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National COVID-19 Health and Research Advisory Committee*

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Advice 23: The epidemiological benefits of short-term lockdowns in managing outbreaks of SARS-CoV-2

Focus

This advice outlines the epidemiological evidence of the effectiveness of short-term (3-5 day[a]) lockdowns in limiting the transmission of SARS-CoV-2. Based on the international literature and local experience, this advice looks at what epidemiological triggers have been used to monitor when a lockdown should be implemented or eased.

This advice complements NCHRAC Advice: *Optimising the efficiency of contract tracing as a part of managing and outbreak of SARS-CoV-2*.

Note

This report is point in time and may need further review as more evidence is available.

This report was developed by a working group of the National COVID-19 Health and Research Advisory Committee (NCHRAC), Chaired by Professor Kamalini Lokuge, with Professors Brendan Crabb, Raina MacIntyre, Angus Dawson and Fran Baum, Ms Christine Morgan, and Dr Katie Allen. External expert advice was provided by Associate Professor Kathryn Glass. Consultation also occurred with states and territories through the Communicable Disease Network Australia.

Key points:

- Short lockdowns become necessary when there are indicators that the contact tracing and management system alone will not be able to identify all transmission chains and quarantine contacts prior to their infectious period.
- Indicators include:
    - The spread of SARS-COV-2 is dispersed in time (delay between primary case and index case), or place (multiple cases with unknown source), or both.
    - The current or expected volume of contact tracing is such that the maximum contact tracing time has or will soon exceed the minimum serial interval.
    - The characteristics of the disease suggest it has a shortened serial interval and is moving more quickly through the community (i.e. despite efficient contact

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[a] i.e. less than one average serial interval

tracing, contacts are already infectious when the case they were exposed to is identified).
    - The characteristics of the disease suggest it has become more transmissible (i.e. infections are occurring through very minimal contact, the proportion of household contacts becoming cases increases etc.) and therefore the number of primary close contacts per case is much higher.
        - e.g. the Delta variant is estimated to 60% more transmissible than the already highly infectious Alpha variant identified in the United Kingdom.

- In areas where the population is insufficiently vaccinated[b] and vulnerable to COVID-19, lockdowns are a suitable and effective means of limiting transmission when there are indicators that other non-pharmaceutical interventions (NPI) will not be able to control transmission.
- The maximum benefit of a lockdown to prevent and control transmission is seen when done early and combined with other NPI such as social distancing measures, mask wearing and effective and timely contact tracing.
- Early implementation of lockdown measures that sufficiently decrease social mobility are effective at rapidly reducing transmission to contain an outbreak, i.e. "go hard and go early".
- The severity, duration and geographical range of lockdowns differ based on their goal and purpose, such as:
    - to prevent health care collapse and overwhelming morbidity and mortality when there is widespread community transmission; or
    - to identify and completely curtail transmission when community transmission is very limited.
- The published evidence identified was predominantly focused on the former goal (i.e. limitations of health and health system impacts); no published literature was identified which directly assessed the effectiveness of short-term lockdowns in controlling low-level transmission.
- Toward the end or at the beginning of an epidemic there are lower rates of community transmission and lockdowns are effective in responding to epidemiological triggers.
- Early implementation also reduces the amount of time required to be in lockdown.

[b] It should be noted that although a substantial majority of the population needs to be vaccinated in order to be confident that lockdowns would not be required in future, the exact level of coverage needed will be dependent on a range of factors, including some that continue to evolve such as the transmissibility and severity of current and future strains of the virus in both the vaccinated and unvaccinated individuals.

Approach

Search for epidemiological studies on the impact of short-term lockdowns on SARS-COV-2 transmission was conducted in PubMed and MedRvix on 22 June 2021 and identified 35 publications, 27 of which were considered in this review. A quality assessment of the studies was not conducted.

