# Institute of Medicine of the National Academies
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## *Improving Genetics Education in Graduate and Continuing Health Professional Education:* ***Pharmacists***


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# Presentation Outline

- Clinical implementation of pharmacogenomics and the pharmacy profession landscape
- Efforts on pharmacist genetics/genomics education
  - Collaborative work on updating pharmacogenomics competency
  - Case presentation of the PharmGenEd progress
- Barriers and future strategies

# Clinical Implementation of Pharmacogenomics

- Promises of pharmacogenomics (PGx)
  - Optimizing drug therapy
  - Minimizing trial-and-error approach to therapy
  - Preventing adverse drug reactions
  - ↑ # of FDA approved drugs have PGx information
  - ↓ costs of PGx tests



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# Pharmacy Profession Landscape 2012 - 2013

- Pharmacist workforce
  - 287,220 pharmacist in 2013 (Bureau of Labor Statistics)
  - 52% works in community pharmacies, 38% in hospitals, and 10% in other non-patient care settings
- Doctor of Pharmacy (PharmD) degree programs
  - 130 colleges or schools of pharmacy in U.S.
  - > 6,000 pharmacy faculty
  - 13,500 PharmD degrees awarded in 2012-2013
- Residency and fellowship training
  - 42% (n=5,637) of graduates applied for residency; 21% (n=2,866) successful

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# Integrating pharmacogenomics into pharmacy practice via medication therapy management

**American Pharmacists Association**

## Abstract

***Objective:*** To explore the application and integration of pharmacogenomics in pharmacy clinical practice via medication therapy management (MTM) to improve patient care.

***Data sources:*** Department of Health & Human Services (HHS) Personalized Health Care Initiative, Food and Drug Administration (FDA) pharmacogenomics activity, and findings from the Utilizing E-Prescribing Technologies to Integrate Pharmacogenomics into Prescribing and Dispensing Practices Stakeholder Workshop, convened by the American Pharmacists Association (APhA) on March 5, 2009. Participants at the Stakeholder Workshop included diverse representatives from pharmacy, medicine, pathology, health information technology (HIT), standards, science, academia, government, and others with a key interest in the clinical application of pharmacogenomics.

***Summary:*** In 2006, HHS initiated the Personalized Health Care Initiative with the goal of building the foundation for the delivery of gene-based care, which may prove to be more effective for large patient subpopulations. In the years since the initiative was launched, drug manufacturers and FDA have begun to incorporate pharmacogenomic data and applications of this information into the drug development, labeling, and approval processes. New applications and processes for using this emerging pharmacogenomics data are needed to effectively integrate this information into clinical practice. Building from the findings of a stakeholder workshop convened by APhA and the advancement of the pharmacist's collaborative role in patient care through MTM, emerging roles for pharmacists using pharmacogenomic information to improve patient care are taking hold. Realizing the potential role of the pharmacist in pharmacogenomics through MTM will require connectivity of pharmacists into the electronic health record infrastructure to permit the exchange of pertinent health information among all members of a patient's health care team. Addressing current barriers, concerns, and system limitations and developing an effective infrastructure will be necessary for pharmacogenomics to achieve its true potential.

***Conclusion:*** To achieve integration of pharmacogenomics into clinical practice via MTM, the pharmacy profession must define a process for the application of pharmacogenomic data into pharmacy clinical practice that is aligned with MTM service delivery, develop a viable business model for these practices, and encourage and direct the development of HIT solutions that support the pharmacist's role in this emerging field.

***Keywords:*** Pharmacogenomics, pharmacy practice, medication therapy management, health information technology, personalized health care.

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*American Journal of Pharmaceutical Education* 2003; 67 (2) Article 39.

# RESEARCH ARTICLE

# The Human Genome Project: Assessing Confidence in Knowledge and Training Requirements for Community Pharmacists

Sujit S. Sansgiry, PhD, Amit S. Kulkarni, MS

College of Pharmacy, University of Houston

**Objectives**. This study evaluated community pharmacists' confidence in their knowledge regarding the advances in the human genome project (HGP) and determined their requirements for education and training on this subject.
**Methods**. A survey was administered to community pharmacists (N=377) working in the Houston Metropolitan Area using a convenient sampling process.
**Results**. In general, respondents indicated that their confidence in knowledge regarding the HGP, genetic testing, and pharmacogenomics was less than 50%. Overall, pharmacists believe that they should receive training on the proper handling of drugs developed from the advances in the HGP. In addition, they agreed that pharmacists should be required to take at least 2 CE credits on human genetics and that pharmacy schools should include information regarding the advances in the HGP in their curriculum.
**Conclusions**. Pharmacist should be educated in the advances of the HGP and the implications of such advances on their professional responsibilities. Colleges of pharmacy across the nation should explore ways to incorporate information regarding the HGP in their curriculums. Furthermore, opportunities to provide continuing education (CE) credits should be explored by various pharmacy organizations.

**Keywords**: Human Genome Project, genetic testing, pharmacogenomics, knowledge, community pharmacists

*American Journal of Pharmaceutical Education* 2011; 75 (3) Article 51.

# RESEARCH ARTICLES

## Assessment of the Pharmacogenomics Educational Needs of Pharmacists

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Submitted August 23, 2010; accepted December 6, 2010; published April 11, 2011.

**Objectives.** To evaluate the self-perceived knowledge and confidence of inpatient and outpatient pharmacists in applying pharmacogenomics information to clinical practice.

**Methods.** A 19-question multiple-choice, electronic needs-assessment survey instrument was distributed to 480 inpatient and outpatient pharmacists in a large, academic, multi-campus healthcare system.

**Results.** The survey response rate was 64% (303). Most respondents (85%) agreed that pharmacists should be required to be knowledgeable about pharmacogenomics, and 65% agreed that pharmacists should be capable of providing information on the appropriate use of pharmacogenomics testing. Sixty-three percent felt they could not accurately apply the results of pharmacogenomics tests to drug-therapy selection, dosing, or monitoring.

**Conclusion.** Pharmacists believe pharmacogenomics knowledge is important to the profession, but they lack the knowledge and self-confidence to act on the results of pharmacogenomics testing and may benefit from pharmacogenomics education.

