

Focus issue: Genomics of infectious disease

The ethics of sequencing infectious disease pathogens for clinical and public health

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Standfirst

Using genomic technology to rapidly sequence and analyse pathogens has the potential to deliver a robust, evidence-based approach to the challenge of infectious disease management. The successful implementation of such a response is going to require consideration of the associated ethical, legal and social issues.

Main text

The ability to analyse and compare entire pathogen genomes with increasingly improved speed, cost and accuracy means that genomics is being applied to the investigation and reconstruction of communicable disease outbreaks and in clinical microbiology. Pathogen genomic information is used in the clinic to diagnose the cause of infection and to assess drug sensitivity, which has enabled the tailoring of individual treatment regimes. Sequencing is also used in the investigation of outbreaks to elucidate the source, timing, transmission and spread of disease¹. Ongoing genomic surveillance has the potential to enhance pandemic preparedness by predicting pathogen evolution and disease burden.

The implementation of a genomics-informed response to infectious disease is an exciting possibility. However, in addition to the continued refinement of the relevant science and technology, the sustainable and successful implementation of genomic technologies is going to require the careful consideration of a number of important practical ethical questions, as well as the development of relevant research models and public health practices. In this Comment, we set out the key challenges that an adequate ethical framework for the implementation of pathogen genomics will need to address (**Box 1**).

[H1] Transmission events and chains

Sequencing provides valuable information on transmission, enabling more sensitive and robust inferences to be made about the source and spread of infection, as well as the direction and mode of transmission. The possibility to use pathogen genomic information to assess patient samples for drug-resistant microorganisms or to reconstruct disease outbreaks raises new ethical questions and imposes additional ethical and legal responsibilities on healthcare institutions. For example, phylogenetic analysis of pathogen ‘family trees’ has been used in criminal cases to rule out or to provide evidence of transmission of infection from healthcare providers to patients². Patients or family members

may seek access to phylogenetic information to bring claims against healthcare providers if an infection was acquired during health care. Moreover, healthcare institutions may seek to regularly test staff to prevent disease outbreaks, raising questions about the rights of healthcare workers and the obligations of employers towards patients and staff. Furthermore, as genomic approaches are increasingly used to diagnose and track the transmission of, for example, drug-resistant infections, near real-time risk profiles may be generated for particular settings and/or subunits within it. Standards of practice by which institutions take appropriate accountability to manage and report such findings will need to be established.

More broadly, information on transmission identified during an outbreak investigation, such as the source of the outbreak or who infected whom, could have potentially harmful consequences, cause distress and/or afford criminal or financial responsibility to individuals who have introduced a disease to others. This may include individuals who did not know that they were a part of a transmission chain and/or who may not be aware of an investigation, such as patients attending a community sexual health clinic or returning overseas travellers. Although genomic data allows for stronger inferences about the source of transmission, judgments about responsibility are complex. The conditions for attributing moral responsibility for spreading disease include numerous factors that need to be taken into account, for instance, knowledge of the risk of transmission routes and ways to avoid infection, as well as competence to take adequate precautions³. The realization that possible consequences of testing include attributions of blame may lead to reluctance to test, which could have considerable implications for outbreak control, particularly in marginalized populations. Data may be especially sensitive when infectious disease is transmitted through behaviours that are socially stigmatizing (for example, intravenous drug use), where the disease itself is stigmatizing (for example, HIV infection) or in certain contexts (for example, countries where homosexuality is criminalized). Ethical standards for the sharing and use of transmission data are required.

