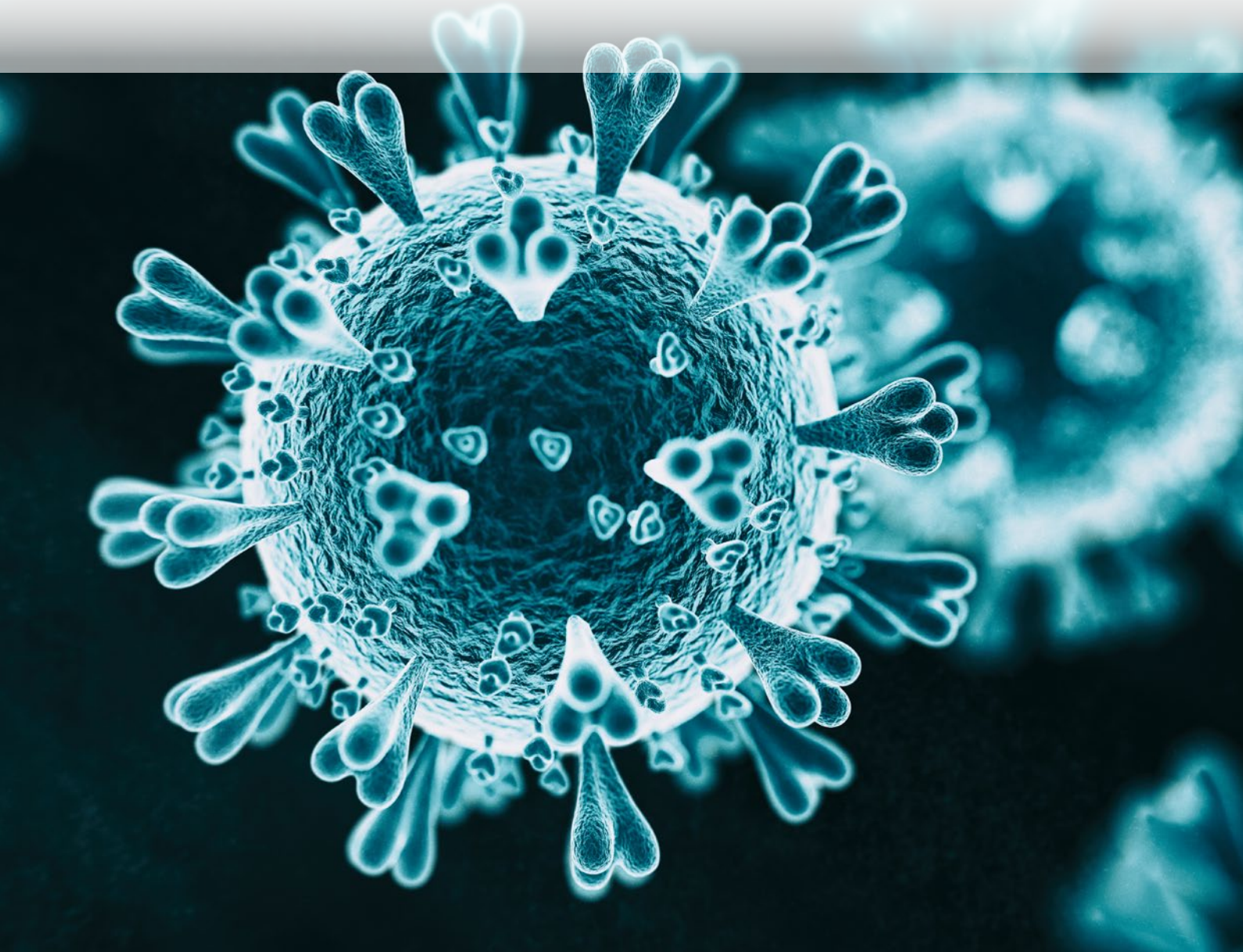
Australia's National
Science Agency

Strengthening Australia's Pandemic Preparedness

Science and technology-enabled solutions

Executive summary | 2022



Foreword

On the back of the 1918 influenza pandemic, advocacy for national leadership in public health management of infectious disease was the primary influence in the establishment of the Commonwealth Department of Health in 1921.

Most recently, much of the world is emerging from the COVID-19 pandemic, the most significant pandemic the world has seen since 1918. This pandemic has had wide ranging social, health and economic impacts, some of which are still to be understood.

This year has also required a coordinated national response to the incursion and spread of Japanese Encephalitis Virus (JEV) into mainland Australia, the first ever JEV outbreak detected on the mainland despite the virus being widespread in South-East Asia.

