

# Preparing for the next pandemic: insights from Aotearoa New Zealand's Covid-19 response



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## Summary

In 2020 Aotearoa New Zealand, like many other countries, faced the coronavirus pandemic armed with an influenza-based pandemic plan. The country adapted rapidly to mount a highly strategic and effective elimination response to the SARS-CoV-2 pandemic. However, implementation was hampered by gaps in pandemic preparedness. These gaps undermined effectiveness of the response and exacerbated inequitable impacts of both Covid-19 disease and control measures. Our review examines the Covid-19 response, reflecting on strengths, limitations and implications for pandemic planning. We identify three key areas for improvement: 1) development of a systematised procedure for risk assessment of a new pandemic pathogen; 2) investment in essential capabilities during inter-pandemic periods; and 3) building equity into all stages of the response. We present a typology of potential pathogens and scenarios and describe the evidence assessment process and core capabilities required for countries to respond fluidly, equitably, and effectively to a rapidly emerging pandemic threat.

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## Introduction

Aotearoa New Zealand's Ministry of Health published an influenza pandemic plan in 2017.<sup>1</sup> The plan was intended to "be adopted and applied to any pandemic event". However, recent experiences with the Covid-19 pandemic underline the need to be better prepared for a wider range of potential pandemic agents and scenarios.<sup>2</sup> The influenza pandemic plan assumed that influenza could not be eliminated and did not recognise that an effective public health response could completely alter the course of the epidemic; an opportunity that needs to be recognised and planned for. The 2017 plan was replaced by an interim update in July 2024.<sup>3</sup>

We describe the key features of an effective and equitable response, and how this relates to the unique setting in Aotearoa New Zealand. We then examine the first years of the Covid-19 response in Aotearoa New Zealand, reflecting on strengths, limitations and implications for national and global pandemic planning. We

present a typology of pathogens and scenarios that are likely to require a pandemic response<sup>2,4</sup> and draw on a previous framework developed in Aotearoa New Zealand to describe the sequence of decisions required to assess and manage an evolving pandemic.<sup>2,4</sup> Finally, we outline the core capabilities needed to support a next-generation pandemic plan that prepares countries to respond fluidly, equitably, and effectively to a rapidly emerging pandemic threat.<sup>2</sup> This work draws on our previous report on pandemic preparedness<sup>2</sup> that was written in part to inform New Zealand's Royal Commission of Inquiry into Covid-19<sup>5</sup> and based on multi-disciplinary expertise and the experience of people involved in the pandemic response in a range of different capacities.<sup>5</sup>

## Unique features of Aotearoa New Zealand that must be considered to achieve equitable and effective outcomes

The founding document for Aotearoa New Zealand is Te Tiriti o Waitangi. This document provides an obligation to protect Indigenous Māori rights, ensure Māori exercise authority over their affairs, and assert protection and

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equity in achieving outcomes that are fair and just. All obligations must be actively given effect to and applied in the development of pandemic plans and responses. Te Tiriti affirms Māori rangatiratanga (leadership) in decision-making and requires a partnership approach with the Crown (executive government). These relationships must be proactively developed and maintained to ensure equitable outcomes in future pandemic scenarios. These obligations were reaffirmed by the recent phase 1 report of the Royal Commission of Inquiry into Covid-19.<sup>5</sup>

The National Ethics Advisory Committee has identified a set of ethical principles to guide the response to a pandemic: promoting health and wellbeing; equity; kotahitanga (building social cohesion); tika (doing the right thing); manaakitanga (care for others); and liberty.<sup>6</sup> A thorough review of all these aspects of the response is beyond the scope of this article. Among these we focus particularly (though not exclusively) on equity as the Royal Commission report highlighted this as a key area for improvement in future pandemic responses.<sup>5</sup>

Māori and Pacific peoples continue to be negatively impacted by longstanding inequities in healthcare in Aotearoa, resulting in part from colonisation, systemic racism and mistrust of the healthcare system.<sup>7,8</sup> Disproportionate impacts have been consistently observed during epidemics, such as measles,<sup>9</sup> and the 1918 influenza pandemic.<sup>10,11</sup>

A pandemic response plan must account for these factors and acknowledge the importance of Māori-led and flexible services to meet the specific needs of Māori communities, and not unintentionally exacerbate negative health outcomes.<sup>12</sup> This requires a willingness to share power in decision-making and proactive resourcing of Māori-led responses. Autonomy in decision-making at the strategic and operational level should be respected. The composition of decision-making bodies and expert advisory groups should reflect the population and give effect to tino rangatiratanga (self-determination).