**Keywords:** pharmacogenomics, needs assessment, genetic testing, continuing education, survey

# NIH G2C2 Meetings – Pharmacist Education in the Era of Genomic Medicine

- 1st Meeting – November 30 – December 1, 2011
  - Scope and importance of genetics education discussed
  - Genetics educational competency shared by nurses, physician assistants, and genetics counselors
  - Meeting with representatives from 11 pharmacy organizations and others
  - Discussed current status of pharmacist genomic education, barriers, facilitators
  - Next step: to collaborate with AACP and pharmacy organizations to update competency based on NCHPEG and 2001-2002 AACP committee recommendations

- 2nd Meeting – June 19, 2012
  - Reviewed genetics/genomics competency for pharmacists
  - Assessed collaboration with the G2C2 program

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# Pharmacist education in the era of genomic medicine

W. Gregory Feero, Grace M. Kuo, Jean F. Jenkins, and Michael A. Rackover

## Abstract

***Summary:*** Pharmacists are increasingly expected to incorporate an understanding of the genomic contributions to medication management in their daily practice, and a general consensus exists that many pharmacists are not adequately prepared to effectively make use of genomic information. In November 2011, the National Human Genome Research Institute of the National Institutes of Health convened a meeting to discuss the status of genomics education for pharmacists. A variety of pharmacist organizations and other stakeholder groups attended the 2-day event and explored the current status of pharmacist genomic education, barriers and facilitators to enhanced education, and important next steps to ensure that pharmacists are prepared for the coming decades. This report summarizes the background, content, and outcomes from this meeting.

***Keywords:*** Pharmacogenomics, pharmacogenetics, pharmacy education.

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Feero WG, Kuo GM, Jenkins JF, Rackover MA. J. Am Pharm Assoc. 2012;e113-e121.

# Pharmacist Education in the Era of Genomic Medicine

**Table 1.** Participants at meeting addressing pharmacist education in the era of genomic medicine

| Organization | Representative |
|---|---|
| **Pharmacy organizations** | |
| American Association of Colleges of Pharmacy | Robert Kerr |
| American Association of Pharmaceutical Scientists | Pramod Mahajan |
| American College of Clinical Pharmacy | Wafa Y. Dahdal |
| Accreditation Council for Pharmacy Education | Peter H. Vlasses |
| Academy of Managed Care Pharmacy | Elizabeth Sampsel |
| American Pharmacists Association | Thomas Menighan and Marialice Bennett |
| American Society of Consultant Pharmacists | Joe Gerber |
| American Society for Clinical Pharmacology and Therapeutics | Issam Zineh |
| American Society of Health-System Pharmacists | Gerald McEvoy and Elaine Snow |
| National Association of Boards of Pharmacy | Mary Newport |
| National Alliance of State Pharmacy Associations | Rebecca Snead |
| University professor/PharmD | David Kisor and Mary W. Roederer |
| **Other attendees** | |
| American Medical Association | Katherine Johansen Taber |
| Centers for Medicare & Medicaid Services | Cheryl Gilbreath |
| Health Resources and Services Administration/Maternal Child Health Branch | Sara Copeland |
| Military: U.S. Air Force | Ron Miller |
| National Cancer Institute, National Institutes of Health (NIH) | Kathy Calzone |
| National Coalition for Health Professional Education in Genetics | Joan Scott |
| National Human Genome Research Institute (NHGRI), NIH | Greg Feero, Eric Green, Jean Jenkins, Michael Rackover, Laura Lyman-Rodriguez |
| NHGRI Council Member | Howard McLeod |
| Office of Rare Diseases Research, NIH | Michele Lloyd-Puryear |
| University of California, San Diego | Grace Kuo |
| Physician Assistant Program, University of Utah | Connie Goldgar |
| Food and Drug Administration | Elizabeth Mansfield |

Feero WG, Kuo GM, Jenkins JF, Rackover MA. J. Am Pharm Assoc. 2012;e113-e121.

# Pharmacist Education in the Era of Genomic Medicine

**Table 3.** Reports on current PGx education efforts within pharmacy organizations

| Organization | Current efforts |
|---|---|
| American Association of Colleges of Pharmacy | PGx special interest group; curriculum resource center |
| American Association of Pharmaceutical Scientists | PGx working group; creating a lab course; workshops, roundtables, teleconferences |
| American College of Clinical Pharmacy | Promoting role of pharmacists to include PGx with integrated requirements to address ethical issues. Website on genetic testing is in process; book available on PGx. |
| Accreditation Council for Pharmacy Education | Considering PGx topics for the accreditation of pharmacy schools and continuing education programs |
| Academy of Managed Care Pharmacy | No official statement on PGx but has provided continuing education. Works with the Food and Drug Administration to assess clinical utility of tests. Called for guideline development and harmonization/ comparative effectiveness research. |
| American Pharmacists Association | Published PGx white paper; 2010 delegates approved statement supporting evidenced-based personalized medicine; partnership with the Coriell Personalized Medicine Collaborative to research whether personalized genetic information can be used to improve people's health. |
| American Society of Health-System Pharmacists | Advocates for leadership roles in therapeutic applications of PGx, including placing the data in a usable Web-based format. |
| American Society of Consultant Pharmacists | Online module to train members who work with elderly populations and PGx. Advocated for harmonization of guidelines, competencies, and recommendations. |

Abbreviation used: PGx, pharmacogenomics.

Feero WG, Kuo GM, Jenkins JF, Rackover MA. J. Am Pharm Assoc. 2012;e113-e121.

1. seek coordination and collaboration with an interdisciplinary team of health professionals
2. recognize the limitations of his or her own genetics expertise
3. demonstrate willingness to update his or her own genetics knowledge at frequent intervals.

