

Pathways to the end of the COVID epidemic: scientific and public health considerations.

1) The purpose of this paper is to describe a range of options for relaxing current social distancing measures and other restrictions in relation to the COVID epidemic. Decisions around which of these measures should be taken, singly or in combination, at different time points will be a matter of policy.

Background:

2) The COVID virus is a new pathogen which spreads rapidly via aerosol or direct contact and to which there is no population immunity. As long as R_0 (the number of susceptible individuals to whom the virus is transmitted by a case) is >1 , then the epidemic will increase in an exponential fashion. The greater the value of R_0 , the more rapidly the epidemic will spread.

3) In the early stages of the epidemic in NI, R_0 was > 2.4 . During this period a significant increase in cases, hospital admissions, ICU occupancy and deaths was observed. If no measures to reduce R_0 had been taken, the epidemic would have continued to increase in such a way that capacity to deliver health and social care services would have been overwhelmed, and continued to increase further until a substantial proportion of the remaining population ($>60\%$) had achieved immunity as a result either of recovery from infection or successful vaccination.

4) Following the implementation of social distancing and other restrictions, there is a high probability that R_0 for community transmission has fallen to <1 . Most recent estimates indicated that R_0 is currently around 0.8 or less, in line with early estimates derived from contact matrix work. This has resulted in a levelling off in hospital admissions, ICU occupancy and deaths and provided that restrictions remain in place and public adherence remains at current levels we would expect each of these to fall significantly in the coming weeks.

5) If R_0 is maintained at just <1 , ICU requirements and weekly deaths will fall very slowly and remain significant until late summer. If R_0 is closer to 0.6, we would expect a rapid fall in ICU occupancy and weekly deaths to low levels by mid-May.

6) There is an increasingly recognised problem with transmission of COVID within enclosed settings, particularly care homes (nosocomial infection). Each of these constitutes a separate “city-state” in epidemiological terms, and will have its own R_0 value. Separate measures will be required to minimise the risk of mini-epidemics in these settings.

7) To date, all aspects of the epidemic have been less severe in NI than in the rest of the UK. Reasons for this are unclear, but probably relate to a smaller number of seeding cases in the early stages of the epidemic along with a relatively low population density. There is no persuasive evidence that compliance with social distancing has been better in NI than in the rest of the UK.

8) The epidemic also appears somewhat less severe in NI compared with ROI, although the differences are less marked than between NI and the remainder of the UK. Differences in testing strategies, data collection and introduction of social distancing make NI / ROI comparisons more difficult, but it appears as if the course of the epidemic across the island of Ireland is relatively uniform.

Extent of population immunity:

9) There is considerable uncertainty around the percentage of COVID cases who remain asymptomatic or have such mild symptoms that the possibility of infection is not recognised. However, it is likely that the number of COVID cases is much higher (at least one order of magnitude higher) than currently identified. Asymptomatic individuals are important to the spread of the epidemic and also to the development of significant population immunity.

10) Determining the extent of population immunity requires a reliable test which can measure the antibodies which individuals produce in response to infection. Levels of antibodies begin to rise around seven days after infection and are probably most reliably detected by measurements performed more than three weeks after infection. At present, a reliable test is not available to assess population immunity. Directly measurement of NI population immunity is a priority; however, based on results of best-available tests in other populations we currently estimate that less than 5% of the NI population are likely to develop immunity in wave one of the epidemic. In order to prevent future waves, at least 60% of the population will need to achieve immunity.

Measures to improve outcomes and reduce infection rates:

11) Extensive clinical trial work is underway to assess the impact of existing and novel drugs on the progression of infection. It is likely that treatments will be identified in the next few months which can somewhat reduce mortality or the risk of infection becoming severe. However, a cure for the infection is not anticipated at present.

12) There is also extensive work underway to develop a COVID vaccine. While it is possible that a vaccine may be available towards the end of this year, it is more likely to be 2021 or even 2022 before an effective vaccine can be widely rolled out to the population. In the initial phases, it is likely that the vaccine will be offered to highest risk groups first.

Other factors:

13) The behaviour of the virus and the nature of the immune response to it are not fully understood, and other factors may therefore influence the course of the epidemic.

