Optimising the use of non-pharmaceutical interventions (NPIs) in future pandemic response: Applying evidence from the COVID-19 response

Authors: Professor Kamalini Lokuge, OAM, HOSM, Professor Katie Glass, Professor Emily Banks AM
Australian National University

Professor Kamalini Lokuge is a public health physician and epidemiologist, and has >25 years experience in a range of humanitarian emergencies, including several high-risk pathogen outbreaks. This expertise informed her contribution to Australia's SARS CoV2 (COVID-19) response in the areas of surveillance, outbreak response and community engagement. She advised State and Federal governments on their response to COVID-19, and was a founding member of Australia's National COVID-19 Health and Research Advisory Committee, from its inception in April 2020, to September 2021. In that role she chaired the working groups that produced advice to the Commonwealth Chief Health Officer on preventing resurgence, outbreak control and lockdowns. Professor Katie Glass has over 20 years of experience in mathematical modelling of infectious diseases, including >40 papers and reports on pandemic planning. Professor Emily Banks is an epidemiologist and public health physician with expertise on applying large-scale evidence to improving population health.

Summary of key points

The acute phase of the COVID-19 global pandemic was an unprecedented health event in modern times and had wide-ranging impacts across all aspects of human society. Another pandemic is inevitable, and it is critical that the lessons learnt from COVID-19 are understood and integrated into response systems for future pandemics, recognising that:

- During a future pandemic, even under optimal conditions, there is likely to be a delay of several months before pharmaceutical interventions (vaccines, antivirals etc) are readily available.
- During this period, as occurred during the initial phases of the COVID-19 pandemic, the only measures available to control transmission will be non-specific non-pharmaceutical interventions and public health measures (NPIs) such as surveillance, outbreak response, masks, social distancing and movement restrictions.
- Despite their critical importance, there is little systematic thought being applied to the role of NPIs in future pandemics, informed by their use during COVID-19.
- Underpinning the effectiveness of all response measures (both pharmaceutical and non-pharmaceutical) is the social contract between governments and the community. Little ongoing investment is being made in strengthening this social contract, in particular with structurally disadvantaged communities.
- This submission provides expert guidance on a pathway for addressing these gaps in knowledge and systems prior to the next pandemic.

The role and timing of NPIs*:* For most countries, the COVID-19 pandemic represented the first use in modern times of large-scale population-based NPIs to control transmission of an infectious disease. Measures such as control of social mixing and borders and widespread use of hygiene measures such as masks were critical in the early phases of the pandemic in preventing incursion and amplification of transmission. Surveillance, contact tracing, isolation and quarantine measures were also critical in this period to control transmission once SARS CoV-2 had been introduced.

Given the advent of novel technologies such as mRNA vaccines, the period from pathogen isolation to vaccine development has reduced. COVID-19 also demonstrated that the vaccine development and approval process can be markedly shortened without detrimental impacts on product safety. However, even under optimal conditions, it is likely a vaccine will take at least 3 months to develop and obtain approval[1]. There is then likely to be a further lag of several months, perhaps even years for developing countries, before widespread vaccine and/or antiviral availability. During this period, the only measures available to control transmission will be non-specific NPI's.

There is little systematic thought being applied to the role of NPI's in future pandemics. Much of the current discussion and planning related to future response focuses on technologies, in particular rapid development of

vaccines and antivirals to novel pathogens capable of causing a pandemic. Some attention is also being applied to ensuring such a targeted treatment can be produced at the required scale and distributed rapidly, at least for developed nations. However, understanding the role NPI's played in COVID-19 and how this will translate to future response has received much less focus and investment.

There is a critical gap in pandemic preparedness that needs to be addressed by considering possible future pandemic scenarios, and for each scenario, identifying effective NPI strategies for achieving the goals of disease control. This must be informed by the knowledge and experience of NPIs during the COVID-19 response. A broad overview of this approach is outline below.

The **overarching goals** of pandemic control measures during COVID-19, likely to be unchanged during future pandemics, were to:

- Maintain essential societal functions (health care, food production and distribution, other essential services)
- Minimise mortality and morbidity
- Limit societal and economic harms

NPI use in the initial phase of COVID-19: Two differing strategies were adopted in the early (pre-vaccine/ antiviral) phase of the pandemic by countries globally to achieve these goals. These are described in broad terms below, along with the pre-requisites for implementation of these strategies.