**II. DRUG DISCOVERY AND DISPOSITION/DRUG TARGETS**

A. KNOWLEDGE The pharmacist should:

1. recognize the large number of proteins that influence drug response, including drug transporters, drug metabolizing enzymes, direct protein targets of drugs and other proteins (*e.g.* signal transduction proteins) involved in the pharmacological effect.
2. appreciate the contribution of genetic variability to inter-individual variations in drug response
3. recognize the drugs/drug classes/clinical situations where pharmacogenetic testing is likely to be most useful clinically
4. understand how associations between genetic variations and drug response are investigated and uncovered
5. be able to identify important issues in pharmacogenetic study design, particularly those that differ from non-genetic clinical studies
6. know where/how to find pharmacogenetic information, including primary literature, databases, and other resources
7. understand that pharmacogenetic testing is like all other clinical testing - it will not have 100 percent reliability, but rather is used along with other clinical information
8. appreciate that pharmacogenetic testing may also reveal certain genetic disease predispositions (*e.g.* the Apo E4 polymorphism)
9. recognize the potential of behavioral, social, and environmental factors (lifestyle, socioeconomic factors, pollutants, etc.) to modify or influence genetics in the manifestation of disease
10. understand the influence (or lack thereof) of ethnicityin genetic polymorphisms and associations of polymorphisms with drug response
11. understand the potential physical and/or psychosocial benefits, limitations, and risks of pharmacogenetic information for individuals, family members, and communities
12. appreciate regulatory issues that may result from pharmacogenetics being incorporated into Phase II and III testing
13. understand the risks, benefits and options for a patient undergoing pharmacogenetic testing
14. be familiar with the resources available to assist clients seeking genetic information or services, including components of genetic-counseling and indications for referral to genetic specialists
15. appreciate the ethical, legal and social issues related to pharmacogenetic testing and recording of genetic information (*e.g.*, privacy, the potential for genetic discrimination in health insurance and employment)
16. understand one's own professional role in the referralto genetics services, or provision, follow-up, and quality review of pharmacogenetic tests.

B. SKILLS The pharmacist should be able to:

1. critically evaluate information obtained from pharmacogenetic/genomic clinical trials and identify limitations in study design, technology, and data interpretation that will influence patient care
2. identify the epidemiologic implications of pharmacogenetic/genomic studies and its impact at the societallevel as well as that of the individual patient.
3. identify those patients in whom pharmacogenetic testing is indicated
4. identify the most appropriate pharmacogenetic test for a specific patient
5. effectively use information technologies, particularly databases, to obtain current information about pharmacogenetics
6. interpret the results of pharmacogenetic testing, and make drug therapy recommendations based on the results
7. identify drug therapy problems that may be related to genetic variability, even when a pharmacogenetic test has not been done
8. identify patients who have undergone pharmacogenetic testing in the past so that a specific test is not repeated unnecessarily
9. participate in professional and public education about pharmacogenetics
10. educate clients about availability of pharmacogenetic testing and the situations in which it is indicated
11. provide appropriate information about the potential risks, benefits, and limitations of pharmacogenetic testing
12. ensure that patients who are undergoing pharmacogenetic testing have undergone an appropriate informed consent process
13. provide, and encourage use of, culturally appropriate, user-friendly materials/media to convey information about genetic concepts and pharmacogenetic testing
14. discuss costs of pharmacogenetic services, benefits and potential risks of using health insurance for payment of pharmacogenetic services, including potential risks of discrimination.

**III. ETHICAL APPLICATIONS, SOCIAL AND ECONOMIC IMPLICATIONS**

The pharmacist will:

1. support patient-focused policies
2. understand the increased liability that accompanies access to detailed patient information
3. maintain the confidentiality and security of patient health records
4. be fair, impartial, personable, and accurate in the delivery of patient education
5. tailor information and services to patient culture, education, and language
6. be an outspoken advocate for patient rights
7. adopt a code of conduct in patient treatment that is free of racial, ethnic, and religious bias
8. adopt a culturally sensitive and ethical approach to patient counseling
9. advocate against attempts to ascribe behavioral tendencies (social behavior) to patients on the basis of pharmacogenomic information
10. employ clinical, humanistic, and economic outcomes research relative to pharmacogenomic interventions and services to insure appropriate and cost effective treatment of disease
11. apply basic assessment and evaluation strategies to assess pharmacy-related services directed toward the provision of pharmacogenomic services and education developed for the individual patient and public at large
12. interpret and apply public policy, including regulatory statements and issues, aimed at pharmacogenomic services and interventions
13. participate in educational programs for the public as related to pharmacogenomic services and interventions
14. identify appropriate resources offered by professional organizations, disciplines, or institutions.



Pharmacogenomics competency for pharmacy curriculum. *Johnson JA, et al. AJPE; 2002 (Vol.66): 12S-15S.*

Currently competency being updated by members of pharmacy organizations and the NIH G2C2 program

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# NIH G2C2 Meetings – Pharmacist Education in the Era of Genomic Medicine

- 3rd Meeting – June 26-27, 2013
  - Pharmacist G2C2 Resource Review Meeting (editorial meeting)
  - NIH G2C2 pharmacogenomics resources mapped to competency
  - Resource links available via G2C2 website

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# NIH G2C2

# http://www.g-2-c-2.org/

# NIH G2C2

# http://www.g-2-c-2.org/

# Curriculum Map

http://www.g-2-c-2.org/search_map/0/pharmacist/Search

Pharmacist

## B: BASIC GENETIC CONCEPTS

- **B1**: To demonstrate an understanding of the basic genetic/genomic concepts and nomenclature
- **B2**: To recognize and appreciate the role of behavioral, social, and environmental factors (lifestyle, socioeconomic factors, pollutants, etc.) to modify or influence genetics in the manifestation of disease
- **B3**: To identify drug and disease associated genetic variations that facilitate development of prevention, diagnostic and treatment strategies and appreciate there are differences in testing methodologies and are aware of the need to explore these differences these differences in drug literature evaluation
- **B4**: To use family history (minimum of three generations) in assessing predisposition to disease and selection of drug treatment

## E: ETHICAL, LEGAL AND SOCIAL IMPLICATIONS (ELSI)

- **E1**: To understand the potential physical and/or psychosocial benefits, limitations and risk of genomic/pharmacogenomic information for individuals, family members and communities, especially with genomic/pharmacogenomic tests that may relate to predisposition to disease
- **E2**: To understand the increased liability that accompanies access to detailed genomic patient information and maintain confidentiality and security
- **E3**: To adopt a culturally sensitive and ethical approach to patient counseling regarding genomic/pharmacogenomic test results
- **E4**: To appreciate the cost, cost-effectiveness, and reimbursement by insurers relevant to genomic or pharmacogenomic tests and test interpretation, for patients and populations
- **E5**: To Identify the need to refer a patient to a genetic specialist or genetic counselor

## G: GENETICS AND DISEASE

- **G1**: To understand the role of genetic factors in maintaining health and preventing disease
- **G2**: To assess the difference between clinical diagnosis of disease and identification of genetic predisposition to disease (genetic variation is not strictly correlated with disease manifestation)
- **G3**: To appreciate that pharmacogenomic testing may also reveal certain genetic disease predispositions (e.g. the Apo E4 polymorphism)

