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BRIEF

The Current Landscape of Pharmacogenomics Advanced Pharmacy Practice Experiences at U.S. Pharmacy Programs

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Objective. The objective of this study is to characterize available Advanced Pharmacy Practice Experience (APPE) rotations with a primary focus in pharmacogenomics at schools of pharmacy in the United States (U.S.)
Methods. This was a cross-sectional, multicenter, observational study of pharmacogenomics APPEs at U.S. pharmacy schools. Directors of Experiential Education at the 146 accredited schools of pharmacy in the U.S. were contacted by phone and asked if their school offered a pharmacogenomics APPE rotation. Identified pharmacogenomics APPE preceptors from this phone screen were contacted via email with an online survey that asked about their rotation offerings.
Results. Of the 142 schools of pharmacy that were successfully reached via phone, 40 (28%) offer an APPE rotation with a primary focus in pharmacogenomics. Thirty unique APPE rotations with pharmacogenomics as a primary focus were identified, and the total number of preceptors was 33 (faculty preceptors: n = 19 [58%], non-faculty preceptors: n = 14 [42%]). A survey response for 23 of the 30 pharmacogenomics APPEs (77% response rate) was received. The rotation sites are diverse and include academic medical centers, community health systems, pharmacogenomic testing laboratories, and schools of pharmacy. Each pharmacogenomics APPE rotation accommodates on average six students per year. Rotation activities vary across sites.
Conclusion. Only a minority of schools of pharmacy in the U.S. offer an APPE rotation with a primary focus in pharmacogenomics. These rotations are diverse in scope and offered by both faculty and non-faculty preceptors. There are opportunities for improvement to increase experiential education in pharmacogenomics.
Keywords: pharmacogenomics, pharmacogenetics, APPE, experiential education

INTRODUCTION

The use of pharmacogenomics in clinical practice continues to grow as genetic testing becomes less costly and with the increasing availability of evidence-based, gene/drug clinical practice guidelines from the Clinical Pharmacogenetics Implementation Consortium (CPIC; www.cpicpgx.org). This growth will only continue with the rise of direct-to-consumer pharmacogenomic testing.[1] National pharmacy organizations have called upon pharmacists to embrace pharmacogenomics and champion its use in patient care when appropriate.[2-4] The question remains: How do we best educate pharmacy students to fulfill this role? The 2016-17 American Association of Colleges of Pharmacy (AACP) Argus Commission warned that "the most significant threat to pharmacy will be a failure to enrich our curricula and post-graduate education with the adequate intensity of attention to the expanding field of pharmacogenomics…The need for specialists will grow rapidly and new models of practice have already emerged and will continue to develop in the near future. Our faculty must be exposed to these and our learners must be encouraged to prepare for careers where they can bring expertise on the application of genomic science to patient care and research."[5] Clearly, pharmacogenomics instruction at schools of pharmacy in the United States (U.S.) should be a priority.

Although clinical pharmacogenomics is included in the 2016 Accreditation Standards and Key Elements for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree[6], identifying the optimal structure and content of pharmacogenomics education remains a challenge. Both didactic and experiential education approaches are critical to advance pharmacy student knowledge and skills.[7-9] Previous studies have reported on pharmacogenomics in the

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didactic PharmD curriculum[10-13]; however, none have reported on experiential education in pharmacogenomics. The objective of this study is to characterize available Advanced Pharmacy Practice Experience (APPE) rotations with a primary focus in pharmacogenomics at schools of pharmacy in the U.S. We hypothesize that only a minority of pharmacy schools offer such rotations and that the rotation experiences are diverse across sites.

METHODS

This was a cross-sectional, multicenter, observational study of pharmacogenomics APPEs at U.S. pharmacy schools. This study was reviewed and approved by the MCPHS University Institutional Review Board. Directors of Experiential Education at the 146 accredited schools of pharmacy in the U.S. were contacted by phone in October-November 2019 and asked if their school offered a pharmacogenomics APPE rotation. If their school did not offer a pharmacogenomics APPE rotation and a reason why was provided, this information was recorded. If their school did offer a pharmacogenomics APPE rotation, the preceptor(s)' name and contact information were requested. If a Director of Experiential Education could not be reached during the first phone attempt, up to five additional attempts were made at a later time, which may have included another member of the experiential education department. Identified pharmacogenomics APPE preceptors from this phone screen were contacted via email with an online survey that asked about their rotation offerings and their willingness to share their contact information with other pharmacogenomics preceptors in a publically available database. Surveys were completed between November-December 2019. If a preceptor indicated that their rotation's primary focus was not pharmacogenomics, those data were excluded from the analysis. Survey results were analyzed using descriptive statistics.

