Pharmacy Education, 2012; 12 (1): 31 - 36

The Impact of Incorporating of Pharmacogenomics into the Pharmacy Curriculum on Student Interest

NATALYA VAKSMAN[1], MITCHELL BARNETT[1], LEANN HAKOBYAN[1], ILYA KUCHER[1], MAGGIE C. LOUIE[1,2*]

[1] *College of Pharmacy, Touro University of California, Mare Island, California 94592, U.S.A.*

[2] *Department of Natural Sciences and Mathematics, Dominican University of California; San Rafael, California 94901, U.S.A.*

Abstract

Background: Pharmacogenomics content in the pharmacy curriculum has increased since AACP adopted NCHPEG guidelines in 2001.

Aims: To evaluate how program level curricular changes impact pharmacy student opinions regarding pharmacogenomics, and gauge student interest in pursuing a career in pharmacogenomics.

Methods: First and third year students from eight pharmacy schools in California completed a survey indicating their attitudes towards pharmacogenomics.

Results: The survey concluded that the presence of a stand-alone pharmacogenomics course did not impact student perceived preparedness for a career in pharmacogenomics. Furthermore, the presence of a course did not influence student interest in pursuing a residency, fellowship, or career in pharmacogenomics. While the presence of a faculty specialising in pharmacogenomics increased student awareness, it did not increase student interest in pursuing a pharmacogenomics career.

Conclusion: The integration of pharmacogenomics into the pharmacy curriculum resulted in positive perceptions regarding student preparedness for a pharmacy career in pharmacogenomics, but did not cultivate student interest.

Keywords: *pharmacogenomics, pharmacy curriculum, pharmacogenetics*

Introduction

Pharmacogenomics is the study of how inherited variations in genes dictate drug response and the use of these variations to predict responses to drugs (Rogers *et al*., 2002). By facilitating individualised patient medication regimens, it is hypothesised that pharmacogenomics will enhance both patient safety and drug efficacy while improving pharmacotherapy outcomes (NCHPEG, 2007). The burgeoning advances in pharmacogenomics creating an acute need for competent practitioners will likely alter many aspects of pharmacotherapy. In recognition of this need, the American Association of College of Pharmacy (AACP) has recommended that pharmacy schools begin educating future practitioners on the use of gene-based therapies, including patient specific drug regimens. AACP has adopted guidelines from the National Coalition for Health Professional Education in Genetics (NCHPEG) and set forth recommendations to evaluate pharmacogenomics in pharmacy education (Johnson *et al*., 2002). Specifically, AACP recommends that:

- Pharmacogenomics be formally incorporated into the pharmacy curriculum; and that
- Faculty use teaching strategies that emphasise the impact of pharmacogenomics on the future of healthcare.

A recent study evaluated the current presence of pharmacogenomics in U.S. pharmacy schools and found that the vast majority (92%) of responding colleges were complying with the AACP recommendation of incorporating pharmacogenomics into their Doctor of Pharmacy degree curricula (Murphy *et al*., 2010). The study showed nearly a three-fold increase in inclusion of pharmacogenomics in curriculums compared to a study completed only five years earlier (Latif *et al*., 2005). The increase in pharmacogenomics instruction over a relatively short time period would appear to be appropriate given the growing importance of pharmacogenomics in patient care (Abrahams *et al*., 2009) The expansion is also consistent with the attention given the topic area by national stakeholders including, AACP, ACPE (Accreditation Council for Pharmacy Education), and NCHPEG.

Although the AACP guidelines on pharmacogenomics may have helped created a shift in pharmacy curricula, it is unclear how this change has impacted pharmacy students' actual perceptions of pharmacogenomics and whether this curricular shift has increased student interest in pursuing careers in pharmacogenomics.

The objectives of this study are: 1) to assess student awareness and perceptions regarding pharmacogenomics; and

*Correspondence: Dr. Maggie C. Louie, *College of Pharmacy, Touro University of California, Mare Island, CA 94592; Department of Natural Sciences and Mathematics, Dominican University of California; San Rafael, CA 94901. Tel: +00 1 707 638 5989; Fax: +00 1 707 638-5266 . Email: maggie.louie@tu.edu*

ISSN 1447-2701 online

2) to evaluate interest in pursuing a residency or research fellowship and/or career in pharmacogenomics among pharmacy students. Examining student perceptions of pharmacogenomics will advance the understanding of the impact of this curricular shift in pharmacy education. It will identify potential barriers surrounding the implementation of pharmacogenomics into pharmacy curricula. Additionally, findings will help educational leaders determine whether the incorporation of pharmacogenomics into pharmacy curricula generated the effect intended by AACP.