## P: PHARMACOGENETICS/PHARMACOGENOMICS

- **P1**: To demonstrate an understanding of how genetic variation in a large number of proteins, including drug transporters, drug metabolizing enzymes, direct protein targets of drugs, and other proteins (e.g. signal transduction proteins) influence pharmacokinetics and pharmacodynamics related to pharmacologic effect and drug response
- **P2**: To understand the influence (or lack thereof) of ethnicity in genetic polymorphisms and associations of polymorphisms with drug response
- **P3**: Recognize the availability of evidence based guidelines that synthesize information relevant to genomic/pharmacogenomic tests and selection of drug therapy (e.g. Clinical Pharmacogenomics Implementation Consortium)

# Pharmacist Education Requirements

- Pharmacy school
  - Genetics/genomics education will be required for pharmacy school accreditation (ACPE - Accreditation Council for Pharmacy Education 2016 guidelines)
  - Part of a collaborative efforts from pharmacy faculty, professional organizations, interdisciplinary collaboration, and NIH G2C2
- Pharmacist continuing education (including graduate residency training)
  - No ACPE requirements for PGx education yet
  - CE tracked by CPE Monitor Service of the NABP (National Association of Boards of Pharmacy)

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# University of California San Diego Pharmacogenomics Education Program (PharmGenEd™): bridging the gap between science and practice

Clinical application of evidence-based pharmacogenomics information has the potential to help healthcare professionals provide safe and effective medication management to patients. However, there is a gap between the advances of pharmacogenomics discovery and the health professionals' knowledge regarding pharmacogenomics testing and therapeutic uses. Furthermore, pharmacogenomics education materials for healthcare professionals have not been readily available or accessible. Pharmacogenomics Education Program (PharmGenEd™) is an evidence-based pharmacogenomics education program developed at the University of California San Diego Skaggs School of Pharmacy and Pharmaceutical Sciences and the School of Medicine (CA, USA), with funding support from the Centers for Disease Control and Prevention. Program components include continuing education modules, train-the-trainer materials and shared curriculum modules based on therapeutic topics, and virtual communities with online resources.

**Grace M Kuo[†1,2], Joseph D Ma[1], Kelly C Lee[1], James R Halpert[1], Philip E Bourne[1], Theodore G Ganiats[2] & Palmer Taylor[1]**

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**Reference**: Kuo GM, Ma JD, Lee KC, Halpert JR. Bourne PE, Ganiats TG, Taylor P. Institutional Profile: University of California San Diego Pharmacogenomics Education Program (PharmGenEd™): bridging the gap between science and practice. Pharmacogenomics. 2011 Feb; 12(2):149-53.

# PharmGenEd Project Aims

## https://pharmacogenomics.ucsd.edu/

1) Develop an educational curriculum focusing on pharmacogenomics primer concepts and clinical applications in concentrated therapeutic areas;

2) Disseminate the educational curriculum to healthcare professionals and students via a train-the-trainer approach

3) Evaluate outcomes and processes of the educational program in different audience groups using different delivery methods.

*Funded by* the CDC (*Grant Number IU38GD000070* )
*from 2008 to 2012*

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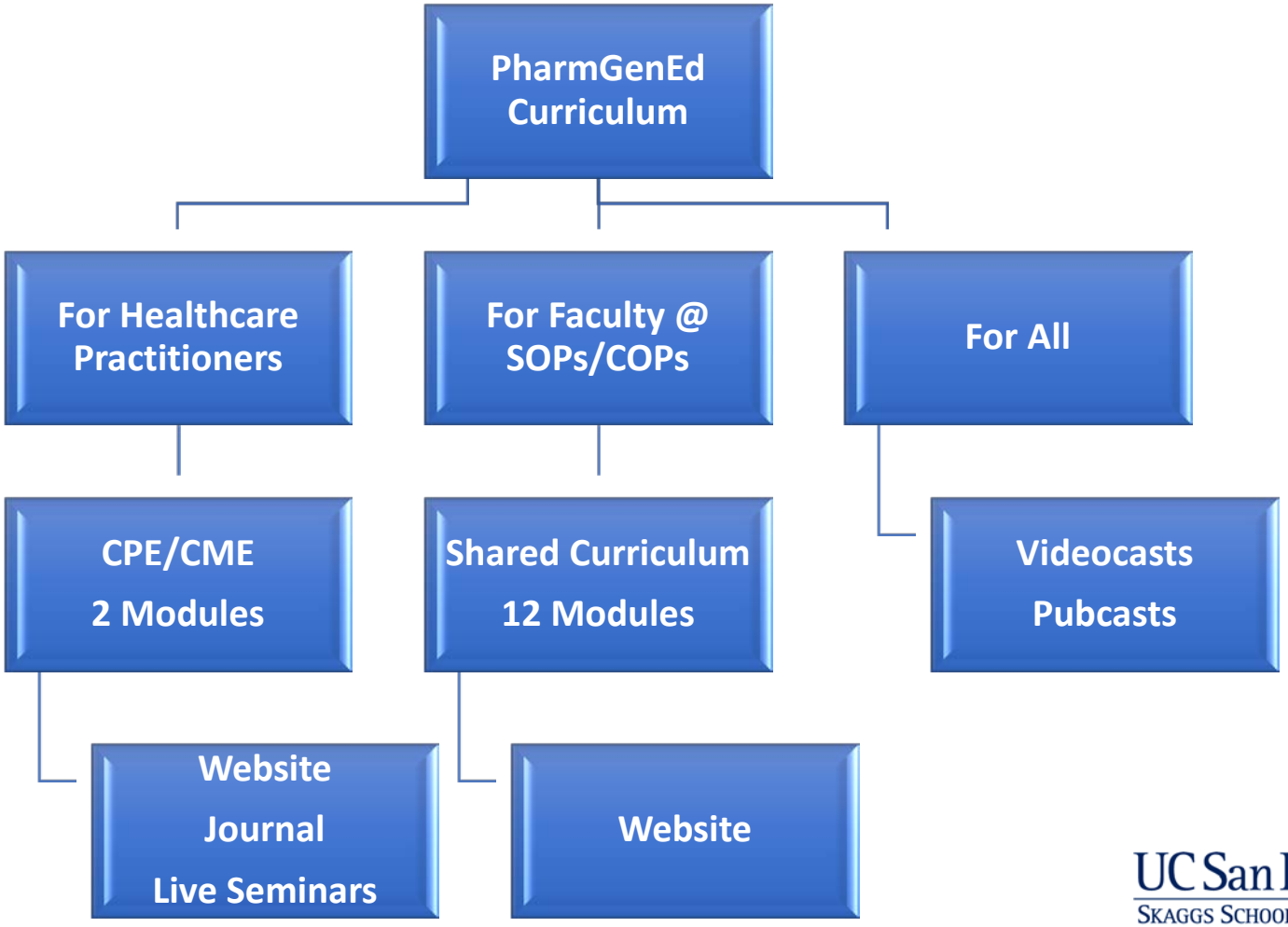
# PharmGenEd
# Train-the-Trainer Program