Aotearoa New Zealand also has a large, diverse and multilingual population of Pacific peoples, with strong relationships with the Pacific and specific responsibilities to and partnerships with Pacific Realm countries. The demography, location, community structure, employment and disproportionate impacts of disease outbreaks on Pacific peoples need to be incorporated into preparedness and pandemic planning. This includes continued Pacific community and provider engagement and participation in planning and responses.

Aotearoa New Zealand's relative isolation and ability to control borders facilitated the rapid implementation of border measures that were effective in minimising the number of imported cases.<sup>13,14</sup> In addition, population uptake of proportionate, clearly justified and well

communicated public health measures has been relatively high.

## Strengths and limitations of the initial pandemic response in Aotearoa New Zealand

Aotearoa New Zealand's response to Covid-19 limited the health impact of the pandemic compared to most countries, with one of the lowest rates of confirmed Covid-19 deaths and excess deaths in the world.<sup>15–17</sup> During 2020 and 2021, sustained periods of elimination of community transmission protected healthcare systems and societal functioning. This success can be attributed to several factors. The New Zealand Government acted swiftly once the likely impact of Covid-19 became apparent.<sup>18</sup> It was responsive to scientific advice and was the first country to adopt an explicit elimination strategy.<sup>19</sup> Strict border controls were imposed early, before the virus had significantly spread within the country.<sup>13</sup> This intervention included mandatory quarantine for all incoming travellers and eventually closing the borders to non-residents.<sup>20</sup> Such measures were crucial in preventing the virus from entering and spreading widely, aided by the nation's lack of land borders with other jurisdictions. Aotearoa New Zealand benefited from observing the experiences of other countries that were affected earlier by the pandemic.<sup>13,18,19</sup> This also allowed the country's healthcare system to respond better than others, despite not being the largest or best funded among similarly wealthy nations. Aotearoa New Zealand rapidly increased its testing capacity and implemented a robust contact tracing system, allowing health officials to identify and isolate cases rapidly.<sup>13,14</sup> These measures were key in keeping the infection rates low while minimizing the need for school and business closures and other disruptive measures until vaccines became available.

The country also benefited from effective communication and leadership, with consistent communication from the Prime Minister and other leaders helping to build public trust and promote compliance with health directives, including lockdowns and physical distancing measures.<sup>4,13,14,21</sup> Extensive public health campaigns promoted vaccine uptake and countered misinformation.<sup>4</sup> The collective effort and social cohesion among New Zealanders played a significant role in the country's ability to control the virus.

There were also global advances that Aotearoa New Zealand could draw on. These included: the rapid development and licencing of mRNA vaccines; the use of genomic sequencing to support the public health response in real-time<sup>22–24</sup>; wastewater surveillance for early outbreak detection and tracking of infection rates; the design of a digital app to support contact tracing; and the expanded use of telemedicine and digital health services to provide care while minimizing infection risk.<sup>25–27</sup> Together this enabled Aotearoa New Zealand to

eliminate SARS-CoV-2 and then implement a phased vaccination strategy, prioritizing vulnerable populations and essential workers, eventually expanding to the wider population.

However, while Aotearoa New Zealand's overall response to Covid-19 was broadly successful, the response was inequitable in several key respects. Māori and Pacific peoples were disproportionately affected by both the health impacts and the economic consequences of the pandemic. These populations have higher rates of underlying health conditions, increasing the risk of severe outcomes from COVID-19. There was evidence of delayed care and a slow public health response for those at highest risk.<sup>28,29</sup> Additionally, they are more likely to be employed in sectors hardest hit by lockdowns, such as tourism and service industries, leading to greater economic hardship.<sup>30</sup> The top-down, one-size-fits-all design of pandemic control measures meant that they often did not align with the values or lived realities of marginalised populations, further increasing systemic disparities.<sup>12,31</sup>

Māori leadership was of critical importance to the response and there is a need to strengthen and empower leadership particularly at the community level. Te Tiriti o Waitangi means that addressing ethnic disparities can involve obligations specific to Māori, such as shared decision making. Māori and Pacific community providers moved swiftly to protect their communities, despite being relatively under-resourced and often excluded from centralised decision-making. Culturally appropriate tikanga and kawa (akin to correct procedures and protocols) were adapted to meet the needs of communities. The extensive and highly connected networks between Māori and the wider community reinforced the need for effective partnerships when responding to pandemics. These highly effective local responses are examples of Māori exercising tino rangatiratanga (self-determination).<sup>30,32–38</sup>

Concerns have been expressed about equitable access to healthcare services and vaccinations.<sup>39</sup> Initial vaccine rollout phases saw disparities in access and uptake among different demographic groups, with Māori and Pacific people being vaccinated at lower rates compared to the general population. Vaccination rates improved once Māori and Pacific providers were resourced to deliver vaccine programmes, highlighting the importance of trusted community providers for improving vaccine equity.

