Are We Prepared for the Genomics Era?

By J. Lyle Bootman, PhD

During the past year, we attended numerous seminars, meetings, and conferences where a significant portion of the programming was dedicated to the topics of genomics, proteomics, drug discovery, biotechnology and the like. Clearly, the era of genomics has begun, bringing crucial issues to the forefront of our consideration. Gene mapping and the Human Genome Project are only the beginning of a new revolution in the discovery, development, and application of pharmaceuticals. The genomics era is an inherently new approach to the diagnosis and treatment of disease in general.

Some suggest that physicians, pharmacists, nurses and other health practitioners are ill-prepared to deal with this new era of science, evidenced by difficulties in providing quality health care within our current system. Reports in the literature, such as that released by the Institute of Medicine entitled "To Err is Human," and the toll of patient suffering and death due to medical error support this claim.[1] Other studies suggest that this problem might be more severe in the ambulatory care setting rather than in the institutional setting, and results in billions of dollars of unnecessary hospitalizations and emergency room visits.[2] Many fear that inadequate preparation for dealing with new genomic technology will only worsen these problems. We must ask ourselves whether or not we are prepared for such changes, and give immediate attention to this at all levels so that we may effectively provide leadership in the area of "genomic technology application."

Genomics will drive dramatic change in the practice of medicine, pharmacy and healthcare delivery. Using genomics, scientists will be able to identify novel therapeutic targets, identify patients most suited to a particular therapeutic intervention, conduct genetic risk assessments for disease, and generate novel strategies for disease prevention. Individual consumers may possess knowledge of their individual genetic makeup, and panels of tests for the most common genetic abnormalities may be offered in the physician's office.

The potential benefits of understanding an individual's genetic makeup are numerous. Knowledge of genetic predisposition may enable better use of pharmacological agents to prevent or delay disease onset and organ damage. Additionally, genomics information will enable us to determine who might respond to a particular drug therapy in advance, or even more, who might experience certain side effects or drug interactions. Such information could help improve physiological response with minimal adverse effect and a favorable pharmacokinetic/pharmacodynamic action. In terms of the future discovery of new therapeutic agents, genetic information will allow us to study the impact of environmental and geographical factors causing disease, and could eventually lead to the ability to even alter one's individual genes.

The final area that we all need to be prepared for in the genomics era will be to successfully address the many ethical issues along the way. Many questions will arise, such as: What is the impact of specific genes on intelligence? How will the knowledge of an individuals genetic makeup effect life decisions? How will this knowledge effect decisions within the workplace? These are serious ethical questions that will need to be addressed by all in a coordinated and responsible fashion.

At a recent national pharmaceutical conference, the pharmacist attendees suggested that they should play a key role in the application of pharmacogenomics, and recommended that at a minimum, clinical pharmacists take care of the genes and supply them to physicians for particular application to the patient. With regard to cell-based therapies, they put themselves forward as the clinical group best suited to provide care for those particular cells and the overall basis of control and application in their use. In addition, the risk assessment made possible by identifying patients who are predisposed to certain diseases will enable us to design pharmaceutical interventions, based upon their genetic makeup. The pharmacist may be in a good position to

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apply this information and make sure these new pharmaceutical agents are used safely and appropriately.

We were impressed by the leadership role being attempted by the pharmacy profession in the pharmacogenomic revolution. However, we also strongly believe this is an area where the interdisciplinary team needs to be engaged. Successful application of pharmacogenomics research will occur only through multidisciplinary practice across physicians, phamacists and other healthcare providers where appropriate. Providing excellent health care in the genomics era will require commitment, leadership, and support from policy makers and those in a high level of management within our healthcare systems. This will also require alignment of financial incentives and clinical goals across all sites of care and service settings.

At the same time, centralized responsibility and accountability for the delivery of pharmaceutical care are also of upmost importance. Only in this way will we ensure that coordinated pharmaceutical care will lead to the appropriate outcomes and efficiencies within the healthcaresystem. Effective communication amongst our providers could be the most limiting factor. To this end, the use of computer technology such as PDA's may allow easy communication across settings, providers, and within particular isolated settings.

This is an exciting period for the practice of medicine, pharmacy, and nursing. As educators and as scientists we look forward to the environment in which current and new practitioners will be engaged. Strategies and resources within our academic health centers are now being dedicated for the education and training of our future health practitioners. However, more attention needs to be directed toward existing practitioners in order to ensure that application of this new science will result in appropriate outcomes. As editors, we welcome your comments and opinions on this particular topic.

REFERENCES

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2. Johnson JA, Bootman JL. Drug-Related Morbidity and Mortality: A Cost-of-Illness Model. *Arch Intern Med.* 1995;155:1949-1956