RESULTS

Of the 146 accredited schools of pharmacy in the U.S., 142 Directors of Experiential Education or a member of the experiential education department were successfully reached via phone. Of these 142 schools of pharmacy, 40 (28%) offer an APPE rotation with a primary focus in pharmacogenomics. For the schools that do not offer an APPE rotation with a primary focus in pharmacogenomics, some common reasons cited included the lack of pharmacogenomics clinical practices available nearby, not having a faculty member or local non-faculty preceptor with pharmacogenomics expertise, and never thought to look into it. Fourteen school of pharmacy representatives indicated that their institution has plans to begin a pharmacogenomics APPE rotation in the near future. Fifteen schools of pharmacy currently offer a pharmacogenomics APPE rotation with a faculty preceptor (38%) and 24 offer pharmacogenomics APPE rotations with a non-faculty preceptor (62%) (note that one school of pharmacy offers two pharmacogenomics APPE rotations with two different faculty preceptors). Most non-faculty-led pharmacogenomics APPE rotations accept students from multiple schools of pharmacy. The total number of unique APPE rotations identified with pharmacogenomics as a primary focus was 30 (see Figure 1 for the location of these sites), and the total number of preceptors identified was 33 (three rotations have two co-preceptors) (faculty preceptors: n = 19 [58%], non-faculty preceptors: n = 14 [42%]). We received a survey response for 23 of the 30 pharmacogenomics APPEs (77% response rate). The survey results are summarized in Table 1.

The length of each pharmacogenomics APPE rotation varied from three to eight weeks, depending on the school. The number of students who take a particular pharmacogenomics APPE rotation in a given year ranges from 1 to 60. Excluding the one rotation that takes 50-60 students per year, each pharmacogenomics APPE rotation accommodates on average six students per year. The total number of pharmacogenomics APPE rotation spots available each year is estimated to be less than 200 (some respondents provided range of students they accept per year, as it may change year to year). The length of time that these rotations have been offered ranges from less than one year to seven years, with 91% (n = 21) of the rotations having been offered for 5 years or less. All of these APPEs are classified as elective rotations. The sites are diverse and include academic medical centers, community health systems, pharmacogenomic testing laboratories, and schools of pharmacy (Table 2). Rotation activities vary across sites. Some of the most common rotation activities include gene/drug literature reviews (n = 22, 96%), topic discussions (n = 22, 96%), journal clubs (n = 21, 91%), CPIC calls (n = 19, 83%), clinical implementation (n = 18, 78%), clinical research (n = 17, 74%), and educating healthcare providers about pharmacogenomics (n = 17, 74%).

DISCUSSION

Experiential education in pharmacogenomics exposes student pharmacists to the real world application of pharmacogenomics including test interpretation, clinical decision making in patient care, implementation activities, research, and education of patients and clinicians. This study is the first to formally assess the current landscape of APPE rotations with a primary focus in pharmacogenomics offered by accredited schools of pharmacy in the U.S. Only a minority of pharmacy schools (< 30%) offer an APPE rotation with a primary focus in pharmacogenomics; however, it is

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reassuring that several schools of pharmacy have plans to implement a pharmacogenomics APPE rotation in the near future. From our study, the APPE rotations identified could accommodate less than 200 pharmacy students per year. Based on approximately 15,000 U.S. student pharmacists taking APPE rotations each year, only a tiny fraction of them (1.3%) are afforded this opportunity.[14] Although it may not be reasonable to expect that every pharmacy student completes or has access to an elective APPE rotation with a primary focus in pharmacogenomics, it is clear that these types of rotation offerings can and should be expanded to accommodate more students given the importance of pharmacogenomics to the future of pharmacy practice. Through our work, we also inadvertently identified APPE rotations (n = 7) that have an alternative primary focus but integrate pharmacogenomics nonetheless. Although a formal assessment of such rotations was beyond the scope of the present study, we acknowledge the vital role that these rotations play in advancing pharmacogenomics experiential education and see this approach as a viable and necessary path to scale pharmacogenomics experiential opportunities to increase availability.

Barriers to establishing pharmacogenomics APPE rotations include not having an affiliation with a faculty member or non-faculty preceptor with pharmacogenomics expertise and there being few sites with established pharmacogenomics implementation programs. To address the shortage of preceptors with pharmacogenomics expertise, additional post-graduate residency and fellowship training programs in pharmacogenomics are needed.[9] Pharmacogenomics certificate programs for pharmacists may also help fill this gap to develop the preceptor workforce. In the interim, schools of pharmacy without a dedicated pharmacogenomics APPE rotation may reach out to existing rotation sites to expand this type of offering to their students. Many non-faculty-led pharmacogenomics APPE rotations currently accept student pharmacists from several schools of pharmacy, and based on our survey results, many are open to accepting additional students. With consent from the study participants, preceptor contact information will be shared with schools of pharmacy through the AACP Pharmacogenomics Special Interest Group and the Experiential Education Section Connect platforms. This database of pharmacogenomics APPE preceptors will allow these individuals to connect with each other, explore opportunities for collaboration, and share best practices, thus strengthening existing rotation offerings.