Aotearoa New Zealand's lockdowns were short relative to other countries', but they were stringently applied and disproportionately affected low-income individuals and families.<sup>17,30,40</sup> Those in precarious employment situations, without the ability to work from home, faced greater economic strain. Housing conditions, particularly overcrowding, also posed higher risks of transmission among disadvantaged groups. Migrant workers, temporary visa holders,

people in informal employment sectors, and those experiencing homelessness or insecure housing often fell through the cracks of the support systems. The reliance on digital tools for communication, education, and services during lockdowns highlighted the digital divide.<sup>27</sup> Families without reliable internet access or digital devices faced significant barriers in accessing information, education, and support services, as did those with English as a second language.<sup>41</sup> Disabled people suffered higher Covid-19 hospitalisation and death rates<sup>42</sup> and were disproportionately affected by disruption to routine healthcare and the negative impacts of social distancing measures.<sup>43</sup> The mental health impact of the pandemic was uneven, with vulnerable populations, including those with pre-existing mental health conditions, experiencing heightened stress and anxiety. In the early stages of the pandemic, stigmatization and racism towards Asian populations was reported to have negative impacts on the mental health of these populations.<sup>44,45</sup> Access to mental health services was also a concern, especially during lockdown periods,<sup>35,40,46</sup> and mental disorders were linked to increased rates of domestic violence, particularly on women and children during lockdowns.<sup>47</sup> Women also experienced more economic, health and social impacts during the pandemic.<sup>48</sup>

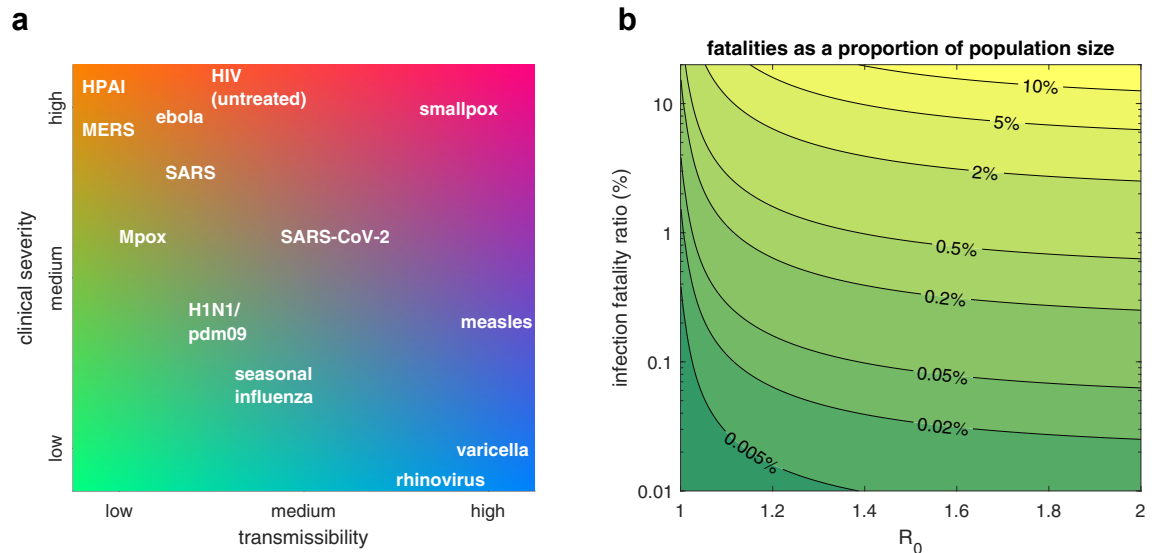
Several of the above adverse consequences of the pandemic were widely experienced globally,<sup>49</sup> but Aotearoa New Zealand has several defining characteristics that must be considered and incorporated into pandemic preparedness, planning and response.

In the sections that follow we present key points in the sequence of decisions involved in assessing and managing a pandemic. The ability to apply these decision steps successfully depends on long-term pandemic preparedness based on investment in essential infrastructure. We conclude by describing the capabilities required to implement an effective and equitable response.

