MedicalXpress

NHGRI charts course for the next phase of genomics research

February 9 2011

A new strategic plan from an arm of the National Institutes of Health envisions scientists being able to identify genetic bases of most single-gene disorders and gaining new insights into multi-gene disorders in the next decade. This should lead to more accurate diagnoses, new drug targets and the development of practical treatments for many who today lack therapeutic options, according to the plan from the National Human Genome Research Institute (NHGRI).

Molecular pathways that are implicated in single-gene disorders may hold important clues for the diagnosis and treatment of common disease, according to the strategic plan, Charting a Course for Genomic Medicine from Base Pairs to Bedside, in the Feb. 10 issue of the journal *Nature*. The new strategic plan comes on the 10th anniversary of the first analysis of the human genome sequence.

"Researchers around the world are working towards a future when health care providers will use information about our individual genomes to better diagnose and treat disease," said Eric Green, M.D., Ph.D., NHGRI director. "While significant challenges remain to our understanding of how the genome operates in health and disease, there are enough examples to say with confidence that genomics research will lead to important advances in medicine."

The new vision, produced in consultation with the research community over the past two and a half years, is framed in terms of five research domains. They span activities from basic research into how the human

genome is organized and functions to clinical applications that will use knowledge of the genome and genomic technologies to improve medical care and health maintenance. The research domains are:

- Understanding the structure of genomes
- Understanding the biology of genomes
- Understanding the biology of disease
- Advancing the science of medicine
- Improving the effectiveness of healthcare

The plan envisions continuing to expand the understanding of the biology of the genome, including creating more diverse and complete catalogs of genomic and other "-omic" information, along with new tools and technologies to develop and interrogate those catalogs. Investigators in all fields of biomedical research use these resources to identify the functional contributors within the genome that determine normal, healthy biology, as well as those that, when altered, lead to common as well as rare diseases.

The new sequencing technologies, which have been widely adopted in the past three years, are a major driver of the developments in genomics research. "It took all the sequencing capacity in the world about 13 years to produce the first human genome sequence," said co-author Mark Guyer, Ph.D., director of the NHGRI Division of Extramural Research. "In 2003, around the time we completed the Human Genome Project, technology had improved to the point where 100 machines could sequence a human-sized genome in about three months. In 2011, one machine can produce a human-sized sequence in about five days."

DNA sequencing technologies, however, are just one of the tools needed to answer the research questions that will advance human health. Technological improvements in many other areas will be critical to successfully integrate genomic knowledge into clinical care. The plan calls for fast, low-cost and highly accurate tools that will allow researchers to read and interpret much longer sections of the human genome and clinicians to use sequence information at the point of care.

The plan also calls for new technologies to measure the interaction between the environment, behavior and genes and for routine clinical applications of genomic tools such as newborn genetic screening and other types of diagnostic screening. It also calls for electronic medical records systems that integrate family histories and genomic data to generate personalized diagnoses, treatments, and prevention plans.

Development of new analytical methods, software tools and a robust computational infrastructure will be essential. Researchers need these tools for accessing, analyzing, integrating and storing the mountains of complex genomic data that will be gathered from thousands of individuals, according to the report.

With this ever-expanding body of knowledge, scientists will likely identify the genetic basis of most single-gene disorders in the next decade, the plan asserts. Furthermore, molecular pathways that are implicated in single-gene disorders may hold important clues for the diagnosis and treatment of common disease, the plan says.

The plan anticipates the increasingly important role of multi-disciplinary and international teams for collaboratively producing and analyzing comprehensive sets of data about a condition. Rapid data release for immediate research applications, which has been essential to genomic research, will continue to be fundamental for the field's success, according to the plan.

Beyond technology, educational efforts will be critical to making genomic medicine practical for both clinicians and the public, according to the plan. Health care providers must be trained to interpret genomic information and to use it in counseling patients. Health consumers will need to familiarize themselves with genomic medicine so they can understand their personal risks, participate in clinical decisions, make the best use of new therapeutics and, if they so choose, modify their behaviors in response to genome-based health information. Legislators and policymakers must craft policies that continue to promote the confidentiality of participation in genomics research. Other policies will be needed to protect individual privacy and access to health coverage, and to encourage investment in genomic health technologies through intellectual property incentives.

Genomic medicine will only reach its full potential when its benefits become accessible to all, including at-risk and low-income individuals around the world. Towards this end, the plan notes the need for greater reliance on non-geneticist health care providers and a consideration of the larger societal implications of increasing genomic knowledge.

"Our base-pairs-to-bedside plan maps the next steps in the herculean endeavor not only to discover medical secrets hidden within the human genomes, but to bring those discoveries to the practitioner and patient," Dr. Green said.

"All of us in this field share a sense of urgency about using genomics for clinical applications. The challenges are enormous, but we believe that, working together, the goal of improving human health is within reach."

Dr. Green observed that genomic approaches already inform some medical treatments. Breast cancer and colorectal cancer patients are now tested for Her2 and KRAS gene mutations, respectively, in order to guide drug choices. Likewise, genetically guided prescriptions of the anti-

retroviral abacavir (Ziagen) are now the standard of care for HIV-infected patients, and the uses of tamoxifen, clopidogrel (Plavix) and possibly warfarin will soon benefit from genetic guidance. These successes demonstrate that genomic science is already having an impact on medical care, and portend much wider application as genomics increasingly becomes an integral part of health research and development, Dr. Green said.

Provided by National Institutes of Health