Contact Us

We would love to hear from you! You can reach the school of pharmacy at **cedarville.edu/pharmacy** or at 937-766-7480. Prospective students should contact admissions at 1-800-CEDARVILLE (233-2784) or pharmacy admissions at 937-766-3290. We welcome your ideas, recommendations, partnerships, and support.

Watch for the Next Issue

In the next issue, watch for profiles of our new faculty as well as an update on the Springfield Project, an initiative patterned after the successful Asheville Project, which saved millions of dollars in health care costs while improving the health of Asheville, North Carolina, citizens.

Nineteen high school students from eight states joined us for an exciting week of Pharmacy Camp on July 5-9. Presentations from practicing pharmacists; field trips to area pharmacies and hospitals; and labs featuring compounding, high-fidelity mannequins, and patient assessment highlighted the week.

Cedarville University is a Christ-centered learning community equipping students for lifelong leadership and service through an education marked by excellence and grounded in biblical truth. More than just a mission statement, this focus attracts more than 3,000 Christian students from around the nation to study in our 100 academic programs on a beautiful 400-acre campus in southwest Ohio.

Outstanding students, world-class facilities, talented professors, and award-winning technology contribute to an education that *U.S.News & World Report*, *The Princeton Review*, and *Peterson's Competitive Colleges* all recognize as one of the best in the Midwest.

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PHARMACY FORECAST

Volume 3 | Issue 1 | 2010

PHARMACY FORECAST

NEWS AND INFORMATION FROM THE CEDARVILLE UNIVERSITY SCHOOL OF PHARMACY

CEDARVILLE UNIVERSITY

IN THIS ISSUE

Message From the Dean

As founding dean of the Cedarville University School of Pharmacy, much of my effort in the past two years has involved recruiting faculty, attracting students, building relationships with potential partners, and laying the administrative groundwork for an effective academic unit. However, another area that has consumed a great deal of time and effort has been the planning of a facility to meet the needs of our academic program. Consequently, it gives me great pleasure to share some of the details of this beautiful new Health Sciences Center in this newsletter.

I want to express our appreciation to the many pharmacy and other health professionals who have provided invaluable insights and counsel during the design phase of this significant project. This input helped shape our thinking about both the function and design of the building, bringing about a result that we believe will serve our students and other constituents extremely well.

Scheduled for completion in the summer of 2012, this three-story, 95,000 square-foot building will be located on the south side of the Stevens Student Center to provide access from both the heart of campus as well as the University's south entrance on Bridge Street. Designed and positioned to serve as both a teaching and potentially a patient service center, the facility will house Cedarville's growing pharmacy and nursing programs as well as the Center for Bioethics. Distinct features of the building include generous research laboratories for pharmaceutical science, clinical pharmacy simulation laboratories using high-fidelity mannequins, multiple small group study rooms to support our case study approach in the professional curriculum, a high-tech informatics center, and contemporary pharmacy practice stations. Ten additional classrooms and lecture halls will serve nursing, pharmacy, and other departments with excellent teaching and presentation venues. The center will also offer ample open areas as well as student lounges, designed to support gatherings and other programming that is so vital in building strong relationships within the school and with the many partners who will help us by providing experiential sites.

We believe that this wonderful new facility positions us to offer an exceptional education for our pharmacy students and thank the Lord for His provision thus far. Fundraising continues as we anticipate an early spring ground breaking. Watch for additional details as the project moves ahead. Please contact me if you have any questions or have an interest in supporting this initiative in some way.

Marc A. Sweeney
Dean of the School of Pharmacy

Pharmacogenomics: Back to the Future of Drug Dosing

Douglas C. Anderson, Pharm.D., D.Ph., C.A.C.P.
Professor and Chair of Pharmacy Practice

Pharmacists have long championed the cause of individualizing medication therapy to the specific patient in order to maximize benefits and minimize adverse effects. However, until recently the thought of selecting or dosing medications based on the patient's genetic makeup was the stuff of science fiction. For those of you who remember the movie, *Back to the Future*, pharmacogenomics appears to be the flux capacitor of individualizing medication therapy. Let's fire up the DeLorean and take a look at the future of medication therapy individualization.

