Institutional Profile

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.

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'Pharmacogenomics Education Program (PharmGenEd™): Bridging the Gap between Science and Practice' is an evidence-based pharmacogenomics education program designed for pharmacists and physicians, pharmacy and medical students as well as other healthcare professionals. PharmGenEd at the University of California San Diego (UCSD, CA, USA) was established in 2009 with the objective of increasing awareness of health professionals of the current knowledge concerning the validity and utility of pharmacogenomics tests and the potential implications, both positive and negative, from the use of these tests. To achieve this objective, program staff collaborate with pharmacogenomics experts, clinician and faculty trainers and representatives from professional organizations across the country to design educational materials and disseminate pharmacogenomics information. PharmGenEd started with a core group of seven faculty investigators (the authors of this article), two consultants and one staff member. In the past 18 months, the faculty and staff have worked with nine additional staff members, two multimedia experts, 12 authors, 18 speakers, 32 peer reviewers, 20 clinician trainers and 79 pharmacy school faculty trainers. Collaborators are from UCSD, other academic institutions, health sciences centers and professional organizations. The PharmGenEd registry LISTSERV currently includes approximately 1000 members who have registered through the PharmGenEd website [101]; the program has reached approximately 51,000 health professionals. In the following sections we introduce the PharmGenEd educational program components and descriptions of collaborators (inside and outside UCSD), and provide a future perspective.

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PharmGenEd program & scope

Development & overview of program components

The main PharmGenEd program components include:

- Continuing education programs for healthcare practitioners through live presentations, online modules, and written articles;
- Train-the-trainer program for healthcare practitioners;
- Train-the-trainer program for health professional school faculty;
- Online pharmacogenomic resources with virtual communities and pubcasts (i.e., published articles combined with video).

Continuing education programs for healthcare practitioners

Two 1-hour continuing education lecture materials currently provide accreditation for pharmacists (continuing pharmacist education) and physicians (continuing medical education). The continuing education materials have been disseminated to clinicians by PharmGenEd program staff and affiliated speakers at professional conferences, state and regional chapter meetings. Each continuing education module is posted on the PharmGenEd website and available at anytime. Continuing education credits are also available via written articles in *Pharmacy Today* and the *Journal of the American Pharmacists Association*.

Train-the-trainer program for healthcare practitioners

The train-the-trainer approach has been used to train healthcare practitioners and students on numerous educational topics, including smoking cessation, Medicare Part D, and common geriatric problems [1–3]. PharmGenEd uses the train-the-trainer approach to disseminate pharmacogenomics information to healthcare practitioners who practice in various settings. Train-the-trainer online webinars (in video and audio format) include the review of pharmacogenomics material content and discussions regarding program preparation, implementation and logistics. The educational materials include PowerPoint slides with speaker notes, handouts, a coordinator guide and ten self-assessment questions and answers. Qualified clinician trainers have continued to present educational modules via live presentations (e.g., grand-round, hospital or clinic in-service and professional meetings) to their professional colleagues.

Train-the-trainer program for health professional schools

The train-the-trainer program for health professional schools is intended to provide resources and training for faculty to teach their students about pharmacogenomic principles and applications in clinical practice. Based upon a previous survey of pharmacy faculty, 88% were interested in having access to a pharmacogenomics curriculum and 68% were interested in collaborating on designing and implementing a pharmacogenomics curriculum [4]. The PharmGenEd program created a shared curriculum platform for qualified faculty to use as instructional materials and adopt into their existing or new didactic courses.

To date, nine educational modules to be used by faculty trainers have been developed by PharmGenEd content experts and reviewed by peer reviewers. Topics of the nine modules are related to an overview of pharmacogenomics; two modules in cardiology, two modules in oncology, two modules in psychiatry, one module in asthma and one module in economics. The modules (except for the economics module) are organized systematically encompassing (in order): gene/allele, functional effect, population prevalence, clinical relevance, pharmcogenomics testing, and testing recommendation. In addition to presentation slides that include detailed speaker notes, the faculty has access to classroom handouts, self-assessment questions and answers, and website resources. Faculty members have the flexibility to incorporate PharmGenEd materials in any year of the curriculum as a required or elective course. In addition, faculty may incorporate one module or all modules into their existing courses.