Methods

A survey tool was designed to measure student interest and their perception of preparedness for a career in pharmacogenomics. Some of the content of this pharmacy student survey was adapted from a previous pharmacogenomics survey of pharmacy school academics by Murphy *et al*. (2010). Additional questions were developed from a focus group comprised of pharmacy students and a faculty advisor. The survey instrument was tested to assess item completeness and question clarity and revised to reflect comments received from the pilot data. The research project was reviewed and approved by Institutional Review Board (IRB No. P-0409). The population surveyed included first year (P1) or third (P3) year students from the eight pharmacy schools in California: California North State (Cal-N), Loma Linda University (LLU), Touro University of California (Touro), University of California San Francisco (UCSF), University of California, San Diego (UCSD), University of the Pacific (UOP), University of Southern California (USC), and Western University (Western).

Survey invitations were sent out on three separate occasions at end of year to all eligible first and third year students via an email list serve. First and third year students were chosen because their opinions would reflect both pharmacy students early and late in their pharmacy education, and third year students were also more accessible than fourth year students. Student email addresses were obtained from the respective colleges of pharmacy. Hard copies of the survey were distributed to P1 and P3 students at all schools except students at UOP and UCSD as a means to achieve higher response rates. Students completed either the hard copy or the electronic survey tool. The survey was 29 questions in length requiring approximately five minutes to complete. A series of demographic as well as dichotomous (Yes/No) and 5-Point Likert Type scale (e.g., 1=strongly agree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree) opinion questions were utilised.

In addition to the student survey instrument, Deans from the California colleges of pharmacy were e-mailed inquiring: 1) if a stand-alone pharmacogenomic course existed in their curriculum; 2) the year in the curriculum of the pharmacogenomics course; 3) if there was not a stand-alone pharmacogenomics course, was pharmacogenomics taught as a part of another course, and 4) did the school have a faculty member who specialised in pharmacogenomics.

A database was created using Statistical Analysis System, version 9.1.3, (SAS, Cary, NC). The median, as well as the mean and standard deviation were tabulated for the Likert scale variables. Statistical comparisons were made using a Wilcoxon Rank Sum for the ordinal Likert scale questions and a chi-square test for dichotomous measures. The a *priori* level of significance was set at 0.05 ($\alpha < 0.05$).

Results

Of the 1,471 surveys distributed, 714 students initially responded and attempted the survey tool. Of these, 644 questionnaires were considered eligible for analysis resulting in a final response rate of 44%. Reasons for exclusion of completed questionnaires included: not completing the survey tool to its entirety, not currently attending a California School of Pharmacy, and/or not currently classified as a P1 or P3. Table I provides the self-reported demographics of the students who completed the survey questionnaire with a breakdown of participation by Colleges of Pharmacy. Values for student measures such as mean age (27 years) and gender (73% female) appear to be representative of State of California College of pharmacy students. Among respondents, however, first year students (68.2%) outnumbered third year students (31.8%) despite the fact that class sizes were similar between the years.

Table I: Demographics (N=644)

Age	Mean years ± SD	25.7 ± 3.5
Sex		
	Males, number (%)	172 (26.7%)
	Females, number (%)	472 (73.3%)
Year in pharmacy school		
	First year, number (%)	439 (68.2%)
	Third year, number (%)	205 (31.8%)
School		
California North state University, number (%)		66 (10.3%)
Loma Linda University, number (%)		90 (14.0%)
Touro University-California, number (%)		88 (13.7%)
University of Pacific, number (%)		21 (3.3%)
University of California-San Diego, number (%)		32 (5.0%)
University of California- San Francisco		107 (16.6%)
University of Southern California, number (%)		153 (23.8%)
Western University, number (%)		87 (13.5%)

The majority of first and third year students (87.7% and 96.7% respectively) responded that they were “aware of what pharmacogenomics is” (Table II). A larger percentage of third year students reported "awareness of what pharmacogenomics is" (p<0.001). Similarly, both first and third year students agreed that pharmacogenomics is “important for the future pharmacist” (Table II). However, students were relatively neutral (and different student groups were similar) regarding whether "pharmacists are prepared for an active role in pharmacogenomics". Third year students reported a lower "interest in a residency, fellowship and/or career specialising pharmacogenomics" (Table II, p<0.050) relative to first year students (mean score of 3.0 and 2.7).