### Preparing for a range of pandemic scenarios

Infectious diseases may be categorised in several ways, including the type of causal agent, mode(s) of transmission, syndromes, portal of entry or site of replication and other epidemiological features, such as transmissibility. Key scenarios to consider and prepare for include infectious diseases that are: transmitted between people with short to medium incubation periods (e.g., novel respiratory viruses); transmitted between people with predominantly asymptomatic transmission and long incubation periods (e.g., some sexually transmitted infections and drug-resistant infections); and predominantly transmitted from animals, vectors, food or water.

An important typology for infectious diseases is the transmissibility-severity map (see Fig. 1a). Pathogens



**Fig. 1: Examples of (a) transmissibility-severity mapping and (b) simplified impact assessment framework.** In (a), pathogens in the lower-left part of the map may be manageable with relatively low stringency or business-as-usual public health approach. Pathogens in the lower-right have the potential to cause significant impact due to a high number of infections in a short time period; suppressing transmission may be difficult, but mitigation measures may help to “flatten the curve”. Pathogens in the upper-left may be more amenable to measures aimed at preventing or delaying an epidemic wave, which are likely to include a test-trace-isolate system. Pathogens in the upper-right are likely to require a more stringent response and preventing healthcare system overwhelm will be a key concern. (b) Shows how the number of fatalities as a proportion of the total population  $R_0$  (a measure of transmissibility) and the infection fatality ratio (a measure of clinical severity) assuming an unmitigated epidemic in a well-mixed population. See [Supplementary material](#) for further explanation of transmissibility and  $R_0$ .

are positioned approximately in a two-dimensional space representing transmissibility (as measured by, for example, the basic reproduction number  $R_0$ ) on one axis and clinical severity on the other axis.<sup>50,51</sup>

Clinical severity may be quantified by the proportion of infections that lead to specified clinical outcomes, such as hospital attendance, intensive care unit (ICU) admission or death. Like  $R_0$ , clinical severity is a combined property of the pathogen (here virulence) and the population in which it is spreading. For example, if there is a strong age gradient in risk of severe disease, clinical severity will depend on the age profile of the population. Similarly, clinical severity may be highly heterogeneous and groups with high rates of comorbidities may be at substantially higher risk. Severity can also be affected by the healthcare system capacity, and as such can be complex and dynamic. For example, flattening hospital admissions could indicate an overwhelmed healthcare system rather than a change to true underlying severity, particularly if combined with signs of increasing case rates in the community.

Consideration of population-level metrics of transmissibility and severity as illustrated in Fig. 1 is an important first step towards assessing potential impact. However, looking only at population-level averages hides important heterogeneity that exists along both the transmissibility and severity axes. Transmissibility will be higher in population groups that have larger

household sizes, and higher proportions of key workers and people unable to work from home or to take paid sick leave. Clinical severity is likely to be higher in groups with higher levels of comorbidity and multimorbidity, and reduced access to healthcare services. There is considerable overlap between the socioeconomic drivers of transmissibility and severity, meaning that the same groups are likely to suffer both from higher infection rates and a higher per-infection risk of severe illness. Developing robust methods to estimate the extent and nature of disparities in impact, disentangle the contributions of heterogeneity in transmissibility and clinical severity, and understand how inequities can be effectively mitigated should be a priority for future preparedness.

Preparing for a range of potential pandemic scenarios and minimising harm were identified as priorities in the Royal Commission of Inquiry’s Phase 1 report.<sup>5</sup> This requires quantitative, integrated health, social and economic modelling of those scenarios and the potential response; input from different areas of expertise and communities into pandemic planning; and regular national pandemic response exercises.

### Visibility and controllability

Other important characteristics to consider include visibility and controllability of the disease.<sup>52</sup> High visibility (and associated surveillance) is dependent on good

diagnostics and widespread symptom-based testing. Visibility may be reduced if there are high rates of asymptomatic infection, long incubation periods, a non-specific syndromic profile (e.g., common respiratory symptoms), or lack of access to testing.

Controllability can be thought of as a joint property of the pathogen, the host population, and the available resources. Pathogen characteristics such as high human-to-human transmissibility and the potential for pre-symptomatic transmission can lead to fast-growing outbreaks that are difficult to control.<sup>53</sup> Factors such as low visibility and a short latent period will hamper efforts to find and isolate cases and trace contacts before they transmit. The presence of environmental or wildlife reservoirs, including invertebrate vectors, is a barrier to elimination or eradication. Host characteristics that influence controllability include contact rates, patterns of disease-specific immunity in the population, and the extent of human contact with vectors. Resources that aim to modify host characteristics or susceptibility (e.g., vaccines) need to be distributed such that equitable outcomes are achieved without placing excess burden on vulnerable populations. This may involve prioritisation of high-risk groups for interventions such as vaccines, antivirals or testing.