APPE rotations with a primary focus in pharmacogenomics are a relatively new experiential education offering (most less than 5 years old), which mirrors the recent efforts to accelerate the implementation of pharmacogenomics into clinical practice. As pharmacogenomics pharmacy specialists launch new clinical pharmacogenomics services, it is critical that they consider starting a corresponding APPE rotation to support student education in pharmacogenomics. Establishing these sites early, while new clinical implementations are being considered, both recognizes the rich training environment present during the establishment of new clinical services and leverages the fact that many institutions are currently in early phases of pharmacogenomics implementation. To date, all APPEs with a primary focus in pharmacogenomics are in hospitals/health-systems, which highlights the need for developing these types of experiences in the community setting as well. In addition, student capacity is a concern as on average, pharmacogenomics APPE rotations accommodate just six students per year, with several just taking one or two students per year. Pharmacy schools without access to an existing pharmacogenomics APPE rotation should evaluate strategies to partner with these sites and provide the necessary support to allow them to accommodate more students since the infrastructure is already in place. This may be an easier way to increase capacity compared to building new sites from the ground up.

There are several limitations to our study. The survey used was not previously validated. Some school of pharmacy representatives indicated that they did not offer a pharmacogenomics APPE rotation, but a non-faculty preceptor may have reported that they accepted students from those institutions. In these cases, the school of pharmacy was categorized as one that offers a pharmacogenomics APPE rotation. In contrast, some schools of pharmacy that indicated they offered a pharmacogenomics APPE rotation were discovered later to be rotations that did not have a primary focus in pharmacogenomics, but rather integrated pharmacogenomics as part of the rotation experience. In these cases, the school of pharmacy was categorized as one that did not offer a pharmacogenomics APPE rotation. For those preceptors that were sent the survey but did not respond (n = 7), their rotation was assumed to be one that had a primary focus in pharmacogenomics. While this approach may potentially over- or under-count rotations that provide students with a limited exposure to pharmacogenomics, the assignments of whether a rotation had a primary focus on pharmacogenomics were left to local experts (eg, the preceptor or experiential coordinator). An independent evaluation of breath or depth of pharmacogenomics training in each APPE rotation offered by U.S. schools of pharmacy is beyond the scope of the current evaluation. Lastly, for two schools of pharmacy, the school of pharmacy representatives indicated that a pharmacogenomics APPE rotation was offered but they declined to share preceptor information, and for four schools of pharmacy, a school of pharmacy representative could not be reached at all.

CONCLUSION

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This landscape analysis provides important data on the status of pharmacogenomics experiential training opportunities for student pharmacists. Only a minority of U.S. schools of pharmacy offer an APPE rotation with a primary focus in pharmacogenomics. These rotations are diverse in scope and are offered by both faculty and non-faculty preceptors. There are opportunities for improvement to increase experiential education in pharmacogenomics.

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Table 1. Characteristics of Advanced Pharmacy Practice Experiences with a Primary Focus in Pharmacogenomics (n = 23)

Characteristic	n (%)
Type of preceptor	
Non-faculty	12 (52)
Faculty	11 (48)
Rotation classification	
Elective	23 (100)
Ambulatory Care	0
Community	0
Institutional	0
Internal Medicine	0
Number of students per rotation block	
1 student	14 (61)
1-2 students or 2 students	8 (35)
4-6 students	1 (4)
Rotation activities	
Gene/drug literature reviews	22 (96)
Topic discussions	22 (96)
Journal clubs	21 (91)
CPIC calls	19 (83)
Clinical implementation	18 (78)
Clinical research	17 (74)
Educating healthcare providers about pharmacogenomics	17 (74)
Direct patient care that involves pharmacogenomics	14 (61)
Educating other students about pharmacogenomics	13 (57)
Other [a]	7 (30)
Direct patient care that does not involve pharmacogenomics	6 (26)
Student genotyping	4 (17)
Bench research	3 (13)
Molecular tumor board	3 (13)
Length of time that the rotation has been offered	
≤ 1 year	7 (30)
2-3 years	8 (35)
4-5 years	6 (26)
6-7 years	2 (9)
Willing and able to take additional pharmacy students from other institutions	
Yes	13 (57)
No	10 (43)
Willing to share contact information in publically available database	
Yes	24[b] (96)
No	1 (4)

