and upon graduation are also needed.

ACKNOWLEDGEMENTS

The authors greatly appreciate the financial support from Merck & Co, Inc, for this investigation.

REFERENCES

1. Core Competencies in Genetics Essential for All Health-Care Professionals. National Coalition for Health Professional Education in Genetics. January 2001.
2. Johnson JA, Bootman JL, Evans WE, et al. Pharmacogenomics: A scientific revolution in pharmaceutical sciences and pharmacy practice. Report of the 2001-2002 Academic Affairs Committee. *Am J Pharm Educ*. 2002;66: 12S-17S.
3. Venter JC, Adams MD, Myers EW, et al. The sequence of the human genome. *Science*. 2001:291:1304-51.
4. Evans WE, McLeod HL. Pharmacogenomics: Drug disposition, drug targets, and side effects. *N Engl J Med*. 2003; 348:538-49.
5. Evans WE, Johnson J. Pharmacogenomics: The inherited basis for inter-individual differences in drug response. *Ann Rev Geonomics Hum Genet*. 2001:02:9-39.
6. 2003-04 Roster of Faculty and Professional Staff, American Association of Colleges of Pharmacy, Alexandria Va. 2003, 23-189.
7. Salant P, Dillman DA. *How to Conduct Your Own Survey*. Ft. Worth, Tx: John Wiley & Sons, Inc;1994.
8. Churchill GA. *Marketing Research: Methodological Foundations*, 3rd ed. Holt, New York NY: Rinehart and Winston, 1996.
9. Trompenaars F. Resolving international conflict: culture and business strategy. *Bus Strat Rev*. 1996; 7:51-68.