Online pharmacogenomic resources with virtual communities & pubcasts

The PharmGenEd website [101] hosts a virtual community in collaboration with the SciVee technologies, where interested individuals can create their scientific profiles and network with others interested in pharmacogenomics. Several videocasts and pubcasts (i.e., published articles combined with video) are available via the website [102].

Collaboration with other genomic programs at UCSD

A major asset to pharmacogenomics research and education at UCSD is the Institute of Genomic Medicine (IGM). Founded by the School of Medicine and the Skaggs School of Pharmacy and Pharmaceutical Sciences (SSPPS), the IGM is making major advances in research, clinical care and education, with the goal of linking clinical and genomic information to facilitate personalized healthcare. The IGM is directed by Dr Kang Zhang and consists of 16 faculty members from a variety of departments ranging from computer science and bioengineering to psychiatry. The major approaches utilized are genetics, genomics and system-level analysis; the pathways of primary interest are RNA processing and epigenetics. Major disease areas of interest at present are neurological and mental health disorders (epilepsy, amyotrophic lateral sclerosis, autism, schizophrenia, bipolar disorders and ataxias), cancer and DNA repair, and retinal diseases (macular degeneration and glaucoma).

The Pharmacogenomics of Mood Stabilizer Response in Bipolar Disorder (PGBD) Program at UCSD is led by Dr John Kelsoe. Treatment of bipolar disorder remains a significant challenge to clinicians and patients. Response to medications for treatment of this debilitating disorder is highly variable between individuals. The goal of this program is to identify genetic variants that are associated with response to mood stabilizer medications that may be potentially used in clinical practice as a predictive test. The UCSD Chromaffin Cell and Hypertension Research Group is directed by Dr Dan O'Connor. His laboratory works on the genetic determination of common, complex human cardiovascular/renal traits, such as hypertension, renal function/disease, heritable responses to environmental stress and antihypertensive drug responses. At SSPPS, Dr Palmer Taylor's research group has conducted studies on the pharmacogenomics of butyrylcholinesterase SNPs and succinylcholine apnea, nicotinic receptor SNPs in relation to receptor structure, and acetylcholinesterase SNPs with respect to erythrocyte activity in man. Dr Tony Catanzaro (pulmonary medicine) conducts a multinational study of the genetics of TB drug resistance, including extensively drug-resistant TB to identify the genetic basis of discordant results between the rapid tests and standard drug susceptibility testing. Several other UCSD faculty members work on genetics of transporters from a phenotypic view point, including Dr Milton Saier in the Biology Department (transporter database), Dr Sanjay Nigam in the Department of Pediatrics (human phenotypes), Dr Ana Pajor in the SSPPS (structure and mechanism) and Dr Vivian Hook in the SSPPS (peptide studies).

Collaboration with partner organizations outside of UCSD

Pharmacy organizations

PharmGenEd has collaborations with several professional organizations, including the American Pharmacists Association, the American Society of Health-System Pharmacists, the American College of Clinical Pharmacy, and the American Association of Colleges of Pharmacy to initiate and promote pharmacogenomics educational activities. Through information, education and advocacy, the American Pharmacists Association empowers its 60,000 members working in a variety of practice settings to improve medication use and advance patient care. The American Society of Health-System Pharmacists represents 30,000 pharmacists who practice in hospitals, health maintenance organizations, and long-term care facilities. The American College of Clinical Pharmacy is a professional and scientific society that provides leadership, education, advocacy, and resources to enable 10,000 clinical pharmacists to achieve excellence in practice and research. The American Association of Colleges of Pharmacy represents US colleges

and schools of pharmacy and their faculty (reaching 4300 pharmacy school faculty and 48,500 students). Pharmacogenomics is an essential area of growing emphasis within the pharmacy training curricula. Through collaboration with professional organizations, we have initiated educational campaigns for the PharmGenEd program and conducted educational activities. In addition, PharmGenEd has worked with state and local pharmacy organizations to bring educational materials to their members.

Centers for Disease Control & Prevention Evaluation of Genomic Applications in Practice & Prevention

The PharmGenEd program staff at UCSD works closely with the Centers for Disease Control and Prevention (GA, USA) program staff and incorporate recommendations released from the Evaluation of Genomic Applications in Practice and Prevention (EGAPP) Evidence Working Group. EGAPP was established in 2005 to develop systematic methods for evaluating the evidence regarding the validity and clinical usefulness of emerging genomic applications. Evidence reports and tools for providers and the public are available on the EGAPP website [103].