[a]Protocol development for new studies, data analysis for ongoing studies, weekly oral case presentations, final case presentation with written case, drug information questions, drug information project, pharmacogenomics patient case development, pharmacogenomics quiz question development, data collection from publicly available pharmacogenomics data sources, writing a short piece for an internal newsletter, data analysis of de-identified pharmacogenomics results, testing of implementation logic, shadowing clinical consultations, seminar presentation, educational materials development, writing clinical decision support language, writing summaries of relevant pharmacogenomics literature

[b]Two rotations with co-preceptors listed the contact information for both preceptors

CPIC=Clinical Pharmacogenetics Implementation Consortium

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Table 2. Type of Site for Advanced Pharmacy Practice Experiences with a Primary Focus in Pharmacogenomics (n = 23)

State	Hospital / Health-System (n)	School of Pharmacy (n)	Pharmacogenomic Testing Laboratory (n)	Other[a] (n)
California		1		
Colorado	1			
Florida	2			
Indiana		1		
Massachusetts	2			
Michigan	1			
Minnesota	1	2	1	
New York	1			1
North Carolina	2			
Ohio	1			
Pennsylvania	1	1	1	
South Dakota	1			
Tennessee	1			
Washington			1	
Totals	**14**	**5**	**3**	**1**

[a]Concierge pharmacy services company

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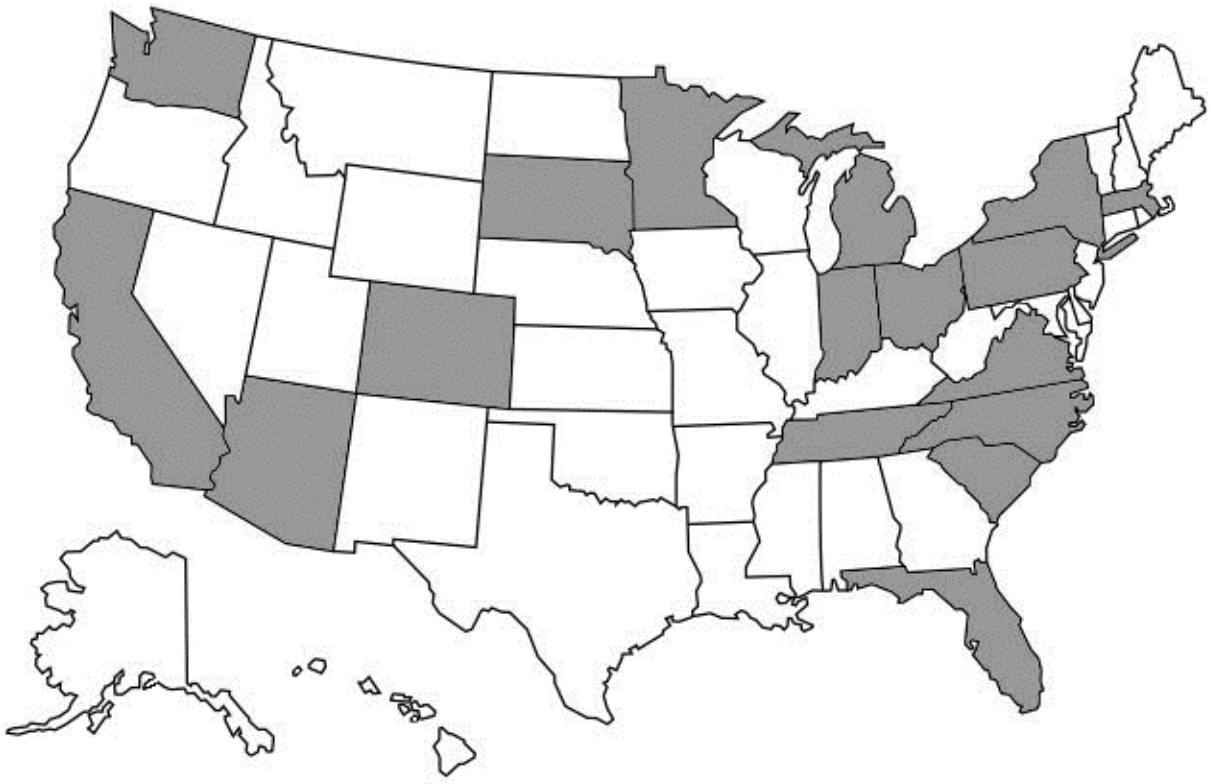
Figure 1. U.S. States (n = 17) with Advanced Pharmacy Practice Experience (APPE) Rotations that have a Primary Focus in Pharmacogenomics (n = 30).



The total number of unique APPE rotations identified with pharmacogenomics as a primary focus was 30, and a survey response was received for 23 of these rotations (see Tables 1 and 2).

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