Resources play an important role in determining controllability and are much more modifiable in the early phases of a pandemic than either pathogen or host factors. This indicates the need for pandemic planning that proactively directs resources towards infrastructure which aims to maximise the controllability and minimise the impact of a range of emerging pathogens (see Core Capabilities section below).

### Dealing with uncertainty

The early phases of the response to an emerging pandemic may require consequential decisions to be made before robust evidence is available. There are multiple measurement challenges for early assessment of transmissibility and clinical severity. Emerging pathogens may not be fully characterized, and zoonotic pathogens may evolve rapidly to adapt to human hosts. Biases arising from incomplete case ascertainment, variable surveillance effort, lags in clinical outcomes, and uncertainties in variables such as the generation interval can lead to high uncertainty in early estimates of transmissibility and clinical severity.

This uncertainty may be reduced by collecting more data, such as data from intensively tested cohorts like international travellers, First Few “X” (FFX) studies, household and contact tracing studies and seroprevalence data. There is a need to apply precautionary principles when risks are not fully understood.

In the absence of data to inform decisions it may be necessary for measures to be introduced and systematically evaluated in real-time to assess their impact, including efficacy and unintended consequences.<sup>54</sup> An

example of this approach was the introduction of community-based approaches to vaccination for Māori.<sup>55</sup> The initial attempt was constrained by pragmatic factors including the ability to maintain vaccine refrigeration conditions and required modifications to this distributed model to minimise impacts on the most vulnerable.<sup>56</sup>

The Covid-19 pandemic has illustrated many of the limitations of dealing with uncertainty by basing a response plan too narrowly on previous experiences. For example, the epidemiology and transmission of SARS-CoV-2 was very different to SARS-CoV<sup>57</sup> and Covid-19 behaved very differently to previous influenza pandemics in Aotearoa New Zealand.<sup>58</sup> The impact of Long Covid was not anticipated and may become one of the most consequential legacies of SARS-CoV-2.<sup>59</sup> These experiences remind us of the importance of taking a cautious approach to novel pandemic agents.

### Impact assessment

One of the first actions in response to an emerging disease threat is an assessment of the potential impact on the population. Together, transmissibility and clinical severity enable a crude impact assessment, e.g., for the potential number of fatalities (Fig. 1b). Impact assessment should also consider a broader range of health outcomes (e.g., potential for severe acute disease and post-acute sequelae) and indirect impacts (e.g., pressure on health services leading to unmet healthcare needs, social and economic impacts of the disease and the potential control measures implemented, impacts on education and mental health). It is essential to consider how impacts will be distributed across the population, notably their effects on health equity and how they can be mitigated in groups likely to be disproportionately affected. The base assumption should be that a pandemic infectious disease will exacerbate existing health inequities unless active steps are taken to prevent this. Likewise, efforts to mitigate the unintended consequences of control measures (e.g., financial supports) need to be targeted to those with the least resources to absorb adverse impacts.

### Strategy development

Pandemics are highly dynamic events: actions taken at one point in time can have a major effect on the future trajectory; and similarly, the best course of action depends on previous decisions and likely future outcomes. The success or failure of control measures to achieve strategic aims can depend crucially on their timing.

A pandemic response needs to be sensitive to the dynamic nature of the situation and, once determined, is not fixed. The goal of the response and its guiding principles (e.g., minimising harms and inequities) should remain consistent. However, the strategy may shift over the course of the pandemic as circumstances change, whilst control measures may change rapidly with the epidemiological situation or availability of new interventions.<sup>4</sup>

An effective pandemic response requires clearly defined strategic aims to ensure that agencies and communities have a shared understanding of what needs to be done and why, and whether the strategy is working.<sup>4</sup> There are three broad strategic settings that may be used in a pandemic.<sup>4,60</sup>

1. Mitigation; a form of control that accepts transmission at a predetermined, manageable level, e.g., to avoid overwhelming the health system in an influenza pandemic;
2. Suppression; a form of control that aims to keep transmission at a low level to minimise adverse health effects, as for HIV/AIDS;
3. Elimination; which aims for zero community transmission of a pathogen. If global eradication is not possible, elimination is likely to be a temporary strategy that is later switched to mitigation or suppression, e.g., after a vaccine becomes available, which was the approach used for Covid-19 in New Zealand.<sup>17</sup>