14) It is possible that increase in UV light exposure in the summer months may reduce survival of the virus in the environment. This period may also be characterised (depending on social distancing measures) by less time spent in enclosed environments. Both of these would tend to decrease R_0 , and hence may lead to reduced viral spread in the summer which would increase again in autumn / winter months.

15) It is unclear to what extent immunity following recovery from virus infection persists. It is possible that immunity is relatively short lasting (6-9 months), or alternatively may be persistent. These two scenarios would have very different impacts on the medium term course of the epidemic. In either case, however, it is likely that COVID will persist as a healthcare problem for many years to come, with flare ups of infection from time to time depending on the size of the susceptible population.

16) Use of masks. This is currently being looked at in detail by SAGE. It is likely that an increase in mask wearing will be recommended, which is likely at best to have a modest impact on COVID transmission.

Direct and indirect impacts of social distancing and other restrictions:

17) The direct (and desired) impact of social distancing and other restrictions to reduce COVID cases, hospital admissions, ICU admissions and deaths is well understood, and is relatively easily quantified. However, it is important to recognise the direct and indirect short and long term harms on health outcomes which are also a consequence of these restrictions.

18) Changes in clinical care pathways or access to care for patients with non-COVID disease may lead to delayed diagnosis or altered treatment, with poor outcomes and increased deaths. One obvious area of concern relates to changes in cancer pathways, but similar considerations will apply to many areas of care.

19) Current restrictions have led to substantial economic damage which will become worse so long as significant restrictions exist. It is unclear how quickly economic recovery will occur, and the slower this is the worse the harms which will result. This will have many adverse impacts for individuals, communities and society, including long term adverse impacts on health outcomes and mortality.

20) Increased social isolation and time spent at home may lead to the adoption of a more unhealthy lifestyle – weight gain, increased alcohol consumption, reduced exercise, poor diet – which may persist when current restrictions are reduced or reversed. In addition, there is likely to be an increased risk of domestic violence during the current period.

21) All of the factors highlighted above are likely to have adverse implications for mental health, and in addition will tend to impact most severely on the already vulnerable and socio-economically disadvantaged.

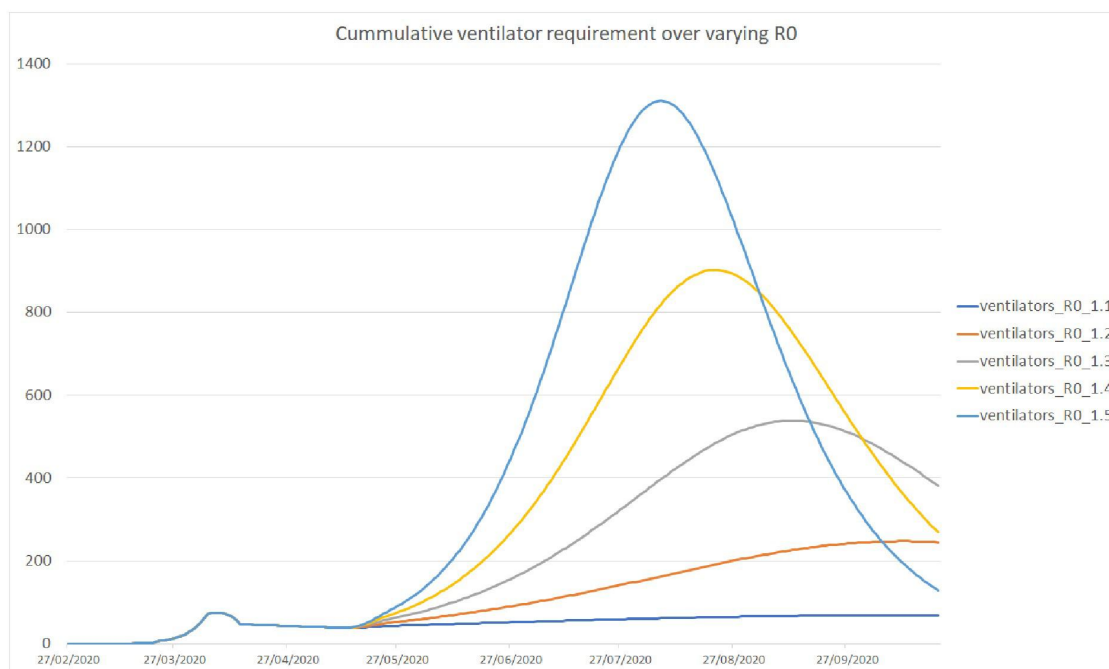
Pathways to the end of the epidemic:

22) The current epidemic will not end until substantial population immunity is achieved either as a consequence of recovery from infection or successful vaccination. Even in the best scenario, it is anticipated that COVID infection will continue to present clinically at a low level with risks of occasional outbreaks. If immunity to coronavirus does not persist, then regular vaccination will be required and it is likely that outbreaks will tend to be more severe and persistent.

