ETHICS OF GENETICS: MORE THAN JUST DESIGNER BABIES

Work around the human genome and advances in the accessibility and analysis of data, creates huge opportunities for early healthcare interventions. But the advent of genomic information and evolving technology also brings a myriad of new ethical considerations and technology challenges. Dr Gene Elliott explores the impact of the data explosion created by genomic innovation.

Access to genome information is more affordable and commercially available at a time when cell biology has advanced to the point where designer humans have become both feasible and technically possible. Many medical laboratories now include genetic testing as part of the routine laboratory request menu.

There is no doubt about the benefit of mainstream applications of genetic information to diagnose diseases and improve the lives of many patients. However, the potential for abuse has opened a heated debate about how far the use of the technology should go, the rights of the individual with whom the information is connected, and the value of big data when used to promote research for the greater good and for better commercial drug development. The possibility of exploitation, victimisation or discrimination remains at the crux of the need to protect the information in an ethical framework. Therefore, laboratories and electronic healthcare systems have been challenged to adapt to data and security requirements.

The Human Genome Project was first discussed globally in 1985 and with initial private funding and later funding from government completed in 2003. Even then the ethical concerns were raised of the possible impact on society and individuals. Since its completion, additional scientific discoveries coupled with technology improvements like high throughput sequencing, gene splicing and epigenetics have allowed many advances in disease management as well as the prospect of personalised health and even potential cure of genetic conditions.

Diagnostic utility was initially targeted at a ‘present or absent’ for a single target. This was followed by the multiplex polymerase chain reactions (PCR) that allowed amplification of multiple targets in a single reaction. Sequencing technology advances now make it feasible to do large-scale rapid sequencing of large targets in stable reactions coupled with exponentially improved computing power for storage and analysis of data. As legacy systems have not been able to accommodate housing the massive amounts of data required, and managing the analytics, the newer more flexible, saleable databases now available are able to fill the niche.

The initial focus was identification of common genetically transferred diseases associated with known single mutations usually done in research laboratories by passionate scientists. Government funding for projects to expand the reach and access to genomic information, like the Genomics England 100,000 Genomes project to detect rare diseases, and the National Human Genome Research Institute funding to incorporate genetic data into electronic medical records (EMRs), encourage the participation of the public and healthcare practitioners.

Concerns about the ownership and use of the information vary depending on the interest. For individuals it is seen as a double-edged sword. Some may not want to know so much about themselves or have the psychological and emotional capability to deal with the unexpected or unanticipated knowledge. Unexpected findings like the possibility of an early death or debilitating old age emphasise the need for comprehensive psychological counseling and assessment of coping mechanisms to deal with the unexpected information. Even when the information is available, behaviour may not be modified to reduce risk. Everybody knows smoking cigarettes is bad for you, but that has not entirely prevented people from smoking. However, recording informed consent against the specimen in the laboratory information system and specifying access of the healthcare worker to appropriate information, is a risk minimising strategy, and at least partially addresses ethical considerations.

The positive aspects – like detecting carrier status of certain common genetic diseases – can prevent tragedy or at least provide some choice in reproduction for both parents in high-risk groups. Many options to manage these situations proactively now exist if the information is known before choices need to be made. This is countered by the risk of finding a known mutation
that will predispose to certain conditions and lead to dreadful diseases that may not currently have a cure or preventative strategy. Fear of the outcome may cause a grief response with unpredictable consequences. Therefore providing comprehensive informed consent for the individual, with the adequate preparation and support when the findings are available will remain a challenge.

Cancer is one of the most notable diseases treated by genomics. Known mutations have identified risk for certain familial cancers like breast cancer. Early detection, accurate molecular classification, and newly designed targeted therapies have made a significant difference in the five-year mortality rate. The International Cancer Genome Consortium made 1,200 whole genome sequences available at the end of 2015 on the Amazon Web Service to the cancer research community allowing collaboration and potentially new treatments.

Wellness programmes and the prevention of disease, support the sustainable development goals of the World Health Organisation for a healthier world population by 2030. This is one of the drivers for personalised medicine where wellness and prevention are emphasised and whole genome screening provides information for risk assessment based on known mutations of genes occurring in random areas. The personal data may now be stored as part of a person’s electronic medical history making it accessible to both the patient and healthcare provider when needed for cancer screening. The results of hacking of health records have highlighted the need for improved security for the protection of privacy.

Antenatal and newborn screening programs to detect chromosomal abnormalities or rare metabolic diseases are well established in many countries and the application of the technology has benefited many before harm is done. Unfortunately, being better informed has not removed all the hard decisions and choices that remain with the parents and may leave them with a personal ethical dilemma.