[H1] Rapid and open data-sharing

A key component of an effective genomic approach to infectious disease management is going to be the continued collection, storage and analysis of large amounts of genomic and phenotypic data. In some cases this will take the form of a fairly localized endeavour (for example, a hospital) but in many cases it will be part of a national or international collaborative effort. Even for local investigations, reference to international data sets will be required. Illustrative examples suggest that effective data collection, storage and use requires large-scale surveillance and data collection initiatives, in which research and public health activities are closely interdependent, and in which data are openly available on web-based applications. Although in many cases the population benefits, nature of the data collected and limited risk to individuals will justify the collection, storage and use of samples without explicit consent, important ethical questions will arise. For example, what types of

phenotypic or syndromic surveillance data (for example, internet searches or mobile phone GPS data) require patient consent? And how can the validity of consent be ensured where the uses of data are not known and/or where informing all parties may be impractical? Standards of practice that facilitate research that will likely benefit the public and that provide oversight commensurate with risk and burdens are required.

The effective, efficient implementation of genomic and data services at scale will likely require the involvement of private companies. These may be large-scale sequencing or data storage companies or smaller-scale companies that provide tools for data interpretation or analysis. Private companies may also fund scientific research or use open genomic data to develop new therapeutic interventions, such as vaccines. Although public–private collaborations can have important societal value, the involvement of private organizations may also mean that the benefits derived from genomic analysis are not shared equitably amongst individuals, communities and nations. Guidelines for partnerships between public and private institutions that effectively address issues such as ownership, attend to issues of equity, and are conducive to well-founded public trust and confidence ought to be urgently established.

[H1] Global challenges

Genome sequencing and analysis capacity within low-income settings remains limited, and one important requirement is to build capabilities within countries most affected by infectious disease outbreaks¹, and to develop globally compatible surveillance systems⁴. The successful implementation of a truly global and collaborative approach to genomic activities requires a careful analysis of the moral conditions for collective action and responsibility — an analysis that is both principled and sufficiently pragmatic to gain widespread international support.

Genomic research in low-income settings is only sustainable and ethical in the context of fair research collaborations, genuine commitment to the building of research capacity and effective and trusted governance, informed by awareness of the expectations of those living in the settings from which data and samples were obtained⁵. The achievement of high ethical standards within this domain requires further work at national and international levels on the establishment of widely shared models of good research practice⁶. Attention should also be given to the conditions for equitable access to the benefits of genomic analysis and a pragmatic framework of funding and resource arrangements.

Importantly, while all nations have a shared interest in global population health, decisions to provide surveillance data and to act on data are likely to be affected by secondary interests, such as national health priorities and economic or political concerns. Collective action, from surveillance to the development of health policy, may not be in the interests of any individual country. For example, the growth of antimalarial resistance in South East Asia has led the World Health Organisation to advocate for changes in national drug policies in this region because of concerns about the global impact of spread of

resistance to African populations⁷. Contribution to genomic data sets that identify disease outbreaks may also have substantial economic implications due to impact on activities such as trade and tourism. If the potential benefits of genomics for global health are to be realized, urgent attention needs to be paid to the development, agreement and implementation of an internationally agreed framework for fair collaboration in this aspect of global health.

Conclusions

Genomic discoveries have potential to lead to major health benefits for individuals and populations. However, ensuring the successful and sustainable use of genomic technologies requires urgent attention to be paid to these important ethical issues.

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Competing interests

The authors declare no competing interests.

Box 1. Core ethical and policy questions in infectious disease genomics

What are the responsibilities of healthcare institutions and individual health providers with respect to the appropriate uses of transmission data?

What should be required of institutions with regard to accountability and transparency in managing and reporting infectious disease risk profiles?

How and when should transmission data be considered confidential and under what conditions should such confidentiality be breached?

What constitutes good practice in the collection, storage and uses of samples and data?

What principles should govern the involvement of private companies in genomic research and practice?

What are the conditions for equitable, effective and sustainable international collaborative research practices?

What are the requirements for equitable access to the benefits of genomic technology?

What responsibilities does the international community have to support the development of genomic and analytic capacity in low-income and middle-income countries?

What are the ethical requirements for the collection, use and dissemination of genomic surveillance data internationally?

What are the obligations of nations to collect, report and act on genomic data?

How can genomic activities be implemented in ways that complement rather than undermine other important and necessary interventions, for example, socio-economic?