All three pandemic strategies are likely to include all or most of the following objectives: to prevent or reduce seeding of new clusters into the area (e.g., via border controls); to identify and extinguish transmission chains (e.g., test-trace-isolate); to prevent transmission (e.g., staying at home when sick); to reduce the pool of susceptible individuals (e.g., via vaccination where available); and reduce the likelihood of adverse outcomes (e.g., using antimicrobial treatment).<sup>4</sup> To achieve these goals equitably, communities need to be supported to reduce barriers. For example, stay-at-home guidance may need to be paired with financial support, or immunisation guidance paired with vaccination programs at local marae (Māori culturally important communal spaces) or mobile vaccination centres.

The chosen strategy will determine the intensity and timing of the objectives, and hence the implementation of control measures. For example, an elimination strategy for a highly transmissible pathogen typically requires control measures to be applied at a high level of intensity early in an outbreak, but once elimination is achieved some types of control can be de-escalated or removed. In contrast, mitigation and suppression strategies require a lower level of peak intensity of the response but are likely to need continuous application of control measures to maintain incidence at a tolerable level. Control measures must be culturally informed and appropriate for those most at risk. Protection against the pandemic disease should be universally accessible and intensity of control measures should be proportional to risk (i.e., with strongest protections for those most at risk).

### Determining the appropriate strategy for an emerging pandemic

The default strategy in many countries' pandemic plans, including Aotearoa New Zealand, was a mitigation

approach, i.e., aiming to reduce cases, slow transmission and spread the epidemic wave out over time sufficiently to protect health systems. This approach needs re-evaluation in the light of the fact that, even in countries that adopted a relatively light-touch approach to interventions, a significant reduction in contact rates and other voluntary mitigations greatly reduced the number of infections. Future pandemic plans need to account for the fact that an effective public health response, combined with spontaneous behavioural change in response to the threat, could drastically alter the course of the epidemic.

Elimination may be the optimum initial strategy for a novel pandemic pathogen with severe clinical outcomes.<sup>60</sup> An initial elimination approach could buy time 1) to evaluate emerging evidence about transmission and severity and 2) to protect population health in the short- and medium-term until effective vaccines and treatments become available. Elimination is also likely to support health equity by keeping case numbers low or excluding an emerging pandemic.<sup>60</sup> Achieving that goal would also require specific policies to minimise inequities generated by the response itself.

A mitigation approach may be more suitable for a pathogen with sufficiently low severity, for example the H1N1 influenza pandemic of 2009. If an elimination response is used, it should be applied rapidly as delay may reduce its chance of success and prolong the need for intensive interventions to eliminate transmission.<sup>18</sup>

Unless transmission is globally eradicated or lasting herd immunity can be achieved through mass vaccination (e.g., as for measles), or infection can be excluded from geographic regions using a combination of public health and social measures (e.g., rabies), elimination is likely to be temporary. In these situations, an elimination strategy needs to be accompanied by an "exit plan" for when and how to shift to a suppression or mitigation strategy. The plan must include prevention of increasing disparities in health impacts as case numbers rise.

