Pharmacogenetics is the study of genetic variations in drug response that are determined by specific genes. Pharmacogenomics refers to the interactions of multiple genetic differences, as well as environmental influence, and the effect on drug responses. Adverse drug reactions are one of the leading causes of death in the United States. A 1998 study of hospitalized patients reported that in 1994, adverse drug reactions accounted for more than 2.2 million serious cases and more than 100,000 deaths (1). It is hoped that the use of pharmacogenetics in clinical practice may improve drug safety and decrease the rate of such untoward events. Currently, however, there are limited clinical indications for the use of pharmacogenetics in routine obstetric and gynecologic practice.

Genetic Variation in Drug Response
Individual variation caused by single nucleotide polymorphisms in genes that encode drug–metabolizing enzymes, transporters, ion channels, and drug receptors has been associated with variation in response to pharmacologic agents. Mechanisms of such variation include extended pharmacologic effect, adverse drug reactions, increased effective dose, and exacerbated drug–drug interactions. Current research in pharmacogenetics focuses on identifying genes that may be targeted in drug development and on genetic variation that affects the level of response to a drug.

Cytochrome P450 Enzyme System
Many early investigations in this field have focused on cytochrome P450, a superfamily of liver enzymes that catalyzes phase 1 drug metabolism (2). The genes that code for these enzymes are highly polymorphic, and enzyme activity may vary markedly depending on individual genotype (3). Individuals with decreased enzymatic activity (ie, poor metabolizers) would be expected to have a greater likelihood of an adverse reaction to a drug, whereas individuals with high enzymatic activity (ie, ultrametabolizers) would be predicted to have an inadequate therapeutic response to standard dosages.

Warfarin
Warfarin has been the most extensively studied drug in the field of pharmacogenetics. All warfarin derivatives inhibit vitamin K epoxide reductase complex, and variants in the gene for this enzyme (vitamin K epoxide reductase complex 1) are known to affect response. A recent review highlights the key issues in the pharmacogenetics of oral anticoagulant therapy, including the effects of genetic variants on dosage and complications (4). Patients carrying the cytochrome P450 alleles cytochrome P2C9*2
or cytochrome P2C9*3 require a lower mean daily warfarin dose than patients homozygous for the cytochrome P2C9*1 allele. These patients show an increased risk of overanticoagulation and major bleeding in the initial phase of warfarin therapy. Likewise, polymorphisms in the vitamin K epoxide reductase complex 1 gene (especially the 1173 C/T allele) have been associated with lower dose requirements for warfarin.

Much of the variability in warfarin response appears to result from the combination of vitamin K epoxide reductase complex 1 and cytochrome P2C9 genotypes, but the usefulness of genotype-specific dosages of warfarin is still unclear; several prospective studies have not demonstrated improved outcomes. A recent American College of Medical Genetics policy statement concluded that there is no direct evidence to advise for or against routine genotyping before warfarin therapy (5). A similar conclusion was reached in a review that concluded that nomograms based on clinical characteristics and response to a standardized warfarin dose had similar, if not better, accuracy when compared with pharmacogenetic-based algorithms (6).

**Pharmacogenetic Testing in Clinical Practice**

Currently, the U.S. Food and Drug Administration recommends pharmacogenetic testing in a few specific instances (see: http://www.fda.gov/Drugs/ScienceResearch/ResearchAreas/Pharmacogenetics/ucm083378.htm) (7). Testing is currently required before administering maraviroc (for human immunodeficiency virus [HIV] treatment), cetuximab (for colorectal cancer treatment), trastuzumab (for breast cancer treatment), and dasatinib (for acute lymphoblastic leukemia treatment). In such specific situations, pharmacogenetic testing is done to determine if an individual is likely to benefit from the specific therapeutic agent, rather than to tailor the dosage.

The use of pharmacogenetics in obstetrics and gynecology practice holds much promise. As in other fields of medicine, however, there continues to be a lack of evidence for routine use in current practice. Prospective clinical trials are needed to develop the appropriate algorithms to introduce pharmacogenomic testing into routine clinical practice in ways that are demonstrated to improve health outcomes.

**Recommendation**

At this time there are no standard clinical indications for the use of pharmacogenetic testing in the routine practice of obstetrics and gynecology, and there is limited use in other clinical situations.

**References**