Out of scope

- Modelling of primary data
- Examination of the socioeconomic impacts of short lockdowns
- Contact tracing.[c]

Summary of published evidence

The majority of the publications identified were reviews of epidemiological reports or predictive modelling estimates. No publications were identified that examined the implementation of short-term lockdowns that were in the realm of 3-5 days. The majority of literature discussed national, regional, localised or targeted lockdowns that were for a period of 14 days or more. The strain of SARS-CoV-2 modelled was not identified in any of the publications identified. Most publications attempted to evaluate the efficacy of national, local and geographical lockdown in conjunction with, and compared to, other NPI in limiting the transmission of SARS-CoV-2.

The use of lockdowns to reduce transmission of infection

NPI have been the main strategy for controlling the viral transmission of SARS-CoV-2 in the absence of a vaccine early in the pandemic. These interventions aim to reduce the probability of infection due to interpersonal encounters and include:

- Individual-level recommendations, i.e. the use of facemasks and frequent handwashing
- Mitigation policies such as case isolation, home quarantine, social distancing[1,2]
- Large-scale regulations, such as large-scale lockdowns and non-essential business closures.[3]

A lockdown is an NPI that encompasses stay-at-home orders, curfews, and quarantine. The implementation of community-wide rules that limit a populations' movement enforces social distancing for the purposes of interrupting transmission. Tran *et al* describes two types of lockdowns:

1. Targeted lockdown to control transmission clusters or if the number of positive tests is above a certain threshold; their success is dependent upon the speed of implementation.
2. General lockdown covers a wider area (potentially a whole country or region) and are specifically designed to manage pressure on the health system.[4]

[c]Contact tracing is discussed in detail NCHRAC Advice 22: Optimising the speed and efficiency of contact tracing in managing outbreaks of SARS-CoV-2

This advice is focused primarily on the first scenario to align with the current Australian context of low community transmission. Lockdowns have been demonstrated to protect the economy (compared with unmitigated transmission) and will continue to be a valuable tool for limiting the spread of viral transmission while vaccination rates remain low or low efficacy vaccines are used.[5]

Targeted lockdowns

In contrast to nation-wide lockdowns, localised or targeted lockdowns are implemented over a limited geographical area, ranging from a neighbourhood to a city, including suburbs, districts, or towns.

The literature highlights that as countries begin to reopen and ease mobility restrictions, targeted lockdowns are beneficial in managing and controlling the resurgence of SARS-CoV-2 infections. Decision making on the optimal size of lockdown area/s should be based on epidemiological criteria and local virus transmission dynamics.[6]

The efficacy of targeted lockdowns are influenced by their duration, and the indirect effects from neighbouring geographic areas that are not under lockdown.[7] The larger the proportion of neighbours under lockdown, the higher the effectiveness to control epidemic growth.[8]

In determining lockdown area, consideration should be given to social mobility through a stochastic and spatial lens to understand the significant interactions with other populations.[9] If cases are still high in other populations, the virus may be subsequently reintroduced through travel. Schlosser *et al*. suggests that changes to local mobility networks, such as targeted mobility restrictions, has direct and nontrivial consequences on viral transmission.[10] Some studies outlined how the use of telecommunications data could substantiate compliance with restriction by examining if interactions were sufficiently reduced during local lockdowns.[10,11]

Given the wide geographical range of mobility for work and schooling, targeted lockdowns are unlikely to be effective unless there is strong evidence that mobility has been limited to the targeted area prior to implementation of the lockdown.