Table II: Responses by Year in School (N=644)

	1st Year (n=439)	3rd Year (n=205)	P Value
Are you aware what pharmacogenomics is, number (% YES)	385 (87.7%)	200 (97.6%)	<0.001 --*
Pharmacogenomics important for future pharmacists, median, mean ± SD[1]	4, 4.34 ± 0.73	4, 4.31 ± 0.73	0.534 **
Interested in a residency/fellowship in pharmacogenomics, median, mean ± SD	3, 2.91 ± 0.96	2, 2.54 ± 1.02	<0.001 **
Interested in a pharmacy career in pharmacogenomics, median, mean ± SD	3, 2.95 ± 0.95	3, 2.67 ± 1.02	<0.001 **
Pharmacists are prepared for a role in pharmacogenomics, median, mean ± SD	3, 3.10 ± 0.73	3, 2.98 ± 0.93	0.110 **
My pharmacy education has sufficiently prepared me for a career in pharmacogenomics, median, mean ± SD	3, 2.85 ± 0.89	3, 2.98 ± 0.91	0.117 **

[1] SD: Standard Deviation
*= chi-square test
**= Wilcoxon rank sum test

Table III: P3 Responses by whether Pharmacy Curriculum Incorporates Pharmacogenomics Course (N=205)

	Curriculum Incorporates Pharmacogenomics as Standalone Course (n=55)	Curriculum does NOT Incorporate Pharmacogenomics as Standalone Course (n=150)	P Value
Are you aware what pharmacogenomics is, number (% YES)	54 (98.2%)	146 (97.3%)	0.727 *
Pharmacogenomics important for future pharmacists, median, mean ± SD[1]	4, 4.30 ± 0.74	4, 4.33 ± 0.73	0.707 **
Interested in a residency/fellowship in pharmacogenomics, median, mean ± SD	2, 2.51 ± 1.09	2, 2.55 ± 0.99	0.765 **
Interested in a pharmacy career in pharmacogenomics, median, mean ± SD	3, 2.76 ± 1.05	2.5, 2.63 ± 1.00	0.390 **
Pharmacists are prepared for a role in pharmacogenomics, median, mean ± SD	3, 2.91 ± 0.97	3, 3.01 ± 0.92	0.556 **
My pharmacy education has sufficiently prepared me for a career in pharmacogenomics, median, mean ± SD	3, 3.09 ± 0.87	3, 2.94 ± 0.92	0.263 **

[1]SD: Standard Deviation
*= chi-square test
**= Wilcoxon rank sum test

Table IV: Curriculum Data from Academic Chairs and Deans of California Pharmacy Schools.

	UCSD[1]	Western[1]	UCSF[1]	USC[1]	Cal-N[1]	UOP[1]	Touro[1]	LLU[1]
Do you have a separate course in pharmacogenomics?	YES	YES	YES	NO	NO	NO	NO	NO
If you DO have a separate course in pharmacogenomics, what year is it taught?	P3	P1	P1	N/A[2]	N/A	N/A	N/A	N/A
If you do NOT have a separate course in pharmacogenomics, is the topic incorporated into another course?	N/A	N/A	N/A	YES	YES	YES	YES	YES
If pharmacogenomics is incorporated into another course, what year(s) is it taught	N/A	N/A	N/A	P2/P3	P3	P1/P2/P3/P4[3]	P2	P1/P2/P3
Do have a faculty member who specialises in pharmacogenomics?	YES	YES	YES	YES	YES	NO	YES	NO

[1]UCSD: University of California, San Diego; Western: Western University; UCSF: University of California, San Francisco; USC: University of Southern California; Cal-N: California North State; UOP: University of the Pacific; Touro: Touro University of California; LLU: Loma Linda University
[2]N/A: Not Applicable
[3]P1: First year pharmacy students; P2: Second year pharmacy students; P3: Third year pharmacy students; P4: Fourth year pharmacy students

To evaluate how the variations in the pharmacogenomics curricula impact student interest, the third year students survey responses were dichotomised by whether a school offered pharmacogenomics as a standalone course. The results showed that regardless of how the pharmacogenomics didactic material was integrated into the pharmacy curriculum, standalone course or blended into existing courses, there was no significant impact on students' opinions regarding the importance of pharmacogenomics for future pharmacists (Tables III and IV). Additionally, having a standalone course in pharmacogenomics did not bias student opinions regarding whether "pharmacist are prepared for a role in pharmacogenomics" and student's interest in pursuing a career in the field.

