Genomics and world health: a decade on

In May, 2002, under the auspices of its Advisory Committee on Health Research, WHO released *Genomics and World Health*, a report that assessed genomics research and its future possibilities. The report addressed issues of equitable sharing of benefits between low-income and high-income countries, ethical concerns, and integration into delivery of health services, and gave recommendations to ameliorate the problems identified. What progress has been made since release of the report?

The past decade has been marked by unprecedented advances in the technologies associated with genomic science, as exemplified by the dramatic increase in speed, and reduction in cost, of genome sequencing. This technology has made possible large-scale genome-wide association studies that aim to identify genes for susceptibility to chronic diseases, such as cardiovascular disease and diabetes, and hence learn more about their cause and prevention. Genomic biobanks, repositories of human DNA linked to clinical and other patient data, promise more incisive analysis of genetic risk factors.

The cautious tone of *Genomics and World Health* seems to have been justified, however. The completion of the Human Genome Project in 2003 was accompanied by predictions that its fruits would transform medical practice within 20 years. Yet, so far, applications of genomics for medical research and practice have had limited clinical benefits. This moderate progress partly reflects the complexity that has emerged in subsequent studies of the regulation of our genomes. Currently, it is unclear whether advances will come from the complex mathematical approaches of systems biology or by focusing on the genetic regulation of individual cells. Given these uncertainties, and the added complexity of the biology of ageing and common diseases, it is not surprising that progress has been slow. However, there is undoubtedly light on the horizon.

The application of genomics to diagnosis and prenatal detection of monogenic diseases, exemplified by the inherited disorders of haemoglobin that affect thousands of children in low-income countries, has already had a role in the control of these disorders. This progress owes much to the development of North/South partnerships, which were strongly recommended in the WHO report. In addition, studies of the genetic variation that underlies resistance or susceptibility to common infectious agents in tropical climates are beginning to raise considerable possibilities for their more effective control. Meanwhile, work on the molecular basis of cancer, for example by the Wellcome Trust Sanger Institute’s Cancer Genome Project, despite revealing underlying genetic complexity, has already provided valuable diagnostic agents following the early lead on the discovery of the *BRCA* genes and their relation to breast and ovarian cancer. This work has also anticipated the era of personalised medicine and pharmacogenomics by identifying the genetic susceptibility of particular tumours to anti-cancer therapy, in the treatment of leukaemia for example.

For infectious diseases, advances in genomics research have led to the rapid identification of emerging and re-emerging pathogens, the most recent example being the identification of a new bunyavirus in China associated with severe fever with thrombocytopenia syndrome. Increasingly large databases of genome sequences of human and animal pathogens mean that early identification has been accompanied, critically, by the ability to develop rapid diagnostic tests to aid in surveillance and implementation of public health containment measures, for example, the recent discovery of the major genome region underlying artemisinin resistance in malaria. Future benefits are expected in therapeutics, drug discovery, and vaccine development. The Malaria Genomic Epidemiology Network was established in 2008 to bring together researchers from 21 countries in a consortium that hopes to better understand genetic variation as an aid to eliminating malaria. Although the lack of therapeutic results from similar approaches to other major infectious diseases is disappointing, it is inevitable that the development of drugs or vaccines from such research is a slow process.

Concerns about equity that were expressed in *Genomics and World Health* have been partially addressed by the creation of biobanks in such countries as China (Chinese Kadoorie Study of Chronic Disease) and Mexico (Mexico City Prospective Study). This is part of an overall desire to ensure that people worldwide benefit from advances in
genomics research by including diverse ethnic groups in large population-scale genetic studies and not just those of European descent.14,15 Indeed, China has become a major player in genomics through the Beijing Genomics Institute, for example.15

Despite the important scientific advances, some ethical, legal, and social concerns remain. There are ethical, privacy, and security concerns associated with direct-to-consumer genetic testing and the establishment of biobanks, which relate mainly to interaction with patients and the problems of confidentiality, as well as continuing concerns about the potential misuse of technology itself—for example, the controversy around publication of the genetic sequence of a mutated H5N1 influenza virus created in the laboratory.16

Progress in the future will depend on the scientific community, industry, government, patient groups, and civil society organisations working together to realise the potential of genomics research. Although the technology of genetic profiling continues to improve37 there is still insufficient detailed analysis of clinical features and heterogeneity of the diseases under investigation. The rediscovery of phenomics,18 which in a clinical context comprises detailed analysis of every aspect of the diseases that are being studied, is therefore encouraging. Progress in this area will require much closer collaboration between clinicians and geneticists. Finally, genomics must not continue to neglect rare diseases, lessons learned from which have often had implications for the better understanding of common disease;19 a fact conveyed in a letter written to a colleague in 1657 by William Harvey. As evidenced by William Harvey’s discoveries, revolutions in the biological sciences often take a long time to yield practical applications. Genomics, although still in its infancy, promises a great deal for the future.

We declare that we have no conflicts of interest. DW was lead author and TP editor for the Genomics and World Health report.


Pazopanib and the treatment palette for soft-tissue sarcoma

Development of new therapeutics for adults with metastatic soft-tissue sarcoma has been frustratingly slow, with few effective drugs identified in the past 30 years. Despite their common mesenchymal origin, soft-tissue sarcomas are heterogeneous and increasing knowledge of their molecular biology will drive future drug development.1 Effective targeting of KIT mutations by imatinib2 for gastrointestinal stromal tumours has been a notable success story in modern sarcoma therapy. Unfortunately, similar successes for other soft-tissue sarcomas have been rare, since tumour growth is usually driven by complex molecular alterations.

In The Lancet, Winette van der Graaf and colleagues3 report results of the PALETTE study, assessing pazopanib—an oral multitargeted angiogenesis