23) Following any change in restrictions (either to decrease or increase) an interval of 3-6 weeks will be required to accurately determine the effect on the epidemic. If multiple changes are made at one time, it will only be possible to reliably determine the effects of the package of changes, not individual changes.

24) As outlined above, only if sufficient measures are taken to maintain R_0 at <1 will the epidemic be suppressed. Any relaxation of current measures carries with it a risk of R_0 increasing to >1 , and that exponential growth of the epidemic will recommence. The impact of different values of R_0 assuming restrictions are released in mid May on the requirement for ventilators is illustrated in the figure

below. It is important to remember that R_0 was probably 2.4 – 2.8 prior to restrictions, so all of the illustrated scenarios represent a significant reduction in pre-restriction contacts:



25) At any point, it would be possible to reintroduce the current social restrictions. A continued increase in cases / admissions / ICU occupancy and deaths would be observed for 2-3 weeks before they began to decrease again. In behavioural terms, it is unclear how the public would respond to the reintroduction of restrictions once they are released.

General principles with regard to relaxing current restrictions:

26) In determining the way ahead with regard to social distancing and other restrictions, the total impact of measures should be considered (direct / indirect benefits and harms, and economic consequences, both short and long term).

27) Any relaxation of current restrictions (options discussed below) will be associated with a risk of significant increase in COVID cases. There is no relaxation of the current restrictions which can be considered “safe” in terms of the COVID epidemic. However, some types of relaxation will be associated with less risk than others.

28) In order to minimise the risks of a second wave, it is likely that extensive testing of suspected cases and contacts and individual / family social isolation will be required, along with close monitoring of the impact of any changes on R_0 .

29) Contact tracing and testing will be aided by an app-based approach providing that public uptake and agreement for data sharing is high. However, modelling suggests that manual contact tracing will also be essential. In comparison with other countries it is likely that NI will require 300 – 600 trained contact tracers to make this approach feasible.

30) R_0 can be determined from changes in cases / admissions / ICU occupancy and deaths. However, because of the significant lag in determining changes in R_0 using this approach it should be augmented by a regular population level contact matrix survey. This has the potential to provide an early estimate of R_0 following any relaxation of restrictions. Discussions are underway with NISRA with regard to how they could help to implement this.

31) Measures which result in greater exposure of non-vulnerable young people to infection will place relatively little demand on the healthcare system and may significantly increase population immunity. Conversely, measures which increase exposure of the elderly or vulnerable to infection will place much greater demands on the healthcare system.

32) Shielding of the elderly and vulnerable will need to be maintained until a vaccine is available to avoid significant COVID deaths in these groups.

33) Individuals who come into close contact with many people for an extended period are likely to be both at higher risk of infection and higher risk of infecting others. People in professions such as health and social care, teachers, bar workers, hairdressers have higher contact rates. These individuals potentially act as linking “hubs” between households – in lockdown, such links have been severely limited and so have significantly decreased transmission.

34) Settings that bring together individuals from across several households are likely to be higher risk for transmission. Schools, workplaces, public transport, places of worship, and leisure facilities all create networks between households; the more households that are brought together, linked by individuals, the greater the potential for transmission through the network. Smaller businesses may create fewer links between households than a fully open school.

35) Some institutional settings, such as care or nursing homes, boarding schools, barracks, prisons, etc. are already self-contained, highly connected, networks and SARS-CoV-2 is likely to spread quickly and easily. As a result, all efforts should be made to prevent the virus entering such a setting in the first place i.e. shielding the whole institution and greatly reducing movement between them. If infection occurs in such a setting, aggressive testing and isolation strategies will be required to prevent a mini-epidemic.

36) A significant increase in COVID cases such that there is a risk that the capacity of the health and social care system might be overwhelmed will require the reimposition of social distancing and other restrictions until significant population immunity is achieved.