Australia's planning and preparedness for a public health emergency has served us well in the response to the COVID-19 pandemic. From 2004 to 2017, various reviews on Australia's capacity to respond to a communicable disease outbreak were undertaken and progress was demonstrated as evidenced by evaluations of status evolving from 'critical, but stable' to 'a comprehensive system of capabilities and functions to prepare, detect and respond to health security threats'.

The framework for this success was the effective utilisation of existing government health committees, engagement with external experts and committees, and whole of government leadership and responsiveness at all levels including industry and the community.

The foundations of Australia's COVID-19 public health response were agile early risk assessments leading to international border closures, high case and contact ascertainment and management, public health strategies to control transmission, and high vaccination coverage.

However, in a rapidly evolving and changing situation, rapid and agile decisions are often required to manage the public health impact in the face of a dearth of evidence and uncertainty. There are still many lessons to be learned from Australia's response to the COVID-19 pandemic to inform and improve our response to any future pandemics.

Planning and preparedness for future infectious disease outbreaks, building on lessons learned, will continue to require cross sectoral engagement and coordination across a range of areas. This is particularly true for zoonoses which are the primary driver of pandemics and where a One Health approach will be critical.

CSIRO Futures' Strengthening Australia's Pandemic Preparedness: Science and technology-enabled solutions represents the first of such cross sectoral reports. The science and technology priorities for improvement presented here have been, and will continue to be, important to pandemic preparedness in Australia. I welcome the report.

Dr Sonya Bennett
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Executive summary

This report assesses a range of science and technology (S&T) areas that were identified as being critical to a more technology-enabled approach to pandemic preparedness against viral diseases. These S&T areas, and the recommendations listed to further enhance their impact on Australia's pandemic preparedness, were developed through deep system wide engagement, including contributions from over 140 experts across industry, research and government (see Appendix A).

Large-scale viral disease outbreaks result in significant economic, health and social costs.

Globally, the COVID-19, H1N1, HIV, Influenza, MERS and SARS pandemics have caused more than 45 million deaths since 1981.[1] At the national level, there was a cumulative difference of $144 billion between the pre-COVID-19 GDP trendline and actual GDP, from December 2019 through to March 2022. Less quantifiable indirect costs including impacts on mental health, social cohesion, employment, childhood development, and equity can be longer lasting and may far outweigh the direct costs.

Viral disease outbreaks are increasing in frequency and severity.

The increasing occurrence of virus spill-over from animal populations over the last 100 years has largely been driven by environmental destruction, climate change, urbanisation, human encroachment on natural habitats, and increased global trade and travel**.** In addition to known viruses, on average, two novel viruses are appearing in humans each year, and the proportion that give rise to larger outbreaks is growing.[2]

Travel restrictions and quarantine measures are useful tools for the immediate public health response.

Australia's success in keeping COVID-19 infections lower than most countries has largely been the result of early border closures and the public's broad acceptance of social distancing, lockdown measures, mask wearing and vaccinations. However, many of these interventions involve travel restrictions and quarantine measures that result in significant economic, social and indirect health costs when implemented and are increasingly difficult to implement as the duration of a pandemic grows.[3]

However, enhanced and nationally coordinated investments in science and technology can provide a wider range of complementary preparedness and response approaches.

This can significantly reduce the economic, social and indirect health costs associated with travel restrictions and quarantine measures by facilitating the important transition away from crisis response and towards an integrated cycle of prevention, detection, response and recovery.[4] An integrated cycle can both defend against the emergence of a pandemic and ensure the functions needed to respond are optimised to reduce direct and indirect impacts.[5]

1 CSIRO Futures analysis.

2 Bernstein AS, Ando AW, Loch-Temzelides T, Vale MM, Li BV, Li H, Busch J, Chapman CA, Kinnaird M, Nowak K, Castro MC, Zambrana-Torrelio C, Ahumada JA, Xiao L, Roehrdanz P, Kaufman L, Hannah L, Daszak P, Pimm SL, Dobson AP (2022) The costs and benefits of primary prevention of zoonotic pandemics. Science Advances 8(5).

3 World Health Organization (WHO) (2016) Anticipating Emerging Infectious Disease Epidemics. WHO, Geneva. <https://apps.who.int/iris/bitstream/handle/10665/252646/WHO-OHE-PED-2016.2-eng.pdf> (accessed 28 March 2022).

4 Bedford J, Farrar J, Ihekweazu C, Kang G, Koopmans M, Nkengasong J (2019) A new twenty-first century science for effective epidemic response. Nature 575 (7781), 130-136.

5 Carlin EP, Machalaba C, Berthe FCJ, Long KC, Karesh WB (2019) Building resilience to biothreats. EcoHealth Alliance, USA.

