Elimination of COVID-19: what would it look like and is it possible?

Lancet Infect Dis 2020
Published Online
August 6, 2020
https://doi.org/10.1016/S1473-3099(20)30633-2

In countries that have achieved a low incidence of COVID-19 infection, such as Australia and New Zealand, disease elimination has been proposed.[1,2] Yet we do not have a definition of elimination for COVID-19. Both these countries implemented early, widespread, and strict disease mitigation strategies. With low cumulative incidence, most of the population in these countries remain susceptible to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Before the availability of a vaccine, implementing exit strategies that ease social distancing restrictions will probably result in epidemics if a low level of community transmission remains or is imported through travel, as seen with the resurgence in the state of Victoria, Australia in July 2020. For other respiratory transmitted infections, such as measles, mumps, and smallpox, the prevaccine era saw recurrent epidemic cycles,[3] and a similar pattern is projected for unmitigated SARS-CoV-2 transmission, depending on the duration of immunity.[4] Reduced case counts, flattened epidemic curves, and longer interepidemic periods are also dependent on achieving immunisation coverage and reduced transmission through implementation of non-pharmaceutical interventions (NPIs).[5]

The concepts of disease elimination and eradication mostly relate to immunisation programme outcomes. Disease eradication is the global reduction of infection to zero cases, whereas disease elimination is the absence of sustained endemic community transmission in a country or other geographical region.[6] With ongoing global SARS-CoV-2 transmission, reduction to zero cases in a defined region is only possible with stringent travel restrictions. For COVID-19, modelling estimates suggested that sustained restrictions that reduced travel by 90% to and from Wuhan, China, early in the spread of SARS-CoV-2, only modestly affected the epidemic trajectory to other regions of China.[7] However, in Australia, travel bans were highly effective in controlling the spread of SARS-CoV-2 into Australia and averted a much larger epidemic.[8]

After the eradication of smallpox was declared in 1980, the global eradication of polio and the regional elimination of measles have been goals of WHO. Some countries have achieved the elimination of polio and measles, but eradication remains elusive, especially with global resurgence of measles in 2018–19.[9] Although the regional elimination of a pathogen can be achieved through continued control efforts, eradication of a disease in humans might only be feasible if humans are the only host.[10] Pathogen extinction includes destruction of all natural and laboratory stored samples. Advances in synthetic biology and genetic engineering make extinction of any human pathogen unlikely.[11]

Elimination of any infectious disease is an ambitious strategy, requiring substantial resources to achieve. The WHO criteria for elimination of measles are: evidence of low incidence, high quality surveillance with rapid outbreak response, and high population immunity.[6] Without a vaccine, the criteria of low incidence and high population immunity are mutually exclusive propositions. The basic reproduction number (R_0) for COVID-19 probably lies between 2 and 3;[12] therefore, more than 60% population immunity is required to induce herd immunity.[3] Less than 5% of the population are estimated to have been infected in high burdened countries, such as Italy,[13] excluding any consideration of plans to allow unmitigated transmission of COVID-19. Only vaccination can purposefully achieve a sustained and sufficiently high population immunity to eliminate epidemic respiratory infections such as COVID-19. Until then, NPIs flatten the epidemic curve and can lengthen the interepidemic period.

Elimination criteria require evidence of the maintenance of R_0 below 1 in a health system with the capacity to detect a case of infection if it does occur. For measles, an adequate surveillance system is measured by an annual rate of two negative measles tests per 100 000 population.[6] For infections with presymptomatic and asymptomatic transmission, such as COVID-19, several generations of transmission can occur without detection.[14] Capacity to detect COVID-19 has been estimated to require weekly COVID-19 testing rates of the population with symptoms of fever and cough of approximately 2000 tests per million population,[15] although currently achievable in some countries, this rate of testing might be difficult to maintain in the long term.

In the absence of a WHO goal for COVID-19 elimination, individual countries should instead develop their own criteria for control. This should include extensive surveillance and criteria for differentiating sustained community transmission from sporadic, non-sustaining outbreaks. A low threshold definition of sustained community transmission for COVID-19 could be at least three generations of transmission from an index case or a specified period, such as 3 months, without new cases. Periods shorter than 3 months might not be meaningful, and declarations of elimination might result in a false sense of security for the population. Setting clear parameters for defining resurgence can provide a flag for the start of a potential epidemic period and signal the need for increased use of NPIs. Without country-wide elimination, it is likely that continued management and control of COVID-19 with intermittent periods of restrictions is required until a vaccine is available.[4]

AEH reports grants from GSK, outside the submitted work. CRM reports grants from Sequirus, Sanofi, and National Health and Medical Research Council, outside the submitted work.

Anita E Heywood, C Raina Macintyre
a.heywood@unsw.edu.au

School of Public Health and Community Medicine, University of New South Wales Sydney, Sydney, NSW 2052, Australia (AEH); and The Kirby Institute, University of New South Wales Sydney, Sydney, NSW, Australia (CRM)

1 Cousins S. New Zealand eliminates COVID-19. *Lancet* 2020; **395:** 1474.
2 Group of Eight Australia. COVID-19 Roadmap to Recovery: a report for the Nation, 2020. https://go8.edu.au/research/roadmap-to-recovery (accessed July 23, 2020).
3 MacIntyre CR. On a knife's edge of a COVID-19 pandemic: is containment still possible? *Public Health Res Pract* 2020; **30:** 3012000.
4 Kissler SM, Tedijanto C, Goldstein E, Grad YH, Lipsitch M. Projecting the transmission dynamics of SARS-CoV-2 through the postpandemic period. *Science* 2020; **368:** 860–68.
5 Anderson RM, Heesterbeek H, Klinkenberg D, Hollingsworth TD. How will country-based mitigation measures influence the course of the COVID-19 epidemic? *Lancet* 2020; **395:** 931–34.
6 WHO. Framework for verifying elimination of measles and rubella. *Wkly Epidemiol Rec* 2013; **88:** 89–99.
7 Chinazzi M, Davis JT, Ajelli M, et al. The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. *Science* 2020; **368:** 395–400.
8 Costantino V, Heslop DJ, MacIntyre CR. The effectiveness of full and partial travel bans against COVID-19 spread in Australia for travellers from China during and after the epidemic peak in China. *J Travel Med* 2020; published online May 22. https://doi.org/10.1093/jtm/taaa081.
9 Holt E. Global surge in measles should be "a wake-up call". *Lancet* 2019; **394:** 2137.
10 Dowdle WR. The principles of disease elimination and eradication. *Bull World Health Organ* 1998; **76** (suppl 2): 22–25.
11 Noyce RS, Evans DH. Synthetic horsepox viruses and the continuing debate about dual use research. PLoS Pathog 2018; 14: e1007025.
12 Li Q, Guan X, Wu P, et al. Early Transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med* 2020; **382:** 1199–207.
13 Lavezzo E, Franchin E, Ciavarella C, et al. Suppression of COVID-19 outbreak in the municipality of Vo, Italy. medRxiv 2020; published online April 18. https://doi.org/10.1101/2020.04.17.20053157 (preprint).
14 Peak CM, Childs LM, Grad YH, Buckee CO. Comparing nonpharmaceutical interventions for containing emerging epidemics. *Proc Natl Acad Sci USA* 2017; **114:** 4023–28.
15 Lokuge K, Banks E, Davis S, et al. Exit strategies: optimising feasible surveillance for detection, elimination and ongoing prevention of COVID-19 community transmission. *medRxiv* 2020; published online April 23. https://doi.org/10.1101/2020.04.19.20071217 (preprint).