We further evaluated whether having a faculty member who specialises in pharmacogenomics impacted student opinions of pharmacogenomics (Table IV and V). Stratifying third year students' responses by whether a school has a faculty member specialising in pharmacogenomics, we found that both groups strongly agreed that pharmacogenomics was important for the future of pharmacy. Although having a faculty member who specialises in pharmacogenomics increased the percentage of students reporting having more "awareness of what pharmacogenomics is" (p<0.044, Table V), it did not result in more positive opinions about pursuing a career in pharmacogenomics. Although the difference in awareness between the two groups was statistically significant, it may not be of practical importance since it does not alter interest or opinions regarding pharmacogenomics. While increased awareness of pharmacogenomics could be due to exposure during pharmacy school (Table IV), there could be other reasons (i.e. reading articles about the topic in common publications); thus it is difficult to ascertain whether the increased awareness is directly attributed to the curriculum.

Table V: P3[1] Responses by whether Pharmacy School has a Faculty Member Specialising in Pharmacogenomics Research

	School has a Faculty Member Specialising in Pharmacogenomic Research (n=158)	School Does Not Have Faculty Member Specialising in Pharmacogenomic Research (n=47)	P Value
Are you aware what pharmacogenomics is, number (% YES)	156 (98.7%)	44 (93.6%)	0.044 * —
Pharmacogenomics important for future pharmacists, median, mean ± SD[2]	4, 4.31 ± 0.67	5, 4.34 ± 0.92	0.282 ** —
Interested in a residency/fellowship in pharmacogenomics, median, mean ± SD	2, 2.51 ± 1.06	3, 2.66 ± 0.87	0.249 ** —
Interested in a pharmacy career in pharmacogenomics, median, mean ± SD	3, 2.64 ± 1.02	3, 2.77 ± 1.00	0.416 ** —
Pharmacists are prepared for a role in pharmacogenomics, median, mean ± SD	3, 2.94 ± 0.88	3, 3.11 ± 1.07	0.424 ** —
My pharmacy education has sufficiently prepared me for a career in pharmacogenomics, median, mean ± SD	3, 2.95 ± 0.88	3, 3.09 ± 0.99	0.421 ** —

[1]P3: Third year pharmacy students
[2]SD: Standard Deviation
[*]= chi-square test
[**]= Wilcoxon rank sum test

Discussion

In 2005, Latif and McKay highlighted the need to incorporate pharmacogenomics into the pharmacy curriculum, and revealed that pharmacogenomics was only being taught at a cursory level (Latif *et al*., 2005). The authors recommended the expansion of pharmacogenomics curriculum to closely adhere to the core competencies recommended by the AACP Academic Affairs Committee. Murphy *et al*. (2010) recently reported that most colleges have integrated pharmacogenomics into the pharmacy curriculum, increasing their compliance with AACP recommendations. These earlier studies have been largely focused on the incorporation of pharmacogenomics into curriculum at the pharmacy school level, but none have gauged the impact of this curricular change on student interest in the field. The present study surveyed student opinions regarding the impact of pharmacogenomics coursework and faculty expertise on awareness of pharmacogenomics and interest in pursuing a career, residency, and/or fellowship in the field.

Consistent with Murphy's findings which showed that most US Pharmacy schools (92%) have incorporated pharmacogenomics, results from this study showed that all eight pharmacy schools in California have incorporated pharmacogenomics into their curriculum. However, pharmacogenomics is being taught in different ways among the various pharmacy schools in California. While some schools reported having a stand-alone pharmacogenomics course, others reported incorporating pharmacogenomics as part of another course. In addition, some of the schools reported having at least one faculty member that specialises in pharmacogenomics, whereas other schools did not report having any faculty with pharmacogenomics expertise. However, while curricular changes were recommended in recent years to increase didactic content and it appears that most colleges were teaching this content, current results suggest that student interest in pursuing a residency/fellowship or career in pharmacogenomics is low (Table II).

Surprisingly, having a stand-alone course in pharmacogenomics or having a faculty member that specialises in pharmacogenomics did not appear to play a significant role in increasing student interest, whereas year in school appeared to be related to the level of interest in considering a career in pharmacogenomics, with the first year students showing slightly greater interest (Table II and III). This is likely due to the fact that first year students tend be more open minded about career options, whereas third year students have often established an area of interest to pursue (Furnham *et al*., 2004; Compton *et al*., 2008).

Studies have shown that incorporating active learning experiences often increase student interests (Reddy *et al*., 2000; Armbruster *et al*., 2009). Specifically, Knoell *et al.* (2009) showed that the incorporation of laboratory experiences positively influenced student opinions in pharmacogenomics. By teaching pharmacogenomics through application, students learn to use genetic information in the framework of medication management, which allows students to see the practical applications of pharmacogenomics (Seybert *et al*., 2008).