Key areas of science and technology for strengthened pandemic preparedness.

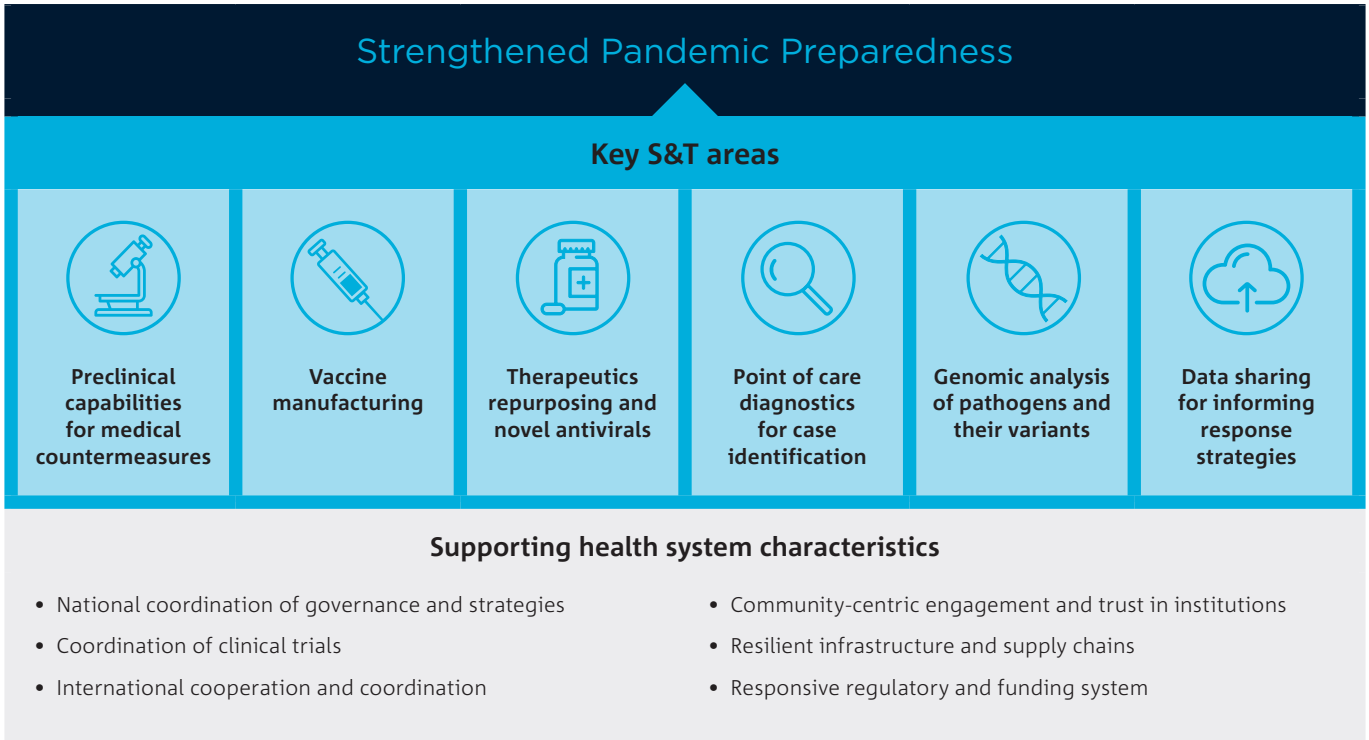
Through a survey and guidance from the project's external steering committee, six S&T areas were prioritised for discussion in this report (see figure below). These areas were selected based on where consulted stakeholders identified further investment would have the most impact on Australia's pandemic preparedness.

These S&T areas do not operate in isolation and investments in one S&T area can pay dividends for others. As such, it is important to consider these linkages, and associated data flows, standards and stakeholders, when developing solutions in these areas and implementing the proposed recommendations (see table on next page).

Consideration and implementation of the proposed recommendations would benefit from national coordination, and so it is likely that the Australian Government would lead initial decision making in these areas, however many of the recommendations will require strong support and implementation from other levels of government as well as industry and research.

While not the focus of this report, it is important to acknowledge that S&T development and implementation is supported by a range of broader health system characteristics. These include strong national coordination, community-centric engagement and collaboration with global initiatives like CEPI and the World Health Organization to ensure Australia is well positioned to identify areas where the nation is uniquely positioned to lead or support.

