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THEMATIC INSIGHTS

Post-Pandemic Reflections: Genomic Innovation

The COVID-19 virus: analysis, diagnosis and potential therapies

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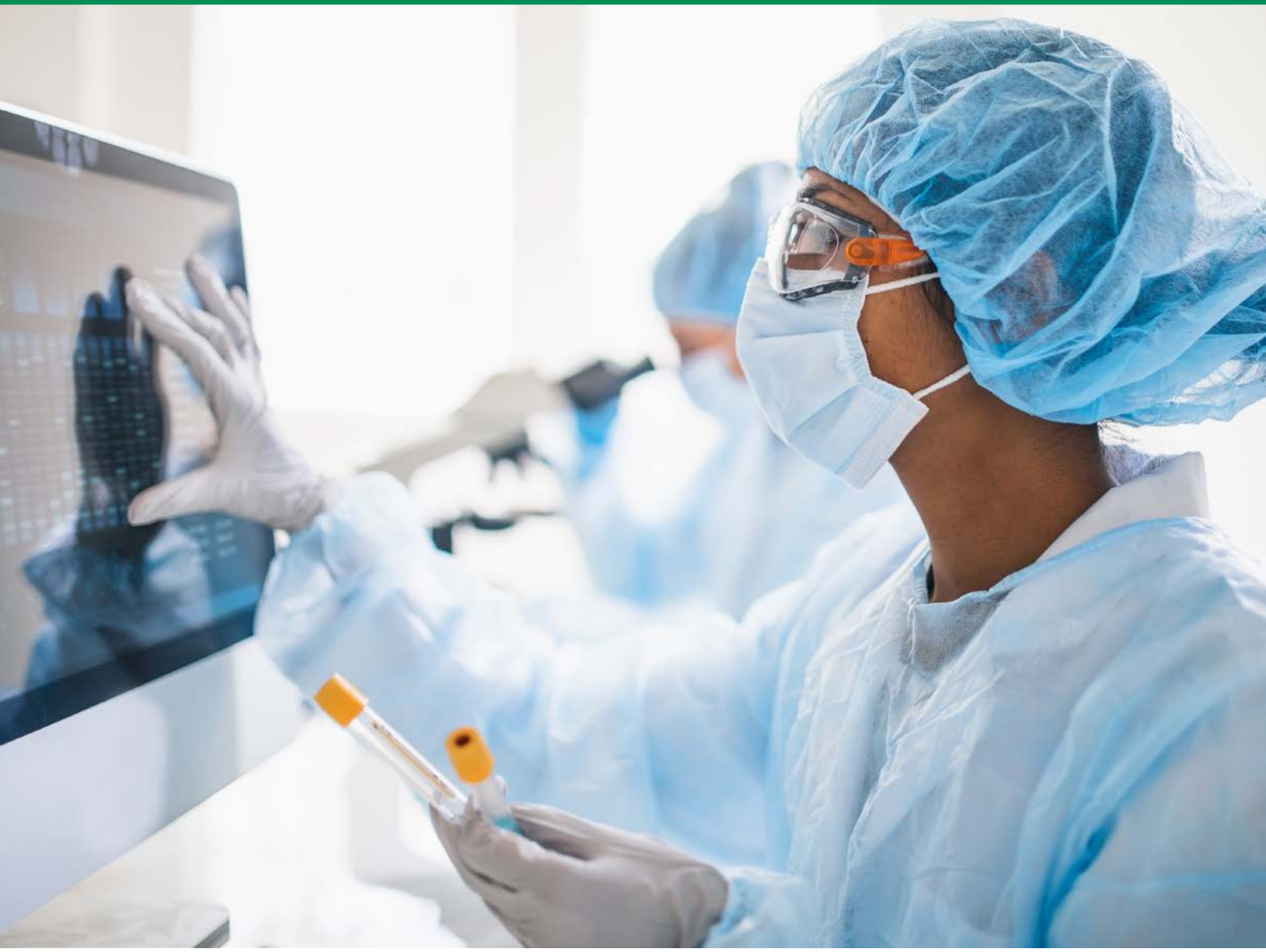

Contents

Genomic Technologies **and the COVID-19 crisis**

In our first Thematic Insight,[1] we outlined the transformative healthcare applications developing from key genomic technologies (DNA sequencing, DNA editing, bioinformatics) reaching inflection points in terms of speed, power and pricing. In this note, we examine how those technologies globally have provided critical capacity to help understand, directly address and adapt to the coronavirus crisis. Next generation genomics-driven technology tools have allowed scientists, public health officials, agencies and governments to identify and understand the disease, track and manage its spread, and develop and evaluate new treatments for those that have been afflicted.

Identifying and explaining the disease

Next-generation gene sequencing technology (NGS) was the key to assembling a first draft of the genome of COVID-19 so quickly in the life of the pandemic – it was released globally by China on 12 January 2020.[2] This genetic information facilitates the uncovering of potentially exploitable molecular susceptibilities and so is likely a key step to preventative and therapeutic strategies (as part of - and complementary to - broad public health interventions). Sequencing different patient samples has continued to be an intense activity of laboratories globally so that researchers can monitor the virus's genetic drift. This provides insight as to its date of entry in different geographies, helps to track its geographic spread and also informs developing vaccine and treatment strategies.[3] This work also has assisted epidemiologists studying how the virus originated and how it has been transmitted.[4]

1 "The information age of medicine: Genomics-driven innovation as a catalyst for growth", MSCI, May 2020

2 https://www.who.int/csr/don/12-january-2020-novel-coronavirus-china/en/ and https://journals.lww.com/cmj/FullText/2020/05050/Identification_of_a_novel_coronavirus_causing.3.aspx

3 For example, https://www.cam.ac.uk/stories/sequencingcovid and https://hub.jhu.edu/2020/03/30/covid-19-gene-sequencing/