Strategy	Pre-requisites for effective implementation	Benefits and costs
Localised/context specific elimination: aim for complete transmission control within a defined area by reducing social mixing to a level that enabled the reproduction number to be brought below 1, control outbreaks through active case detection and management, and prevent/reduce incursions through border management	Disease characteristics: transmissibility such that R<1 when essential social mixing occurs (i.e. person-to-person interaction required for maintaining essential services) Response characteristics: Adequate coverage of testing, contact tracing and border management measures Societal characteristics: willingness and capacity to comply with stringent movement restrictions, stay-at-home orders, undertake isolation and quarantine	Benefits: Allowed social mixing to return to almost normal levels within the borders of the target area once elimination achieved. Costs: significant burden on community, in particular most disadvantaged, if and until elimination achieved
Controlled suppression: reduce transmission through non-pharmaceutical interventions to a level that enables essential services (e.g. health care) to meet demand, despite ongoing transmission	Disease characteristics: transmissibility such that R can be maintained at a level where morbidity and mortality does not overwhelm essential services. Response characteristics: Adequate coverage of testing, contact tracing and border management measures Societal characteristics: willingness and capacity to comply with non-pharmaceutical interventions when essential services are overwhelmed, and accept a sustained increase in mortality and morbidity overall.	Benefits: Less stringent societal control measures Costs: increased disease burden and burden on essential services, in particular health care; additional, more stringent lockdowns are still likely to be required if/when essential services become overwhelmed.

We can apply the evidence generated by the use of NPIs during COVID-19 based on the above strategies to inform the optimal approach to NPI use in future pandemics. This is needed not only in regards to a possible pandemic similar in nature to COVID-19, but perhaps even more importantly, for future pandemic scenarios where the characteristics of the pathogen differ.

Possible future pandemic scenarios:

Pandemic scenario (relative to early phase of COVID-19)	**Strategies/NPI interventions**	**Pre-requisites for effective NPI implementation**
Increased morbidity and mortality, similar transmissibility.	Elimination	Similar to COVID
	Controlled suppression	Less effective than for COVID-19 as limited NPI measures will have even less impact on morbidity and mortality levels, and therefore

		more need for frequent lockdowns due to essential services being overwhelmed.
Increased transmissibility in all groups, similar morbidity and mortality	Elimination	To be effective, R would still need to be able to be brought below 1 with available measures, and outbreak response able to eliminate transmission chains. If this is not possible, measures will not result in elimination. Therefore, measures would need to be implemented more effectively than during early phase of COVID-19.
	Controlled suppression	Less effective than for COVID-19 as limited NPI measures will have less impact on absolute levels of morbidity and mortality, and therefore mean more need for frequent lockdowns due to essential services being overwhelmed (if coverage of essential services remains same).

Other important scenarios that need to be considered with a similar approach are:

- Increased mortality in very young and old, similar transmissibility.
- Increased mortality in young and healthy, similar transmissibility.
- Increased transmissibility in children, similar mortality
- Increased transmissibility in all groups, similar morbidity and mortality

Utilising tools used in work on NPIs during COVID-19, namely public health analysis and mathematical modelling, to apply the evidence outlined in the former table above, would generate critical evidence on the likely impact of NPIs under the different pandemic scenarios detailed in the latter table.

Genuinely effective engagement with communities*:* Underpinning the effectiveness of all response measures (both pharmaceutical and non-pharmaceutical) are societal characteristics that support willingness and capacity to comply with these measures. This is dependent on the strength of the social contract that governments have with the community, which in turn is based on the long-term reciprocity individuals experience from their relationship with government in their daily lives.

As COVID-19 demonstrated, this is particularly challenging for structurally disadvantaged and marginalised groups, whose experience differs from the general community. However, as seen in some aspects of the latter response to COVID-19 (e.g. vaccination in these sub-groups), effective engagement can be achieved within these groups by transferring authority and autonomy to design and deliver interventions to those who have established trust and reciprocity prior to the pandemic. The NCHRAC report on preventing resurgence[2] which Professor Lokuge chaired identified this critical need prior to COVID-19 resurgence in Australia, but action was not taken until after widespread transmission recurred. Subsequent to the acute phase of COVID-19 passing, any steps that were taken to transfer authority have largely been rescinded. This is a missed opportunity not only to prepare for the next pandemic, but to strengthen non-pandemic services for structurally disadvantaged groups. Rather than being rescinded, these measures need to be integrated into Governments' business as usual.

Implications

This evidence indicates the need for:

- Greater investment in research and implementation regarding the role of NPIs for control of future pandemics
- Establishment and maintenance of measures to support community partnerships, in particular the transfer of authority and autonomy to design and deliver interventions to those who have established trust and reciprocity prior to emergencies and pandemics.

Selected References

1. Coalition for Epidemic Preparedness Innovations, Delivering Pandemic Vaccines in 100 Days; what will it take? (2022) https://100days.cepi.net/wp-content/uploads/2022/12/CEPI-100-Days-Report-Digital-Version_29-11-22.pdf
2. *National COVID-19 Health and Research Advisory Committee*, Risks of resurgence of COVID-19 in Australia, Report for the Chief Medical Officer, Commonwealth of Australia, May 2020.