

2001: A Pharmacogenomics Odyssey

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While attending the United States Pharmacopeia Quinquennial Meeting 2000, I listened with fascination as Dr George Poste, a leader in the commercial application of genetic technology, declared his prediction that in the future, patients would have their medical history data recorded on a subcutaneous implantable chip instead of merely having a “smart card”. Other speakers described how the tremendous amount of genetic data generated by the Human Genome Project has fuelled the recent explosion of pharmacogenomics research.

In 1990, the Human Genome Project was conceived as a 15-year project, but because of advances in sequencing technology, mapping the complete set of instructions that make up our human genome is expected to be complete by 2003.¹ This is no small feat, as these instructions consist of approximately 3.2 billion base pairs of nucleic acids, which code for up to 100 000 genes on 23 pairs of chromosomes.²

Although most authorities date the birth of “pharmacogenetics” to the early 1950s, others suggest that observations of highly variable drug response were made as early as 510 BC, when Pathagoras observed adverse reactions (specifically, hemolytic anemia) after ingestion of fava beans by some individuals.³ “Pharmacogenomics”, however, is a more recent addition to our terminology, having first been used in the literature in 1997.⁴ Pharmacogenomics is a broader field and involves genome-wide analysis of the genetic determinants of drug efficacy and toxic effects.⁵

What, then, are the implications of pharmacogenomics research for the institutional pharmacist? Pharmacy practice continues to evolve toward direct patient care. Pharmacogenomics research offers the promise of an important tool to help personalize drug therapy, that is, finding the best drug to be administered at the effective dosage that is safe the first time. To fulfill this promise, pharmacists of the future will need

to apply this new body of knowledge to our patient education and monitoring roles, as in the following examples.

- The pharmacist of the future may need to explain to the patient why a certain medication was chosen over another on the basis of his or her particular genetic profile.
- Knowledge of a patient’s genetic profile may also help us to explain why an adverse drug reaction is more serious for one patient than for another.
- The pharmacist may also help patients to understand the implications of their newly determined genetic profile and field patients’ questions regarding ethical issues.²

As the pharmacogenomics knowledge base continues to grow, it will become increasingly important for the pharmacist to become knowledgeable about this discipline and its societal implications.² As such, modification of curricula in pharmacy schools and extensive educational programming for current practitioners will be essential to enable future practitioners to participate in this “new therapeutic arena”.¹

In the future, instead of targeting a patient’s drug concentrations within a therapeutic range, as in traditional clinical pharmacokinetic monitoring, pharmacists will likely make dosage recommendations for some drugs on the basis of the individual patient’s genotype. Given the waning use of traditional aminoglycoside therapy, which has been the primary focus of pharmacokinetic monitoring over the years, pharmacogenetics-oriented monitoring of other drugs may well become the therapeutic drug monitoring of the future.



This individualization of drug therapy and the complexity of drug selection are expected, more than ever, to necessitate a team approach to health care. Existing collaborative relationships not only between the pharmacist and the patient but also with physicians, clinical laboratories, and other health-care professionals, must be expanded to include this new focus. As pharmacists, we will be expected to be an integral part of the team because of our extensive knowledge base of how other factors (such as food, concomitant medications and pathophysiologic conditions, gender, environment, and socioeconomic status) may contribute to the success or failure of a treatment plan. In addition, the pharmacist is one of the health-care professionals most likely to be “aware of the demand for cost-effectiveness, the rapid growth of disease management programs, and the narrowing of formularies.”⁶

As a 12-year-old in the 1960s, when the movie *2001: A Space Odyssey* was first released, I could hardly imagine what the world would be like at such a distant time in the future. But here we are in what seemed, long ago, to be a futuristic time. While many of the predictions of Stanley Kubrick’s work of science fiction have not come to pass, I continue to be fascinated and amazed by such tremendous advances in science and technology, far beyond the wildest imaginings of that 12-year-old. I hope that the “pharmacogenomic odyssey” will stimulate us all to consider the potential of this dynamic area. Perhaps we will even anticipate and prepare for it together.

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