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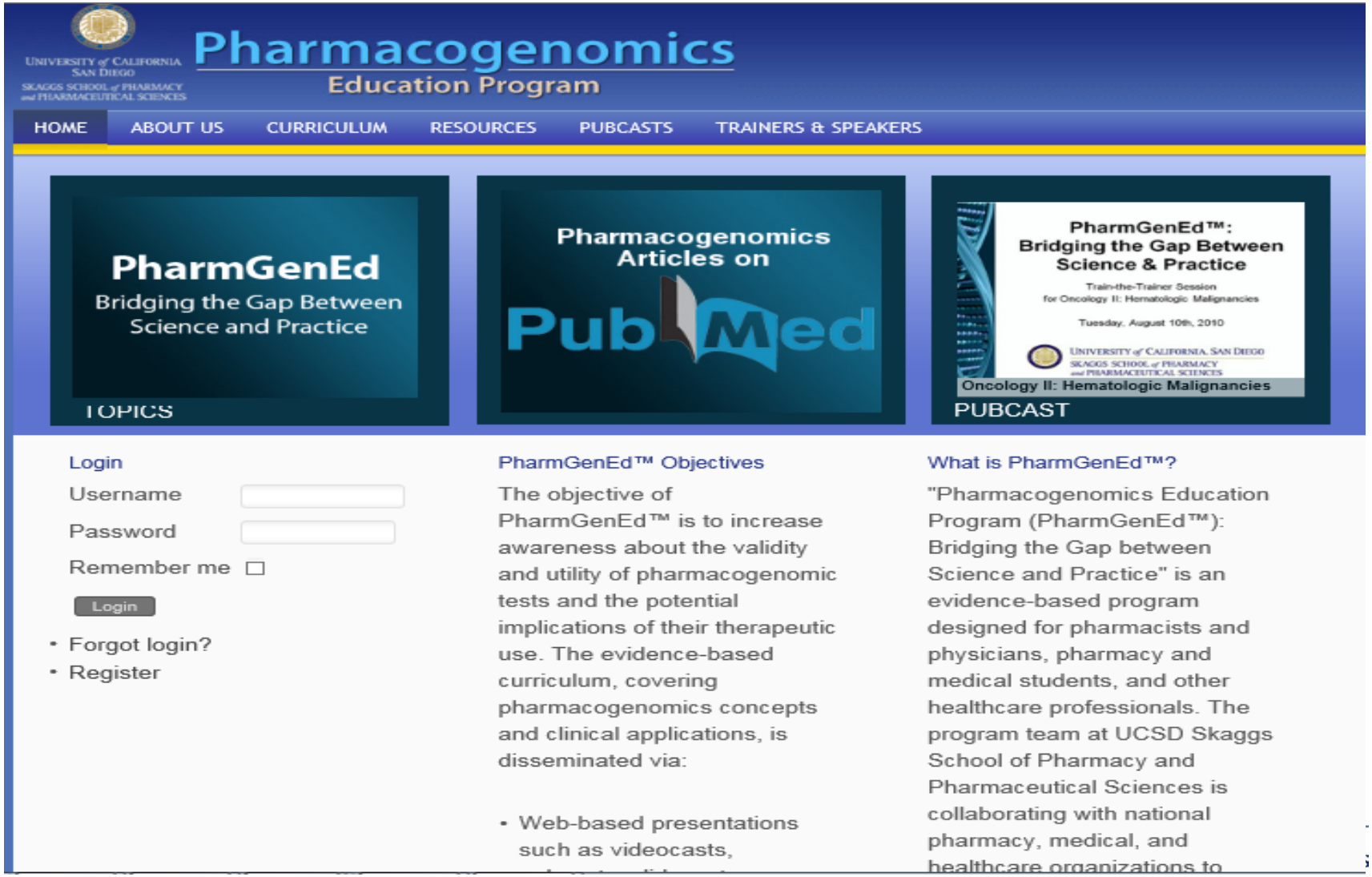
# PharmGenEd

http://pharmacogenomics.ucsd.edu



# PharmGenEd™ Website Outreach


- > 100 countries, 23,000 users
- Website Registrants: 3,364 from 4/16/2009 – 06/30/2014

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# PharmGenEd™ Registrant Disciplines

| What is your discipline? | | |
|---|---|---|
| Pharmacist | 1,031 | 31.40% |
| Pharmacy Student | 969 | 29.52% |
| Nurse Practitioner | 372 | 11.33% |
| Pharmacy Technician | 205 | 6.24% |
| Researcher | 233 | 7.10% |
| Physician | 105 | 3.20% |
| Genetic Counselor | 23 | 0.70% |
| Medical Student | 21 | 0.64% |
| Public Health Educator | 20 | 0.61% |
| Physician Assistant | 21 | 0.64% |
| Other* | 283 | 8.62% |
| Total | 3,283 | 100.00% |

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# PharmGenEd: 2 Oneline Modules CPE/CME Processed by ASHP*

| HCP | Module I (n=440) | | Module II (n=345) | |
|---|---|---|---|---|
| Pharmacist<br>Nurse<br>Physicians | Passed | 97% | Passed | 97% |

*ASHP = American Society of Health-System Pharmacists
Module I: 61% pharmacist
Module II: 52% pharmacist

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# Pharmacogenomics: Bridging the gap between science and practice

**Kelly C. Lee, Joseph D. Ma, and Grace M. Kuo**

## Abstract

***Objective:*** To educate pharmacists about principles and concepts in pharmacogenomics, clinical applications of pharmacogenomic information, and the social, ethical, and legal aspects of pharmacogenomics and to describe a Centers for Disease Control and Prevention (CDC)-supported pharmacogenomics education program for pharmacists and other health professionals.

***Data sources:*** Primary literature from PubMed, recommendations from the Food and Drug Administration and Evaluation of Genomic Applications in Practice and Prevention Working Group, prescribing information, websites of government agencies and professional organizations, and relevant textbooks.