Indicators for the requirement and easing of lockdowns

- Increase in a reproductive number (R_0) above the countries threshold (and sufficient decrease to ease lockdowns)
- Epidemiological triggers such as case incidence or contact tracing capacity[9]
- The number and density (per km^2) of infectious COVID-19 cases[8]
- Daily case incidence and their impact of health system capacity, i.e. daily incidence of Intensive Care Unit (ICU) admissions, number of ICU beds, hospitalisation doubling time.[4,12]

Factors for successful implementation

- Early and intense responses to outbreaks provide better results in controlling community transmission and enable prompt alleviation of restrictions based on the experiences of New Zealand.[13] This is supported by the modelling performed by Li *et al* on the impact timing plays on controlling transmission. Early institution of a mass

quarantine strategy in Hubai Provence by one and two weeks predicted a decrease in the peak number of cases by 25% and 57.3% respectively.[7]

- Modelling, by an Australian not for profit organisation, shows that states who locked down regions within two days of recording community transmission were able to lift lockdown within a week. Victoria's a delay in institution orders by three and four days, respectively, resulted in regional lockdowns being required for just under two weeks each to control the community transmission of the Delta variant. [d]
- Experiences in the United Kingdom on the implementation of tiered restrictions during their first and second wave of SARS-Cov-2 support the conclusion that early implementation of tight restrictions leads to better control.[1,14]
- Vincenti *et al* suggest that restrictions on mobility are inversely related to the daily number of newly diagnosed cases.[15] This is based on an analysis of lockdown measures in Germany where the spread of infection substantially lessened within 14 to 18 days after the implementation of tight lockdown measures. In some areas where more severe disease was prevalent, results were seen within nine days.
- An effective lockdown requires restrictions on the time spent in the workplace and in the public sphere and measures that reduce infection probability by increased hygiene and physical distancing.[16]
- Compliance with social distancing measures greater than 80%, according to Chang *et al*, will enable disease control.[3] Compliance of 90% practically controls the disease, bringing both incidence and prevalence to very low numbers of isolated cases (and reducing the effective reproductive number to nearly zero). Based on modelling of Australian data, compliance at or below 70% is unlikely to succeed in reducing the effective reproductive number to below 1.0.

Complementary strategies

- The maximum benefit (i.e. prevention and control of transmission) is seen when lockdowns are combined with other NPI such as social distancing measures, mask wearing and effective and timely contact tracing.[17]
- On vaccination, Chang *et al* states "Given that the herd immunity -threshold is determined by 1- $1/R_0$, the extent required to build up collective immunity for COVID-19, assuming R_0 2.77, may be estimated as 0.64, that is, 64% of the population becoming infected or eventually immunised'.[3] However this analysis was conducted prior to the emergence of the SARS-CoV-2 Delta variant and other highly transmissible strains.

Comparative strategies

Ng *et al* examined Taiwan's approach to containment of COVID-19, which did not involve lockdowns. Case-based interventions, using Taiwan's efficient contact tracing program and quarantine, were used in conjunction with population-based interventions, i.e. social distancing and use of face masks.[18] Neither of these approaches in isolation were modelled to be sufficiently effective in containing SARS-CoV-2; both were required. However, this

[d] Data used has been verified by state and territory health departments. See Compare Australia's COVID lockdowns | COVID-19 Data (covid19data.com.au)

strategy was prior to the emergence of the highly transmissible Delta variant. In late June 2021, Taiwan implemented stay-at-home orders and closed retail businesses in a number of townships in response to local clusters of SARS-CoV-2 infection in regional areas. These occurred as a result of breaches of quarantine requirements by residents who had returned from overseas and were infected with the SARS-CoV-2 Delta variant.

Note: Detailed discussion regarding the conditions and resources required for contact tracing are discussed in NCHRAC Advice: *Optimising the speed and efficiency of contact tracing in managing outbreaks of SARS-CoV-2*.

Eilersen and Sneppen suggest a one-step contact tracing/quarantine strategy (1STQ) as an alternative to the implementation of localised lockdowns in the later stages of an epidemic.[16] This strategy involves a crude form of contact tracing, testing and then quarantining of symptomatic individuals at home for at least five days, symptom recovery or a negative test result. Effective implementation of this strategy requires the use of social distancing measures in work and social settings, widespread population testing and rapid test turnaround times. Its limitations are that it does not account for those who present with weak symptoms, or are asymptomatic. However, the strategy may be appealing given its reduced impact on the economy and ability to reduce infection probability per encounter.