Pharmacogenomics knowledge base

The PharmGenEd program staff at UCSD are working with the Pharmacogenomics Knowledge Base (PharmGKB) at Stanford University (CA, USA) to review and update pharmacogenomics information. PharmGKB has curators who extract from the published literature information on human genetic variation to drug response. Thus, the resource provides genotype and phenotype data, annotated gene variants, gene–drug relationships and summarizes important genes in drug response and associated drug pathways. PharmGenEd also participates with PharmGKB and the NIH Pharmacogenomics Research Network (PGRN) in the Clinical Pharmacogenetics Implementation Consortium (CPIC) to create a curated resource for storing, annotating and updating specific data relevant for clinical implementation of pharmacogenetic testing and consults.

San Diego Supercomputer Center, California Institute for Telecommunications & Information Technology & Research Collaboratory for Structural Bioinformatics Protein Data Bank

PharmGenEd has access to resources unique to UCSD. The San Diego Supercomputer Center (SDSC) is a major data store, computing resource for the university and a major networking hub for southern California and enables fast access to PharmGenEd resources [104]. California Institute for Telecommunications and Information Technology (CalIT2) is an organized research unit at UCSD providing advanced telecommunications and networking expertise and houses metagenomics and structural genomics projects important to our understanding of the genomic basis of personalized medicine [105]. Finally, the Research Collaboratory for Structural Bioinformatics Protein Data Bank (RCSB PDB) is a collaboration between Rutgers, The State University of New Jersey (NJ, USA) and UCSD. The RCSB PDB provides access to all publically available macromolecular structure data (70,000 structures currently). The RCSB PDB maps nonsynonymous SNPs to protein structures, and thus, provides unique insights into the structural basis of genomic variability [106].

Future perspective

The need to educate practitioners and students is great owing to the widening gap between pharmacogenomics advances and clinical practice. PharmGenEd is dedicated to fostering education of clinicians and students in the area of pharmacogenomics applications in clinical practice. Based upon increasing interest in the PharmGenEd program and resources from a diverse mix of health professionals (e.g., pharmacists, physicians and nurses), the need for resources appears to be great. PharmGenEd will continue its efforts to develop and disseminate pharmacogenomics educational materials by collaborating with a broader base of experts from the scientific community and identifying clinicians and faculty who are willing to serve as trainers.

With the support and infrastructure at UCSD, PharmGenEd is dedicated to providing a platform for dissemination of evidence-based, clinically relevant pharmacogenomics information and fostering educational and scientific collaboration among educators, researchers and clinicians. UCSD is a renowned institution that merges innovative science and stellar education; PharmGenEd is in line to support these missions that ultimately benefit our patients and community to improve personalized care.

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Highlights

- Pharmacogenomics Education Program (PharmGenEd™) is an evidence-based pharmacogenomics education program designed to increase awareness of health professionals of the current knowledge concerning the validity and utility of pharmacogenomics tests and the potential implications, both positive and negative, from the use of these tests.
- Components of the PharmGenEd program include continuing education programs, two train-the-trainer programs and online pharmacogenomic resources with virtual communities and pubcasts.
- The train-the-trainer program for healthcare practitioners provides training for clinicians to present pharmacogenomics information to their colleagues using PharmGenEd educational materials.
- The train-the-trainer program for health professional school faculty provides training and a shared curriculum for faculty to incorporate PharmGenEd materials into didactic course(s).
- Multiple collaborations with research groups at the University of California San Diego (CA, USA) and partner organizations are ongoing in an effort to initiate and expand genomic/pharmacogenomic research and education.
- The University of California San Diego has unique infrastructure resources that are being leveraged by PharmGenEd.

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Websites

101 Pharmacogenomics Education Program http://pharmacogenomics.ucsd.edu

102 Pharmacogenomics Education Program: Pubcasts http://pharmacogenomics.ucsd.edu/pubcasts.aspx

103 Evaluation of Genomic Applications in Practice and Prevention www.egappreviews.org

104 San Diego Supercomputer Center www.sdsc.edu

105 California Institute of Telecommunications and Information Technology www.calit2.net

106 Research Collabatory for Structural Bioinformatics Protein Data Bank www.pdb.org/pdb