### Core capabilities

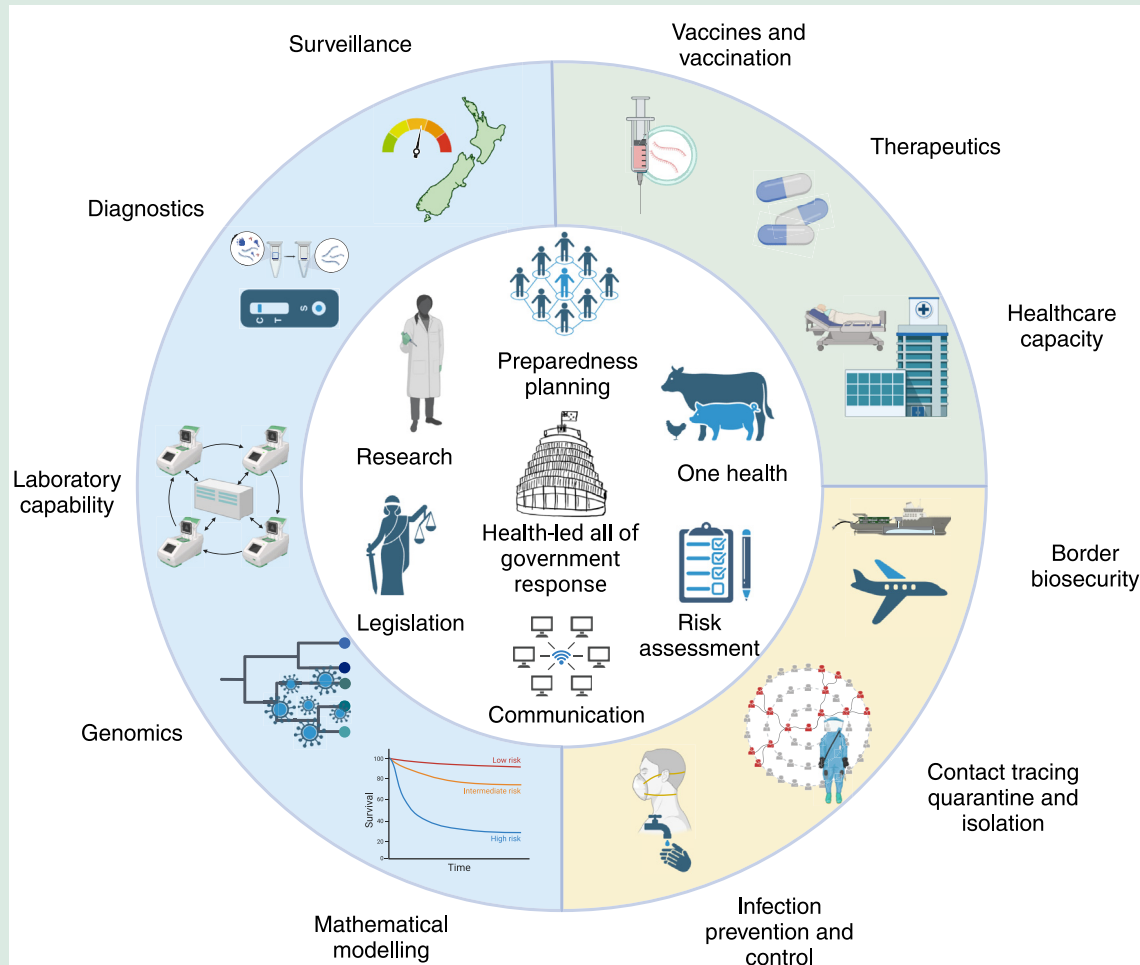
Panel 1 illustrates the core capabilities required to achieve an equitable and effective response to a pandemic threat. These are expanded upon in the [Supplementary material](#) and full report.<sup>2</sup> Investing in these capabilities and associated infrastructure before the next pandemic is the best way to minimize the need for disruptive interventions, such as lockdowns and other blanket measures, and their associated harms.

### Discussion

Aotearoa New Zealand's response to the Covid-19 pandemic had many strengths, but the initial crisis period also uncovered critical gaps in preparedness. Our review identifies the need to prepare for a wide range of potential pandemic pathogens and scenarios, highlighting

## Panel 1: Core pandemic preparedness and response capabilities.

Core capabilities needed to support equitable and effective responses to a pandemic threat grouped into four categories. The public health workforce in these core capabilities should reflect the population in its composition (e.g., gender, ethnicity, disability)



**1. Preparedness, risk assessment, and response coordination (centre circle).** These are arguably the most important capabilities as they operate during the inter-pandemic period to ensure the essential infrastructure and capabilities are in place and are regularly tested and improved to achieve equity and meet a full range of pandemic threats.

**2. Surveillance and testing (blue segment).** Surveillance systems, associated testing, genomic analysis and modelling can be sustained and refined in response to ongoing endemic and seasonal infections. This will ensure they are immediately available to respond to pandemic threats. These systems must ensure that currently underserved populations can be reached during these periods of refinement.

**3. Public health and social measures (orange segment).** These capabilities need attention during the inter-pandemic period so that their effectiveness can be rigorously assessed, and they can be scaled up and equitably applied for a specific pandemic response.

**4. Vaccination, treatment and clinical services (green segment).** These capabilities are an essential part of ongoing healthcare, with a need to continually improve their performance during the inter-pandemic period. Mechanisms must be in place to ensure their affordability, accessibility, and availability to Māori, Pacific Peoples, disabled peoples, and the medically vulnerable.