Introduction

Pharmacogenomics, or sometimes called pharmacogenetics, refers to using the patient's genetic makeup to determine how a patient will respond to a medication or how the medication should be dosed for optimal response or to avoid adverse effects. Until recently, the gold standard for gauging whether a particular trait (be it physical or behavioral) was genetically determined was identical twins studies. Since identical twins have the exact same genetic makeup, then if a trait is genetically determined, it should be found in both twins. Looking at the expression of genetic traits (e.g., eye color) is called phenotyping. A high degree of correlation of a trait in identical twin studies is a good clue as to whether or not the trait is genetically determined. Thus, if a trait is genetically determined, then identical twins should both be of the same phenotype (i.e., if one twin has blue eyes, the other should also be blue-eyed). Recent advances in gene sequencing, however, have made possible looking at the actual sequence of nucleotides, the base units of our genetic makeup, in the DNA, otherwise known as genotyping. Differences in nucleotide bases, or genotype, lead to differences in expression of traits, or phenotype. Genotyping has been the Rosetta Stone that has unlocked the potential of using phenotype to customize medication therapy. Differences in response to a medication can be either pharmacodynamic (the level of response to a particular dose), or pharmacokinetic (how the drug is metabolized by the body), or both.

Clinical Evidence

The earliest known work suggesting a genetically determined difference in response to a medication involved an adverse reaction (aka, side effect). In the 1920s it was discovered that patients with an inherited glucose-6-phosphate dehydrogenase (G6PD — an enzyme important to energy production in cells) deficiency were susceptible to hemolytic anemia after receiving antimalarial medications. Interestingly, the inherited G6PD deficiency, which is most common in African, Middle Eastern, and South Asian populations, also confers a resistance to malaria itself.

Phenotypic differences in the pharmacokinetics of the anti-tuberculosis medication isoniazid (i.e., "rapid-acetylators") were described in the mid-1950s. Acetylation is a metabolic process by which the active compound is converted to an inactive metabolite. Rapid-acetylators metabolize the medication very quickly and thus have less of the active compound available, which reduces the response to the medication. Researchers investigating the differences in how different populations metabolized isoniazid coined the term "polymorphic metabolism" to describe the different phenotypes they were finding. An anti-infective medication, sulfamethazine, was used to determine acetylator phenotype until laboratory methods were devised in the 1970s.

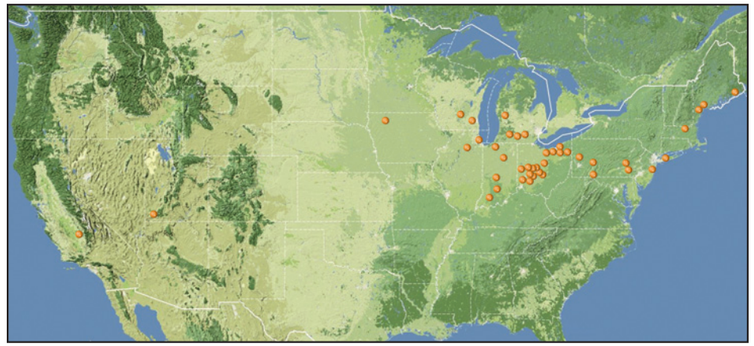
The blood thinner warfarin was approved for human use to treat and prevent blood clots in the 1940s. It is extensively metabolized in the liver by a group of enzymes called the cytochrome P-450 system (CYP450 for short). This is a large group of liver enzymes responsible for metabolizing chemicals for subsequent utilization and/or elimination. The metabolism of warfarin by CYP450 system is complex and produces some active metabolites. Warfarin acts by inhibiting the enzyme vitamin-K epoxide reductase (VKOR), which is the rate-limiting step in the activation of the body's vitamin-K dependent clotting factors (VI, IX, X, and II). Inhibiting VKOR means that there are fewer activated clotting factors available for the clotting cascade, thus preventing clot formation, i.e., thinning the blood. Given the complex metabolism and mechanism of action of warfarin, it is a prime candidate for genetic influences. The earliest evidence that there was a genetic component to warfarin pharmacokinetics and/or pharmacodynamics came in 1965 when a case was reported of identical twins that were warfarin resistant and required very high doses of warfarin. However, it was unknown whether this resistance resulted from an alteration of pharmacodynamics, pharmacokinetics, or both. It is now known that response to warfarin has both pharmacodynamic and pharmacokinetic factors that are genetically determined. Genetic variants in VKOR have been identified, some more or less sensitive to inhibition by warfarin, thus altering warfarin pharmacodynamics. Further complicating warfarin's actions and metabolism, warfarin is like a mixture with two different forms that are like mirror images of each other, or like right and left-handed gloves. The right-handed form (R-warfarin) is metabolized primarily by CYP3A4, and the left-handed form (S-warfarin) is primarily metabolized by CYP2C9. Both forms are pharmacologically active, however, S-warfarin is the more potent of the two. Thus, anything affecting the activity of CYP2C9 tends to have more impact on anticoagulation. Drugs that inhibit or increase the activity of CYP2C9 affect the pharmacokinetics of warfarin and thus the levels of anticoagulation. Genetic variants for CYP2C9 have been found and can have a profound impact on warfarin pharmacokinetics. In August 2007, the FDA mandated that information about genetic testing be included in prescribing information for warfarin. Interestingly, this coincided with FDA approval of commercially available kits to test for genetic variants for CYP2C9 and VKOR. The value of genetic testing for warfarin dosing has been questioned. Specifically, there is little evidence to suggest that dosing warfarin using a pharmacogenomic algorithm yields superior results to management by an anticoagulation service, a clinic with pharmacists who specialize in managing anticoagulants (and especially warfarin). Large clinical trials are underway to evaluate the clinical benefits of pharmacogenomic dosing of warfarin.