So the overall personal benefits seem to outweigh the disadvantages when applied to the individual, but are there benefits to society and the population?

The expanded knowledge base coupled with the advent of big data analytics has allowed epidemiologists and health economists to use the unlinked existing medical information, usually diagnostic codes and billing, to track diseases, model costs and economic benefit of interventions. Use of genetic data for this has been limited but the demand to access and analysis will continue to increase.

As most of the information will exist in laboratory information systems, a policy should be developed for dealing with requests and should be aligned with local legislative requirements. The question “who will have access and how the data could and should be used?” is unanswered, but the push to improve the quality and accuracy of health data and the vastly improved computing power will make it more feasible to include genetic information for population analysis.

Responding to this demand for data with available technologies, also presents another set of challenges that must be addressed in parallel. Some laboratory information management systems (LIMS) are currently in use, for instance, will encounter limitations in meeting the exponential rise in demand for secure, increased storage, along with the accessibility of information required for analysis. It should be noted that the data for a genomics investigation will require more than 10,000 times the storage of a typical laboratory testing profile today. Simply put, traditional LIMS were not designed to cope with the rapidly emerging bioinformatics demands. A LIMS without a tightly coupled analytics platform will become a solution of the past.

Many current LIMS will also demonstrate limitations in accommodating traceability and audit trail requirements that are necessary to mitigate risks over secure handling of sensitive patient data. In addition, they lack the ability to support the 'chain of custody' requirements that underpin the need for laboratories handling genetic samples and information, to be able to show who has interacted with that information. Technology aimed at providing electronic records of any kind to deliver healthcare must now keep pace to protect information and simultaneously allow it to be shared for positive use, in an age where science is rapidly advancing.

An example of this advancement can be seen in gene therapy research, which is now closer to the possibility of implanting missing genes to fight AIDS and certain cancers. Safety issues do remain a limitation. The pharmaceutical industry has however been able to make a case for genomics and because there is a commercial benefit to them, the question around whom the information belongs to and who should benefit, and how, remains unanswered. Pharmacogenomics links the individual response to medication to most beneficial treatment selection and dosage to minimise side effects and achieve the best outcome. The same data can be used if it is de-personalised for population analysis and economic modeling. In the same argument it is a tool to foster new and cheaper drug development and to identify therapeutic targets. Keeping the individual’s privacy intact if the same data source is used is an important consideration.

Healthcare funders are continually using data collected from various sources (mostly administrative) to determine population profiles and assess risk for pricing of insurance premiums. The possibility of funders and even prospective employers using personal information for discrimination based on genomic profiles is prohibited in the Genetic Information Nondiscrimination Act (GINA) of 2008 in the USA. Protection of genome information of individuals globally began in 1993 with the Declaration of Bilbao, and has been expanded and affirmed with the most recent UN Economic and Social Council’s Resolution of 2004/09. Some countries like Canada are looking at creating specific legislation to protect individuals, and others rely on human rights legislation applied to the situation.

Recent approval of mitochondrial donation with three parent babies in the UK to prevent debilitating conditions like muscle dystrophy benefit a small number of women, but the long term effects beyond a healthy genetically related baby is mostly speculation. Controversy still abounds with the first babies due in 2016 where they will be closely watched for their outcomes. As the same technology can be used for “designer babies”, limiting the use to regulated medical applications will be difficult where financial incentives may create a market for less scrupulous practice. The ethics of laboratories growing embryos particularly beyond the 14-day rule, experimentation and modification is an emotionally charged discussion where the desire for expanding scientific research is offset by concern by many ethicists.

In this ever-expanding field with new ethical challenges, finding the balance in the debate for distributive justice for every stakeholder is not going to be easy. Investment by companies looking to commercialise research findings, natural curiosities of scientists, government investment in genomics and the rights of the individuals are some of the facets of the debate that will depend on the specific situation. As new risks are identified and are put into the public domain, laboratories, electronic health platforms and databases will need to adhere to legislation, and regulation and will have to keep up with the questions. The need for privacy and confidentiality to maintain integrity of the individual is the starting point, but not the only perspective.

As science continues to advance, the ability to manipulate DNA and cells for either benefit or harm to individuals and society will too continue to move on. It will be important to ensure that our capacity to manage information across the various healthcare, diagnostic and laboratory disciplines matures in parallel to permit the harnessing of genetic information, whilst in tandem, empowering professionals to protect the privacy of individuals through appropriate safeguards. We must also be sure to keep the evolving boundaries, that come with a growing prevalence of genomics testing, aligned with agreed and approved ethical principles. These objectives are essential for now and the future.

FURTHER READING

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