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the importance of a flexible but systematic approach to impact assessment and response. We also identify essential capabilities that need to be strengthened during inter-pandemic periods. A common thread in all pandemic lessons is the imperative to plan for and resource a more equitable pandemic response.<sup>49</sup> These lessons from Covid-19 should inform future pandemic planning in Aotearoa New Zealand.

### Implications for policy and practice

The “Pae Tū: Hauora Māori Strategy”, one of six Pae ora (healthy futures) strategies, must be central to these efforts, ensuring the health system upholds Te Tiriti o Waitangi, improves equity, and enhances long-term health outcomes for Māori.<sup>61</sup> This strategy includes empowering Māori leadership, decision-making, and governance at all levels; strengthening government-wide commitments to Māori health; expanding the Māori health workforce to meet community needs; supporting culturally safe, whānau-centred (family-centred) and preventive primary healthcare; and ensuring accountability for Māori health outcomes across the health system.

Explicit planning is needed for how to minimise the direct and indirect impacts of a future pandemic on disproportionately affected groups including: ethnic minorities and those with English as a second language; low-income households and those living in overcrowded or poor-quality housing; migrant workers and those in insecure employment; disabled people and people with mental health conditions; those without good access to digital tools. The impacts on and needs of children also need to be prioritised. It is important that active steps are taken to minimize stigmatization of people affected by the disease or perceptions related to the origin of the pandemic.<sup>44,45</sup>

Aotearoa New Zealand, like other countries, urgently needs to strengthen and maintain the core capabilities required for an effective pandemic response. These capabilities include ongoing pandemic preparedness and planning activities, such as risk assessment systems linked to potential strategy options. This needs to be underpinned by a comprehensive surveillance system, including adequately resourced reference laboratories, rapid genomic testing, wastewater surveillance and quantitative modelling tools for translating raw data into epidemic intelligence. Plans are needed for how to rapidly stand-up additional surveillance activities, such as FFX, cohort studies or infection prevalence surveys as required.

Public health and social measures, including border controls, contact tracing and quarantine, and digital tools may be important interventions. Specific attention is needed as to how these can be implemented effectively in disadvantaged population groups, and how unwanted consequences of interventions can be minimised. Aotearoa New Zealand developed a

comprehensive test-trace-isolate system, which was effective in controlling sporadic outbreaks that occurred in 2020 and 2021. However, contact tracing capacity was limited at the start of the pandemic and had to be rapidly expanded during the initial crisis.<sup>62</sup> A key lesson from this experience is that preparedness for future pandemic requires investment in effective contact tracing infrastructure so that it is available and can be scaled up when needed.<sup>63–65</sup>

Vaccination, therapeutics and clinical services are an essential part of ongoing healthcare, as well as pandemic response, and are a key area of focus for reducing inequities. Interoperable healthcare data systems that integrate general practitioner and hospital data would help to manage outbreaks and improve routine healthcare services.

Clear communication standards need to be established for how information will be used, both before and after decisions are made. Investment in knowledge brokers—experts who work with decision-makers—would support informed decisions.<sup>66</sup> Planning and decision-making should be grounded in a strong evidence base that evaluates the costs and benefits of different control measures in various scenarios, recognising inequitable impacts in different population groups. This approach ensures responses are both effective in meeting strategic objectives and proportionate to the threats faced. Together, these steps will build trust and reduce burnout by ensuring institutions are adequately supported.

Pandemic response strategies must remain adaptable to the evolving nature of the situation. While the overarching goals and guiding principles should remain consistent, strategies and control measures may need to change rapidly as the epidemiological situation shifts, new interventions become available, or new systems become operational.

### Conclusion

Pandemic planning presents significant challenges due to the many complexities and uncertainties surrounding the risk assessment and management of emerging infectious diseases. A constant theme across historic pandemics and epidemics is inequity: the heaviest burden often falls on populations with the least resources to manage these threats. Future pandemic plans must minimize limiting assumptions about the nature of potential pandemic threats, while addressing structural inequities through policy and practice. The interconnectedness of societal networks means that tackling inequity is not just a moral imperative but is crucial for the success of any pandemic response.

### Contributors

All co-authors contributed to the design, writing, editing and reviewing of this manuscript. All have given final approval for this work to be published and have agreed to be accountable for all aspects of the work.

**Declaration of interests**

Authors NF, HM, MB, FC, KD, JG, DH, QSH, AK, ER, PS, TPT report no conflicts of interest. Author MP declares relationships with Waka Kotahi, and the New Zealand Serious Fraud Office in which consultancy fees were paid to him and his institution.

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**Appendix A. Supplementary data**

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.lanwpc.2025.101525>.

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