There has been some recent controversy regarding clopidogrel (Plavix), an antiplatelet medication used to prevent heart attacks and strokes, and proton pump inhibitors (PPIs) such as omeprazole (Prilosec and Prilosec OTC) which are used to treat gastric reflux (heart burn) and ulcers. Clopidogrel is a pro-drug, which means that it is an inactive form that has to be metabolized to the active form once inside the body in order for it to have an effect. Anything that prevents clopidogrel from being metabolized to the active form might lessen the effectiveness of the medication. This is where PPIs come in. Clopidogrel is metabolized to the active compound by CYP2C19 and omeprazole inhibits CYP450 enzymes, including CYP2C19. Thus, there is a potential for omeprazole to inhibit the conversion of clopidogrel to the active compound and lessen the beneficial effect. Analysis of data from several large clinical trials indicates that there is no detrimental effect to using clopidogrel and omeprazole together. However, the FDA and manufacturer have recently added warnings to the prescribing information about using the medications together. Pharmacokinetic studies have indicated that the amount of active metabolite of clopidogrel is reduced by almost 50 percent. Genetic variants have been found for the enzyme CYP2C19, and studies indicate that clopidogrel does not work as well in patients with these genetic variants resulting in higher rates of undesired/adverse cardiovascular events. The FDA has recently required a warning about CYP2C19 variants be added to the prescribing information, and the value of genetic testing before using clopidogrel is being hotly debated in the medical literature.

Genetic components to drug responsiveness and/or adverse effects have been suggested for cancer chemotherapy, antidepressants, HIV medications, hypertension (aka, high blood pressure) and heart failure, asthma/COPD, anti-arrhythmic medications, and cholesterol-lowering medications, among others. Only time will tell the number of these for which genetic testing prior to treatment will be common and beneficial. One thing is certain, though. The future of medication individualization includes considering the genetics of the patient.

For the full text of this article including references, go to cedarville.edu/pharmacy.

2010–11 Prepharmacy Students



The school of pharmacy welcomed an additional 50 new students to begin their prepharmacy studies at the University in the fall semester. This brings the number of students enrolled in the program to more than 100.

The new freshmen came from across the country, representing 13 states, to take advantage of Cedarville's distinct approach to pharmacy education. Nineteen (40 percent) came from the state of Ohio, and two came from South Korea. Women make up sixty percent of the group, a proportion that is also reflected in professional pharmacy programs across the nation. These students, like the inaugural class, demonstrated tremendous academic talent with the average member of the class having earned a cumulative high school grade point of 3.8 on a 4.0 scale and scored an ACT composite of 28 (ranking them in the top 10% of college-bound students nationally).

With these credentials, most of these students could have gained admission to many direct entry pharmacy programs. Yet they indicated that their desire to grow closer to Christ and serve Him as pharmacists ultimately led them to choose Cedarville. We look forward to the work that God will do in their lives through the University and the school of pharmacy as they prepare for the profession of pharmacy.

"There may be many schools of pharmacy in America, but only Cedarville offers the multi-faceted education that I want — challenging academics, spiritual encouragement, and promising relationships. Graduating from Cedarville will not only prepare me for a career in pharmacy, but it will also prepare me for life."

— McKenzie Shenk, Granger, Indiana