***Study selection:*** Not applicable.

***Data extraction:*** Not applicable.

***Data synthesis:*** Principles and concepts of pharmacogenomic nomenclature, polymorphism types, and systematic approach to understanding polymorphisms were reviewed. Drug therapy for select therapeutic areas that highlight the applicability of pharmacogenomics are presented, including abacavir, selective serotonin reuptake inhibitors, tamoxifen, and warfarin. Challenges of translating pharmacogenomics into clinical practice included ethical, social, legal, and economic issues. We have developed a pharmacogenomics education program to disseminate evidence-based pharmacogenomics information and provide a resource for health professionals, including pharmacists.

***Conclusion:*** Pharmacists play a critical role in the education of patients and health professionals in the area of pharmacogenomics.

***Keywords:*** Pharmacogenomics, pharmacogenetics, education, clinical intervention.

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**Continuing pharmacy education (CPE) credits:** See learning objectives below and assessment questions at the end of this article, which is ACPE universal activity number 202-000-09-247-H04-P in APhA's educational offerings. To take the CPE test for this article online, go to www.pharmacist.com/education, and follow the links to the APhA CPE Center.

**Disclosure:** Drs. Lee and Ma are coinvestigators and Dr. Kuo is principal investigator in the PharmGenEd program, which is funded by the Centers for Disease Control and Prevention (CDC Cooperative Agreement no. 1U38GD000070). The authors and APhA's editorial staff declare no other conflicts of interest or financial interests in any product or service mentioned in this article, including grants, employment, gifts, stock holdings, or honoraria.

**Reference**: Lee KC, Ma JD, Kuo GM. Pharmacogenomics: Bridging the gap between science and practice. Pharmacy Today. 2009(Dec);15(12):36–48 and J. Am Pharm Assoc. 2010;50:e1–e17.

# PharmGenEd: Journal Article with 2 CPE Credits Processed by APhA

| American Pharmacists Association (APhA) | |
|---|---|
| **Total Pharmacists n(%)** | **Total Passed n(%)** |
| 421 (96.1) | 421 (100) |

Lee KC, Ma JD, Kuo GM. Pharmacogenomics: Bridging the gap between science and practice (CE article).

- *Pharmacy Today*. 2009(Dec);15(12):36–48
- *J. Am Pharm Assoc*. 2010;50e1-e17

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# Implementation and outcomes of a live continuing education program on pharmacogenomics

**Aim:** This study evaluated the implementation and outcomes of a pharmacogenomics education program among pharmacists. **Materials & methods:** Continuing education lectures were presented at local, state and national pharmacy conferences. **Results:** Six hundred and seventy three pharmacist participants (mean ± standard deviation: 45 ± 14 years of age with 19 ± 13 years of practice experience) completed program evaluations. Participants' knowledge and overall ability to address pharmacogenomics testing significantly improved ($p < 0.001$). More than 50% rated self-efficacy for putting pharmacogenomics knowledge into clinical practice to be likely or very likely. Attitudes toward increasing the number of patients to educate, updating pharmacogenomics knowledge, and providing advice were 39, 76 and 64%, respectively. Participants rated program components to be useful or very useful, and the quality of the program format, program content and audience response system as good, very good or excellent. **Conclusion:** Through live continuing education presentations at pharmacy conferences, participants showed significant increases in knowledge and their overall ability to address pharmacogenomics testing with patients.

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**KEYWORDS:** conference ▪ continuing education ▪ education ▪ genetics ▪ genomics ▪ healthcare professionals ▪ pharmacists ▪ pharmacogenetics ▪ pharmacogenomics ▪ program evaluation ▪ training

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**Reference**: Kuo GM, Lee KC, Ma JD. Implementation and outcomes of a live continuing education program on pharmacogenomics. Pharmacogenomics. 2013;14(8):885-95.