4 https://www.sciencedirect.com/science/article/pii/S2090123220300540

Disease diagnosis and managing disease-spread

Synthetic biology and gene-editing technologies have been accelerating the development of diagnostics that can detect COVID-19 (the feasability of antigen tests themselves built upon the sequencing itself).[5]

Synthetic biology (Syn-Bio) is a novel technique to synthesize DNA fragments.[6] Syn-Bio companies, such as Twist, combine COVID-19's genomic sequence information, machine learning models and microscale manufacturing to build molecules that make it cheaper and faster to sequence the virus.[7]

Cloud computing has facilitated the scale of genetic analysis required for these advances in understanding and also supports the scaling of telemedicine services. Telemedicine allows patients to interface with clinicians remotely through a combination of audiovisual, decentralized medical devices and the Internet of Things (IoT). These may enable sick and healthy individuals alike to maintain access to medical care while reducing contagion risk.

The widespread use of telemedicine techniques in the current crisis may mark a jump in the longer-term secular shift towards virtual care: for ambulatory (out-patient) visits, psychiatric consults, chronic disease management and other health services.[8] Telemedicine also is allowing immunocompromised individuals, such as cancer patients and organ transplant recipients, to remain isolated while receiving highly specialized care. Liquid biopsies, novel blood-based diagnostics empowered by NGS, can be used to monitor patients at home instead of requiring them to visit a high-traffic hospital. For example, CareDx's (CDNA) RemoTraC product allows transplant patients to get at-home blood draws, which are then analyzed for signs of organ rejection and health.[9]

5 https://www.genengnews.com/insights/covid-19-drives-crispr-diagnostics/

6 https://en.wikipedia.org/wiki/Synthetic_biology

7 https://www.twistbioscience.com/coronavirus-research-tools

8 https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/healthcares-digital-future

9 https://www.marketwatch.com/press-release/caredx-mobilizes-10000-phlebotomists-for-home-blood-draws-of-transplant-patients-with-remotrac-2020-04-09-7184045?mod=mw_quote_news

Machine learning, combined with mobile connected devices carrying one of the quickly growing list of national track-and-trace apps, is also well placed to support early warnings of new outbreaks, guiding those that experience mild or ambiguous symptoms to seek a diagnostic test and self-quarantine, and potentially allowing policy makers an early read on new disease-clusters. This effort has seen also unusual but understandable collaboration between Apple and Alphabet to create enabling software APIs for their mobile ecosystems[10] against the backdrop of the heated debate over centralized vs decentralized approaches[11] and cybersecurity/privacy concerns.[12]

Treatment of the acutely ill, and long-term therapies and vaccines

Pathogen de-activation and molecular quantitation technologies could prove critical in enabling the safe and economical use of convalescent plasma — the retro-sounding use of blood product from patients that have survived—as a treatment for those still suffering from the disease, especially those at high risk.[13]

Modern genetic manipulation tools are also being used to support multi-pathway next generation vaccine-development. In addition to traditional viral vaccines, DNA, mRNA and even self-replicating mRNA vaccines are under active development increasing the chances of a breakthrough and diversifying the vaccine approaches. Approximately three hours after China had published the sequence for COVID-19, Inovio had developed a DNA vaccine candidate named INO 4800 now undergoing Phase 1 trials.[14] Moderna captured many headlines in mid May when positive Phase 1 trial results were announced based on an mRNA vaccine candidate.[15] The mRNA approaches, if successful, would also see reduced dose size and in the case of self-replicating mRNA, much reduced vaccination time (from 30 days to as little as 1 day).[16]

10 https://www.techradar.com/news/apple-google-covid-19-coronavirus-partnership-ios-android

11 https://techcrunch.com/2020/04/27/germany-ditches-centralized-approach-to-app-for-covid-19-contacts-tracing/ and https://www.hsj.co.uk/the-nhs-covid-contact-tracing-app-risks-and-safeguards/7027534.article

12 For example, https://www.theverge.com/2020/5/1/21243977/gop-senators-contact-tracing-data-coronavirus-covid-19-privacy and https://www.msn.com/en-in/money/news/coronavirus-tracing-app-stirs-rare-privacy-backlash-in-qatar/ar-BB14z9ac

13 https://www.medicalnewstoday.com/articles/using-convalescent-blood-to-treat-covid-19-is-it-possible

14 https://allianceforscience.cornell.edu/blog/2020/05/what-are-the-top-5-most-promising-covid-19-vaccine-candidates/

15 https://www.modernatx.com/modernas-work-potential-vaccine-against-covid-19

16 https://en.wikipedia.org/wiki/RNA_vaccine

Conclusions

Though the newly scalable genomic technologies have been proving hugely important in this particular crisis, the nature of that utility in response to COVID-19 is also indicative of the growing role that they are forecast to play over the next few decades of the 21st century.[17] Next generation sequencing, gene editing and synthesis — the biological toolkit under development for this new health science—when combined with the modern information gathering and computational machinery provided by AI, cloud computing, and connected devices — seems to have the potential to advance the ability to address not just this particular infectious disease, but many other diseases and disorders.

Amidst a profound global crisis with widespread suffering and deep economic distress, there would be some cause for optimism for the future if the collaborative and accelerated way this infectious disease is being unravelled in this acute crisis with these new technologies were to indeed prove deployable against the monogenic diseases that afflict one out of a hundred babies born,[18] and the cancers that kill millions in each year.[19]

17 "The information age of medicine: Genomics-driven innovation as a catalyst for growth", MSCI, May 2020

18 https://www.who.int/genomics/public/geneticdiseases/en/index2.html

19 https://acsjournals.onlinelibrary.wiley.com/doi/full/10.3322/caac.21492

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