Epidemiology of short lockdowns and relationship to contact tracing

The broad purpose of public health control measures in settings of very low transmission is to end active transmission chains. Short lockdowns become necessary when there are indicators that other NPI, including the contact tracing and management system, will not be able achieve this goal. This 'pause and assess' measure aims to assist the public health response and is based on a risk assessment that considers the following factors[e]:

- Length of time the case (or cases) was infectious in the community
- Whether the source of exposure is known or unknown
- The movement of the case during their infectious period, in particular, did they spend the majority of time at home, or did they work in a public facing role or attend high risk venues
- Spread that is dispersed in time (delay between primary case and index case), or place (multiple cases with unknown source), or both
- Perceived vulnerabilities to/in the population e.g. threat of spread to Aboriginal communities
- Progress in identification and isolation of contacts and the expected pressure on subsequent contact tracing demands, i.e. is the maximum contact tracing time expected to increase and exceed the minimum serial interval
- The characteristics of the disease suggest it has a shortened serial interval and is moving more quickly through the community (i.e. despite efficient contact tracing,

[e] Feedback received on 15 July 2021 from ACT and NT via CDNA on epidemiological triggers for short lockdowns.

new contacts are already infectious when their source of exposure is identified). e.g. Delta variant[19]

- The characteristics of the disease suggest it has become more transmissible (i.e. infections are occurring through very minimal contact, the proportion of household contacts becoming cases increases etc.) and therefore the number of primary close contacts per case is much higher.
    - e.g. the Delta variant is estimated to by 60% more transmissible than the already highly infectious Alpha variant identified in the United Kingdom.[20]

As the situation eases, restrictions are reviewed regularly with a view to moving back to a 'COVID normal' as quickly as possible.

The aim of contact tracing is to interrupt transmission of SARS-CoV-2. It is the process of identifying assessing, and managing people who have been exposed to a disease to prevent onward transmission. In practice, contacts in COVID-19 management are isolated from the time they are exposed to the disease for 14 days. When systematically applied, contact tracing will break the chains of transmission of COVID-19 and is an essential public health tool for controlling the virus. For the purposes of routine contact tracing, cases are considered infectious from 48 hours prior to symptom onset. More conservative periods (e.g. 72 hours prior to illness onset) may be considered in high risk settings.

Those who have had direct exposure to a known infectious case are considered primary contacts. Secondary contact tracing is the practice of isolating the contacts of primary contacts. Secondary contact tracing becomes important if, by the time a primary contact has been identified and isolated, they have already passed the disease onto their contacts. This can occur if contact tracing speed is slower than the serial interval (i.e. the time between new generations of cases) either because of capacity being exceeded, because of novel variants with shorter intervals between exposure and onset of infection in cases, or both. The relevant serial interval that should be considered here is not the average, but the likely minimum serial interval. If this is demonstrated to be 1-2 days for some cases, then even highly efficient contact tracing will not prevent further transmission without secondary contact management.

The number of primary and secondary contacts grows exponentially, but at a rate very much greater than the growth of cases. Even efficient and high-capacity contact tracing systems can reach capacity very quickly, from a comparatively small number of cases, when even fleeting contact is considered primary close contact, and when secondary contact tracing is required. This is further exacerbated if the number of primary contacts is high because of cases being in the community for extended periods while infectious.

As well as reducing the number of cases, lockdowns reduce the growth rate of contacts, both primary and secondary. This decrease of contacts will be of greater magnitude than that of cases because their growth rate is much higher.

Other considerations

In the course of developing this advice, NCHRAC identified the following considerations that were out of scope for this advice, but are important and related considerations:

- Mental health impacts from short-term lockdowns [NCHRAC Advice 4: Mental health impacts of quarantine and self-on isolation].
- Ability to comply may be particularly challenging in low- and middle-income countries, where a substantial proportion of the population works informally and there are limited social and financial supports for unemployed.
- Community perception of risk and its impact on compliance and adherence to COVID-19 NPI.

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