# PharmGenEd™ Survey Participant Map (n = 514)

Kuo GM, Lee KC, Ma JD. Pharmacogenomics. 2013;14(8):885-95

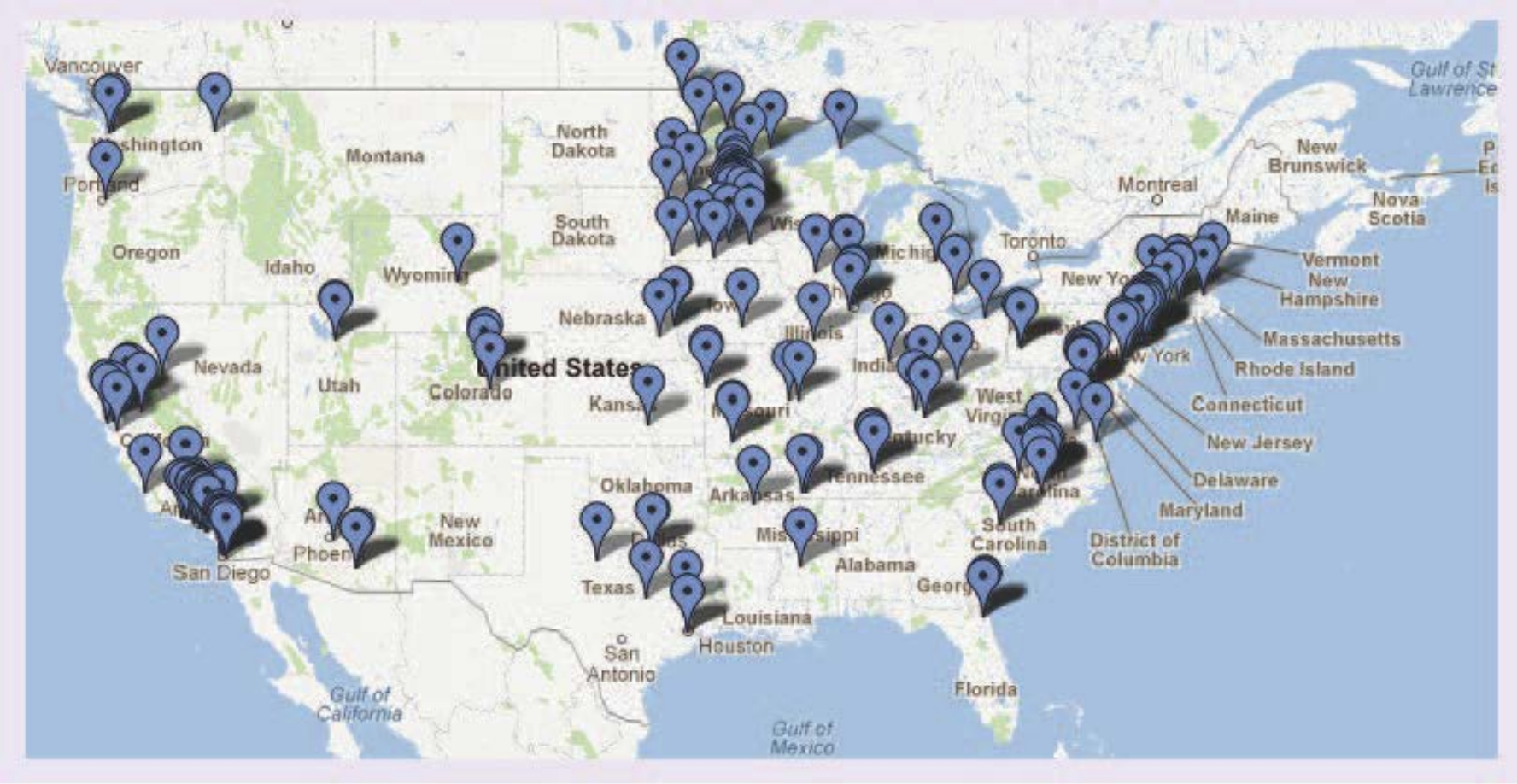


**Figure 1. Practice locations among program attendees within continental USA (n = 514).**
Each pin represents a unique zip code; each zip code may represent attendees from multiple pharmacy practice locations.
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# Knowledge Questions

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**Table 2. Knowledge questions.**

| Question | Correct answer | Correct pre-test response, n (%) | Correct post-test response, n (%) | p-value |
|---|---|---|---|---|
| An example of a SNP is the *VKORC1* 1173C>T. Based on the pharmacogenomic nomenclature of this SNP, what is the gene of interest? (knowledge level) | *VKORC1* | 138 (61) | 198 (88) | <0.001 |
| Nucleotide change occurs, yet the resultant amino acid is unchanged from 'wild-type'. What type of SNP is this? (knowledge level) | Synonymous | 156 (74) | 191 (90) | <0.001 |
| Patients with *HLA-B*5701* variation are at increased risk for which of the following events? (knowledge level) | Hypersensitivity reaction | 126 (55) | 223 (97) | <0.001 |
| Which polymorphisms may most likely improve prediction of warfarin dosage? (comprehension level) | *CYP2C9* + *VKORC1* | 59 (31) | 177 (92) | <0.001 |
| Which of the following would be appropriate regarding initiation of trastuzumab therapy in patients with HER2-positive breast cancer? (application level) | No dose adjustment needed | 37 (38) | 73 (74) | <0.001 |

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# Self-Rated Overall Ability

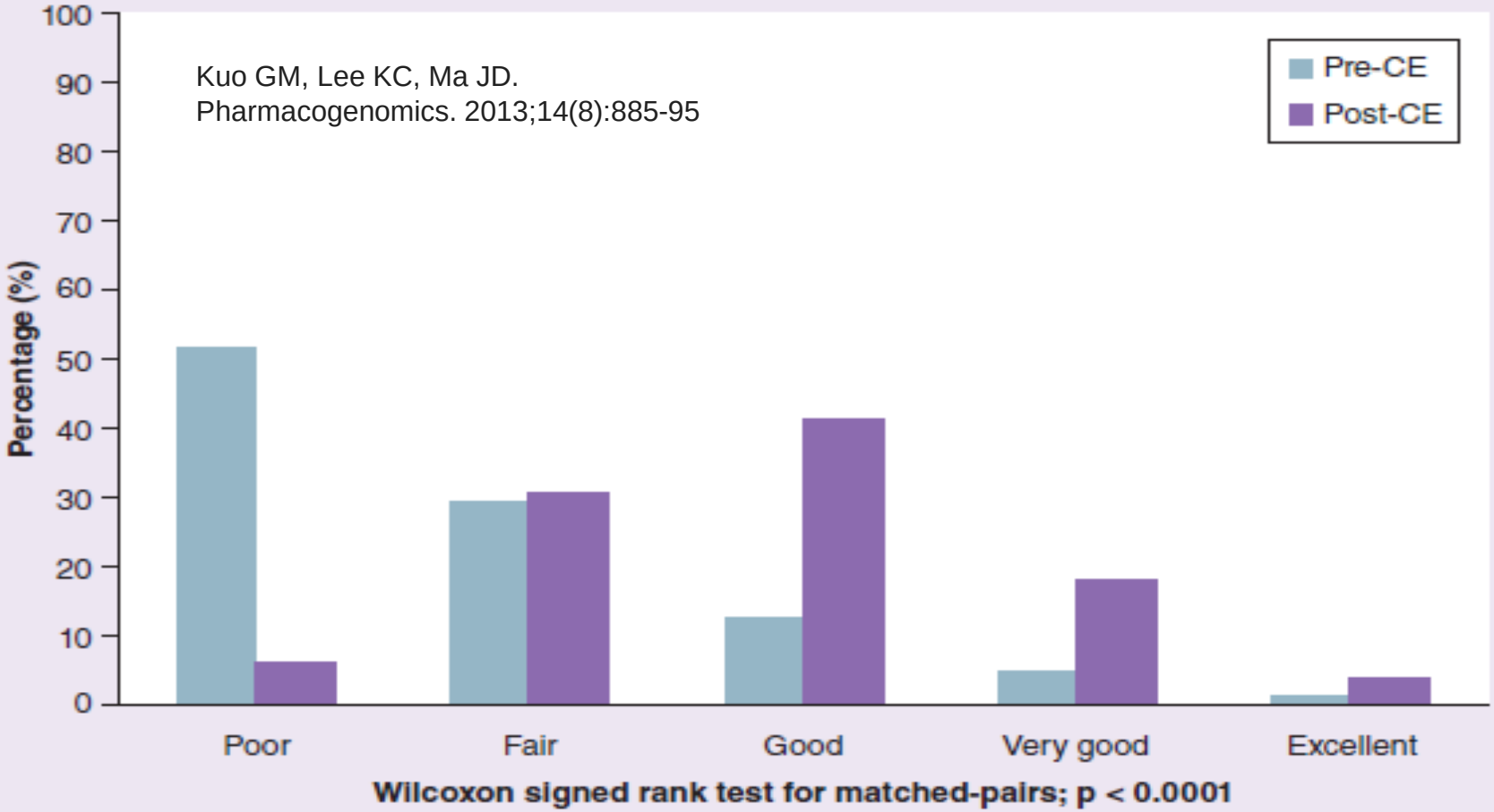


**Figure 2. Self-rated pre- and post-overall ability (n = 643).**
CE: Continuing education.

# Self-Efficacy and Attitude

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**Table 3. Self-efficacy and attitudes towards pharmacogenomics[†] (n = 649).**

