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We need a genomics-savvy healthcare workforce

Twenty years after completion of the Human Genome Project, genetics is rapidly being integrated into everyday clinical practice. But in this era of genomic revolution, genetically trained teams of healthcare workers are needed to optimize delivery of patient care.

On 22 June 2023, the American College of Medical Genetics and Genomics released an update[1] on its recommendations for reporting of secondary findings from clinical exome and genome sequencing. Their first set of such evidence-based recommendations were published in 2013, and the recent decision to update the list annually exemplifies the need for greater understanding of the power — and the consequences — of integrating genetics and genomics into routine clinical practice.

Genetics has long been used in specific areas of medicine, such as for the diagnosis of rare diseases caused by pathogenic mutations or in the context of prenatal genetic testing; however, it is now diffusing across many domains of clinical practice. In the UK, for example, all children with suspected or diagnosed cancer are now offered whole-genome sequencing[2] by the National Health Service to inform the use of targeted treatments. And in the USA, ongoing clinical trials[3] are returning information on genetic risk scores to study participants to assess if this information can be used to aid prevention and clinical decision-making for cardiometabolic diseases. In addition, the US Food and Drug Administration is anticipated to approve[4] the first CRISPR–Cas9-based gene therapy in the next few months, which will pave the way for other gene-editing therapies currently in clinical trials for hemoglobinopathies, vision loss and cancer.

The interpretation of clinical genetic information and its communication to patients are by no means trivial. In the case of genetic tests, for example, the ideal scenario is that the test provides information on whether the patient carries an actionable pathogenic variant. The real-life situation, however, is often more complex. Detection of a germline pathogenic variant in a patient could have serious repercussions for other family members or may represent an incidental finding that requires careful counseling. The evidence in support of the pathogenicity of a variant may be weak — as is the case of 'variants of uncertain significance' — which further complicates the interpretation and subsequent clinical decision-making. In the case of delivering polygenic disease risk score results to patients, clinicians need to understand how to best communicate and act on the results, which are typically broad-range risk estimates. Clinical geneticists and genetic counselors play essential roles in the implementation of genomics in medicine, but their number is limited. In the USA, for example, the number of medical residents entering clinical genetics training programs has not increased substantially over the past 4 years, despite increases in demand.

The increasingly central role of genomics in healthcare means that not only are more genetic counselors needed, but also multidisciplinary teams are essential for utilizing genomic technologies in the clinical setting. Genomic tests (such as those based on whole-exome or whole-genome sequencing) generate an enormous amount of highly complex data, which requires professionals with specialized bioinformatic skills and the know-how to operate within clinically accredited frameworks. In addition, although genomics is currently the most common '-omic' used in the clinic, transcriptomics and proteomics are also being incorporated into algorithms to inform clinical practice. Globally, clinical bioinformaticians are scarce. In a 2020 report, 'Genome UK: The Future of Healthcare'[5], the UK government predicted a considerable increase in demand over the next 10 years and developed recommendations on how to scale up training of and how to retain computational experts in the clinical setting. The generation of large genomic datasets also poses challenges for data protection and informed consent for reuse, which will require specialized input from bioethics experts.

In addition to the need for scaling up the training and retention of bioinformaticians, clinical geneticists and counselors, physicians themselves will need to be better prepared to work confidently with genetic information. Although basic genetics classes are typically offered in medical school curricula, reports from Australia[6] and the USA[7] show that the genetic literacy of physicians varies widely across disciplines, and even within fields it is often inconsistent and dependent on the personal interest of residents and supervisors. Genomic technologies evolve rapidly, and there is a pressing need to update genetics teaching curricula and training in medical education. Some universities[8] have already started to address this gap with initiatives aimed at enhancing undergraduate medical education in genomics and recruiting medical graduates into genetics residency training programs, but more formal education programs for medical students and current clinicians are urgently needed.

Genomics has also introduced new challenges to health equity. Sequencing remains an expensive clinical tool and gene therapies are typically very costly. These expenses risk exacerbating already existing inequities in access to healthcare. Such inequities to access are also widened by the scarcity of genomic data generated from people of diverse ancestries. For the most part, currently available disease polygenic risk scores have been trained on data from people mainly of European ancestries, and the resulting models are consequently less accurate[9] when applied to understudied populations. If this research practice is not corrected, genomic medicine will continue to benefit only the few. Additional funding to diversify sequencing efforts and to increase awareness of these issues is needed to ensure that the promise of genomic medicine is available to all.

A rapidly evolving genomic revolution is poised to shape the future of healthcare, but its full clinical potential can be realized only with the development of a multidisciplinary

healthcare workforce capable of evolving to stay abreast of rapidly developing genetic technologies.

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