Key S&T areas and supporting health system characteristics



Challenge, vision and recommendations for key science and technology areas that can enable pandemic preparedness

S&T AREA	CHALLENGE	2030 VISION	RECOMMENDATIONS
Preclinical capabilities for medical countermeasures	Globally, viral families with pandemic potential are poorly understood, which prevents health systems from being adequately prepared for most threats. Australian efforts to contribute to this global understanding are not nationally coordinated and require prioritisation, given investment is finite.	Australia contributes to global efforts to improving virus and host knowledge across *Coronaviridae*, *Flaviviridae*, *Orthomyxoviridae*, *Paramyxoviridae* and *Togaviridae* families. Preclinical studies and associated infrastructure for priority viral families are adaptable to responding to Disease X. Preclinical studies are coordinated with product development pathways including translational science, manufacturing and health system requirements.	1. Improve virus and host knowledge across priority viral families (*Coronaviridae*, *Flaviviridae*, *Orthomyxoviridae*, *Paramyxoviridae* and *Togaviridae*) 2. Engage with global networks to optimise research efforts across priority viral families and for the development of medical countermeasures 3. Expand research capabilities in animal models for priority viral families 4. Enhance R&D into alternatives to animal models 5. Strengthen translational science to help bridge the gap between research, industry and the health system
Vaccine manufacturing	The absence of manufacturing capabilities across diverse vaccine technologies reduces Australia's capability to produce vaccines onshore for an emergent viral threat. Australian companies face barriers, such as high input costs and small population for clinical trial enrolments, to scale-up manufacture onshore.	Australia has onshore vaccine manufacturing capabilities and infrastructure supporting Phase I to III clinical trials across a diverse range of vaccine technologies. This infrastructure is available to pivot to relevant vaccines in a pandemic, increasing security of vaccine supply.	6. Diversify manufacturing capabilities across vaccine types, including recombinant protein and viral vector technologies 7. Expand the number of contract development and manufacturing facilities to support Phase I to III trials for vaccines
Therapeutic repurposing and novel antivirals	Commercial and candidate therapeutic repurposing is not mapped to viral families with pandemic potential. Early commercial development of direct-acting antivirals that target priority viral families has not been undertaken.	Several direct-acting antivirals that target priority viral families are in development. Australia has a national database of potential therapeutics for repurposing with estimated effectiveness mapped against priority viral families.	8. Expand high throughput screening of commercially available therapeutics to include mapping to priority viral families 9. Develop a central database of therapeutics with repurposing potential for future pandemics 10. Undertake early-development into direct-acting antivirals that act against priority viral families
Point of care diagnostics for case identification	Inconsistencies in jurisdictional diagnostics requirements, and the increasing demands on laboratories during outbreak peaks means Australia needs a diverse range of diagnostic options.	Australia has a national pandemic response strategy that enables rapid and scaled deployment of POCT diagnostics in healthcare settings and in the community to complement IVD capabilities. The country continues to contribute R&D capabilities to the global sector, with strengths in multiplex POCT platform technologies. Biotechnology companies are supported to grow their businesses onshore and Australia has expanded the biobanking capabilities needed to validate commercialised discoveries.	11. Develop a diagnostics deployment strategy for scaling POCT applications 12. Enhance R&D capabilities for multiplex POCT platform technologies 13. Implement a diagnostics development program aimed at small and medium sized enterprises 14. Develop a biobanking repository for diagnostics validation samples
Genomic analysis of pathogens and their variants	The absence of clear national coordination leads to disconnects in the targeted application and integration of genomic analysis at scale during pandemics.	Australia has a national genomic analysis program for routine surveillance which is effectively scaled and targeted during pandemics, utilising cross-sectoral data. The nation's strengthened genomics workforce and pathogen-agnostic capabilities position Australia as a leader for genomic analysis in the region and globally.	15. Establish a national genomic analysis authority to coordinate cross-sectoral collaboration and data sharing 16. Design and coordinate the implementation of a national pathogen agnostic genomic analysis platform 17. Strengthen workforce skills across bioinformatics, metagenomics, statistical genomics modelling, and genomic epidemiology
Data sharing for informing response strategies	Australia faces data sharing limitations due to the varying governance of health systems within and across jurisdictions, and the limited adoption of interoperability systems. This restricts policy decisions being made in a timely and well-informed manner, especially during pandemics.	Australia has national health data standards that are implemented in all jurisdictions and have adaptable guidelines for pandemic responses. These underpin health data collection systems that are interoperable, allowing for the safe, efficient and timely transfer of data insights. These developments enable the use of non-health and sensitive data as deidentified insights to inform government decision making during pandemics.	18. Develop national pandemic data standards to streamline data collection and sharing 19. Improve capabilities to link health data with non-health data 20. Design and integrate smart analytics that can share and analyse sensitive data at a national level

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