| **Self-efficacy: likelihood to complete the following actions as a result of the PharmGenEd program** | | | | | | |
|---|---|---|---|---|---|---|
| ***Action*** | ***Very unlikely, n (%)*** | ***Unlikely, n (%)*** | ***Neither, n (%)*** | ***Likely, n (%)*** | ***Very likely, n (%)*** | ***Regression analysis[‡] (β, t, p-value)*** |
| Explain the rationale to patients for PGx testing in various therapeutic areas | 21 (3) | 51 (8) | 191 (30) | 260 (40) | 124 (19) | -0.01, -3.91, $p < 0.000$ |
| Find credible and current literature related to PGx testing | 10 (2) | 42 (7) | 180 (27) | 253 (39) | 164 (25) | -0.01, -3.66, $p < 0.001$ |
| Recommend or refer patients for PGx testing | 23 (3) | 75 (12) | 207 (32) | 235 (37) | 103 (16) | -0.01, -4.11, $p < 0.001$ |
| Discuss risks and benefits of PGx testing with patients | 19 (3) | 65 (10) | 212 (33) | 255 (40) | 91 (14) | -0.01, -3.67, $p < 0.001$ |
| **Self-efficacy: level of agreement with the following statement** | | | | | | |
| ***Statement*** | ***Very low, n (%)*** | ***Low, n (%)*** | ***Neither, n (%)*** | ***High, n (%)*** | ***Very high, n (%)*** | ***Regression analysis (β, t, p-value)*** |
| The pharmacy profession should be more active in educating patients and other healthcare professionals about PGx testing | 3 (1) | 13 (2) | 87 (13) | 226 (35) | 320 (49) | -0.003, -1.13, $p = 0.262$ |
| **Attitude: rate the following actions as a result of completing the PharmGenEd program** | | | | | | |
| ***Action*** | ***Definitely will not increase, n (%)*** | ***Will not increase, n (%)*** | ***Neither, n (%)*** | ***Will increase, n (%)*** | ***Definitely will increase, n (%)*** | ***Regression analysis (β, t, p-value)*** |
| The number of patients whom you educate about PGx testing | 47 (8) | 104 (17) | 224 (36) | 171 (27) | 78 (12) | -0.01, -4.21, $p < 0.001$ |
| Your willingness to update PGx knowledge | 7 (1) | 29 (5) | 113 (18) | 266 (41) | 229 (35) | -0.01, -2.80, $p < 0.001$ |
| The quality of the advice that you provide about PGx testing | 16 (3) | 43 (6) | 171 (27) | 265 (42) | 140 (22) | -0.01, -4.67, $p < 0.001$ |

*[†]Missing data <1% per survey item.*
*[‡]Regression analysis between years in practice and self-efficacy and attitudes.*
*PGx: Pharmacogenomics.*

# Facilitators and Barriers

**Table 4.** Facilitators of and barriers to genomics education

| Facilitators | Barriers |
|---|---|
| Education: relationship with industry, communication of advances, academic exemplars, standards incorporation, general education for the public, interprofessional education | System: EMR structure, lack of communication among EMRs, lack of decision support tools, unclear delineation of team member roles in the medical home, lack of coordination of care, lack of evidence of clinical utility of PGx, lack of PGx testing guidelines or conflicting guidelines |
| Resources: better standards for what is included, best practices, integrated (not standalone) curricula, competencies and role delineation, common data structures for reporting and communicating | Resources: limited drug information databases, duplication of efforts within the discipline and among health care providers |
| Access by the public: improved dissemination of information, social networking tools, patient empowerment | Regulatory issues: differing state regulations preventing standardization, payment and reimbursement policies |
| Motivation: innovation, recognition of noteworthy PGx education/practice, payment for PGx services, quality care | Education: lack of quality teaching resources including preceptors; few PGx faculty at education institutions; varied competencies, curriculum, and preprofessional requirements; curricula overload (competing priorities, methodology, volume); lack of understanding of relevance of PGx to current practices (perceived as futuristic); lack of collaboration among interdisciplinary team members; lack of demand for services; public genomic literacy |

Abbreviations used: EMR, electronic medical record; PGx, pharmacogenomics.

Feero WG, Kuo GM, Jenkins JF, Rackover MA. J. Am Pharm Assoc. 2012;e113-e121.

# Future Strategies

| Table 5. Action steps for pharmacist genomics education |
|---|
| Action item 1: Promote wider distribution of FDA labeling updates relevant to PGx. Use e-mail blasts to pharmacist organizations. |
| Action item 2: Develop a needs assessment of pharmacy residency education programs regarding PGx. |
| Action item 3: Develop an agenda to ensure that legislative efforts (e.g., Model Pharmacy Act) incorporate incentives for appropriate use of PGx. Have wording placed in the Model Pharmacy Act. |
| Action item 4: Develop a system of electronic notices to inform pharmacists about PGx topics relevant to their practices. |
| Action item 5: Move toward making the G2C2 site a resource for pharmacist educators who are interested in sharing resource materials both within and among disciplines. |
| Action item 6: Engage pharmacists in ongoing interdisciplinary efforts to educate health professionals (e.g., National Society of Genetic Counselors–sponsored Collaborative Genetic Services Project and Summit). |
| Action item 7: Embed pharmacogenomics into emerging performance improvement models of continuing education for pharmacists and other types of health care providers. |
| Action item 8: Identify pharmacist faculty champions, organizational champions, and pharmacy practice champions to promote and collaborate on projects related to PGx education. |
| Action item 9: Work to ensure that PGx guidelines are harmonized across pharmacist and nonpharmacist organizations. |

Abbreviations used: FDA, Food and Drug Administration; G2C2, Genetics and Genomics Competency Center for Education; PGx, pharmacogenomic

- Interdisciplinary continuing education
  - http://www.jointaccreditation.org/
- Practice Guidelines and algorithms
- Reimbursement policies
  - with comparative-effectiveness data
- Regulatory issues
- Privacy issues
- Available ePrescribing tools
- Laboratory tests

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# *Thank you!*


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