37) A co-ordinated campaign of public education and information will be required to underpin the complex actions which may be required. This should include careful explanations of each step and the rationale aimed at all segments of the population.

38) Close co-ordination of actions with ROI should be considered, given the likelihood that community transmission of COVID proceeds as one epidemic on the island of Ireland.

Relaxation of social distancing:

39) It would be possible to relax social distancing based on age in non-vulnerable individuals, given that the clinical manifestations of COVID are more severe with increasing age. This would encourage increased population immunity while allowing a significant proportion of the population to return to economic activity. However, it is unclear if this would be socially acceptable.

40) It may be possible to consider geographical variation in restrictions, with parts of NI considered to have less COVID infection being allowed to relax restrictions first. However, the geographical distribution of COVID infection is not clear and it is unlikely that this would be effective or socially acceptable.

41) It may be possible to relax restrictions for individuals who have recovered from infection, either based on a confirmed viral diagnosis or elevated antibody levels once a suitable test is available. However, such individuals may not retain immunity indefinitely and could still transmit infection. In addition, this would be difficult to police and may lead to adverse behaviours (include individuals deliberately seeking to contract infection so that restrictions on them would be reduced).

42) With regard to more general relaxation of restrictions, it is possible to suggest a hierarchy with those changes likely to be associated with less increase in R_0 being stated first. Those towards the bottom of the list are more difficult to judge but are likely to have more impact on R_0 . Whatever decisions are taken about relaxing social distancing, this should occur in a graduated way, with a focus on maintaining shielding of high risk individuals until a vaccine is available. Continued home working for those groups who can do so should be maintained for as long as possible. Outdoor employment could resume (including construction) providing social distancing is maintained, at an early stage. Shops could re-open but using the social distancing measures which are currently in place. Cafes, restaurants and places of entertainment would probably open at a later stage and be asked to maintain distancing. Indoor mass gatherings would be among the last events to be permitted.

Specific measures:

a) Permitting outdoor activities so long as social distancing of $>2M$ is maintained. This is likely to have a small effect on R_0 and may significantly increase public wellbeing. Could include some outdoor sports where social distancing is maintained and not involving contact with hard surfaces, but not permitting clubhouse opening. In addition parks and other public outdoor spaces could open, but not children's play areas until schools open (see below).

b) Outdoor work maintaining social distancing, particularly during breaks / mealtimes, such as construction, park maintenance, etc. Garden centres (with cafés closed) may also fall into this category or the next.

c) Indoor activities involving limited contacts of less than 10 mins and interactions of only 1-2 people that maintain social distancing and prevent loitering or congregating in places for any extended period. For example, this could include non-essential retail in small shops with limited customers at any one time. Special consideration would be required for hairdressers and other professions where close contact is unavoidable. Opening large shops and shopping centres could encourage gathering and loitering of crowds in indoor, enclosed spaces, which increases the potential for proximity, length of exposure, and thus risk of transmission.

d) Reopening schools and universities: Nursery schools and primary schools could be considered separately from secondary schools / universities. This would allow more parents to return to work. Special consideration would need to be given to risks to staff and to the needs of children living with vulnerable parents. SAGE is currently considering the likely impact of this on R_0 in more detail.

d) Gyms/leisure centres and outdoor playgrounds involve multiple people touching hard surfaces, with no easy sanitation between individuals using equipment. This is partly balanced by likely UV degradation of virus particles in the case of outdoor facilities in the summer months.

e) Outdoor mass gatherings: precise risk will depend on the numbers of people attending, their duration, and how much social distancing can be maintained.

f) Indoor mass gatherings: inherently more risky than outdoor mass gatherings due to the confined space, and potential for bottlenecks of entry and exit routes.

g) Indoor cafés and restaurants bring people together in close proximity. The risk could potentially be reduced by only allowing households to attend together (very hard to enforce) or limiting persons per table and extending distance between tables.

h) Indoor leisure activities, including gyms, places of worship, cinemas, theatres etc., lead to extensive person to person contact and so likely increase risk of viral transmission which is hard to mitigate. This would also include pubs, bars and clubs, which also bring together people from variety of households into a confined space. These sorts of activities happen frequently and constitute a relatively large proportion of people's time, increasing risk of viral transmission. However, they are also very important to the economy and to people's sense of wellbeing.