In order to potentially increase the availability of pharmacist practitioners in the new and expanding area of pharmacogenomics, pharmacy schools should modify their pharmacogenomics curricula to increase student interest. Some curriculum modifications may include incorporating laboratory or active learning experiences to enhance the didactic content, and offering the pharmacogenomics coursework earlier in their didactic years to promote interest. Regardless of whether content is offered as a stand-alone course or integrated into another course, or whether the school has a faculty specialising in the field or not, student interest needs to be sustained through application and constant reinforcement (MacKinnon *et al*., 2001; Spray *et al*., 2007). Didactic curriculum without practical exposure may not be sufficient to influence student interest.

A question worth addressing in future studies is whether the low level interest in a pharmacogenomics is related to the lack of residency programs focused on pharmacogenomics. The American Society of Health-System Pharmacists (ASHP) accredited residency programs do not include any residencies that are specifically categorised as pharmacogenomics in either the postgraduate year-1 (PGY-1) or postgraduate year-2 (PGY-2) years (ASHP, 2011). Although pharmacogenomics is currently incorporated as part of another residency program or as a research fellowship, the absence of specific residencies in this area likely decreases the publicity given to pharmacogenomics. Creating a distinct pharmacogenomics residency programme may directly influence student interest. Additionally, the FDA (Food and Drug Administration) has recognised the importance of pharmacogenomics in drug therapy and has recently approved certain drug labels to contain pharmacogenomic information including: 1) drug exposure and clinical response variability, 2) risk for adverse events, 3) genotype-specific dosing, 4) mechanisms of drug action, and 5) polymorphic drug target and disposition genes (FDA, 2008; FDA, 2011; Frueh *et al*., 2008). As the use of pharmacogenomics in medication management increases, the demand for healthcare professionals with relevant training will increase, underscoring the need for the development of residency programs in the area of pharmacogenomics in order to provide trained professionals to take on this new responsibility (Lee *et al*., 2010).

Several study limitations should be noted, including those inherent with survey research, for example, incomplete sampling, relying on self-reported measures, and limited ability to accurately determine cause and effect. In addition, participation in this study was limited to students attending pharmacy schools in the state of California and results may not be transferable to other geographical areas of the country or beyond. Another potential limitation was that third year (P3) students were less likely to participate in the survey relative to first year (P1) students. Also the proportions of students responding from each school were not representative of their actual distribution, potentially skewing results and exposing a potential flaw in the distribution methods of the survey tool. Both UCSD and UOP were underrepresented in our study, since their first year and third year students received only the electronic survey tool, creating a potential bias in our results. Additionally, the survey did not assess whether the pharmacogenomics curriculum was being offered as a required or an elective course, and thus may limit the interpretation of the results. Although some schools have faculty members who specialise in pharmacogenomics, the study did not evaluate whether the individuals have sufficient contact hours with pharmacy students. This may influence student interest in pursuing a career or fellowship in pharmacogenomics and limit the interpretation of our results. Finally, the study was purely descriptive in nature. Although the study did have several limitations, it is a useful tool in providing feedback from students on the progress of pharmacogenomics education and its future, and establishes a baseline of pharmacy students' opinions regarding an interest and/or career in pharmacogenomics.

Our results suggest that all California pharmacy schools are in compliance with the AACP recommendations related to pharmacogenomic content; however, the implementation of pharmacogenomics into the curriculum does not appear to increase overall student interest in pursuing a residency, fellowship or career in the field. Although the awareness level was high in both year classes, survey results suggest that first year (P1) students appear more receptive about pursuing a residency/fellowship and/or a career relative to third year (P3) students. Additionally, our findings showed that having a stand-alone course in pharmacogeomics and having a faculty member who specialises in the field does not appear to play a role in increasing student interest in the topic. These two variables also do not change student opinions regarding student preparedness for a career in pharmacogenomics. Our results show that students believe that pharmacogenomics is important to the practice of pharmacy, but do not believe that pharmacists are yet prepared for this role (neutral scoring). Understanding student perceptions will help determine the effectiveness of this curriculum shift in preparing future pharmacists for an active role in pharmacogenomics and determine if pharmacy schools are meeting recommendations set forth by the AACP.

Acknowledgements

We would like to thank Dr. Aglaia Panos, and Dr. Katherine Knapp for their support and encouragement. We are grateful to Dr. Paul Perry for his critical reading of the manuscript. We would like to also thank the CAPSLEAD organisation for providing us with the platform to work on this project.

Declaration of Interest

The authors declare they have no competing financial interests.

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