

Modelling the COVID-19 epidemic; the Reproduction Number and number of cases

Current estimate of R: 0.3 – 0.8

Average number of new positive tests per day last 7 days: 3

Current community incidence estimate (new cases per day): < 40

Current community prevalence estimate (total infectious individuals): 60 - 600

It is important to model the COVID-19 epidemic in Northern Ireland in order to plan the delivery of Health and Social Care services and to inform decision making with regard to social distancing and other restrictions which may be required. The Reproduction Number (R) has been central to modelling the course of the epidemic to date. R is the number of individuals who, on average, will be infected by a single person with the infection. R does not have a fixed value but varies with time, and is likely to be different every day.

When R is above 1, the transmission of the epidemic will increase, resulting in more cases, hospital admissions and deaths. The greater the value of R above 1, the more rapid the increase. When R is below 1, there will be a fall in the number of cases, hospital admissions and deaths. The further R is below 1, the more rapid the fall will be. The Executive has indicated that keeping R below 1 is a key objective as we move forwards in the epidemic.

However, when community transmission of the virus is very low, R will no longer be the most important number for the purpose of policy decisions. In particular, once the number of new cases is sufficiently low in the presence of a robust testing programme and test/trace/protect strategy, **number of positive tests per day is likely to be a more important parameter in the context of planning.** In the view of the modelling group, the point has now been reached when R will show a high degree of volatility and be heavily influenced by small local clusters. **In these circumstances we believe that there is very limited value to continuing to publish a weekly value for R, and that it may give a misleading impression of the state of the epidemic.** This position will be reviewed in the event of any significant increase in markers of community transmission such as numbers of new positive cases or hospital admissions.

Determining the value of R:

The most common approach to determining R during an epidemic is to use mathematical modelling, in particular a compartmental model using a SIR (susceptible-infectious-

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recovered) approach or a variation of it. Dozens of such models have been published and are in use throughout the world; there is no single standard model which everyone uses.

In addition to the impact of the mathematical model used, the calculated value of R is also influenced by the choice of input variable. R calculated for new COVID-19 cases will not be the same as R calculated for hospital admissions, or ICU occupancy, or deaths. There may be a significant lag (2-3 weeks) before a fall in R is apparent depending on the input variable(s) used.

Once the activity of the epidemic is at a low level (as at present) marked fluctuations in R may be observed over short periods of time as a result of localised outbreaks or clusters. Local measures to address the cluster or outbreak will represent the most appropriate response in those circumstances, rather than general measures which are more appropriate when there is widespread community transmission.

At present there is no evidence of sustained community transmission or significant localised outbreaks in NI.

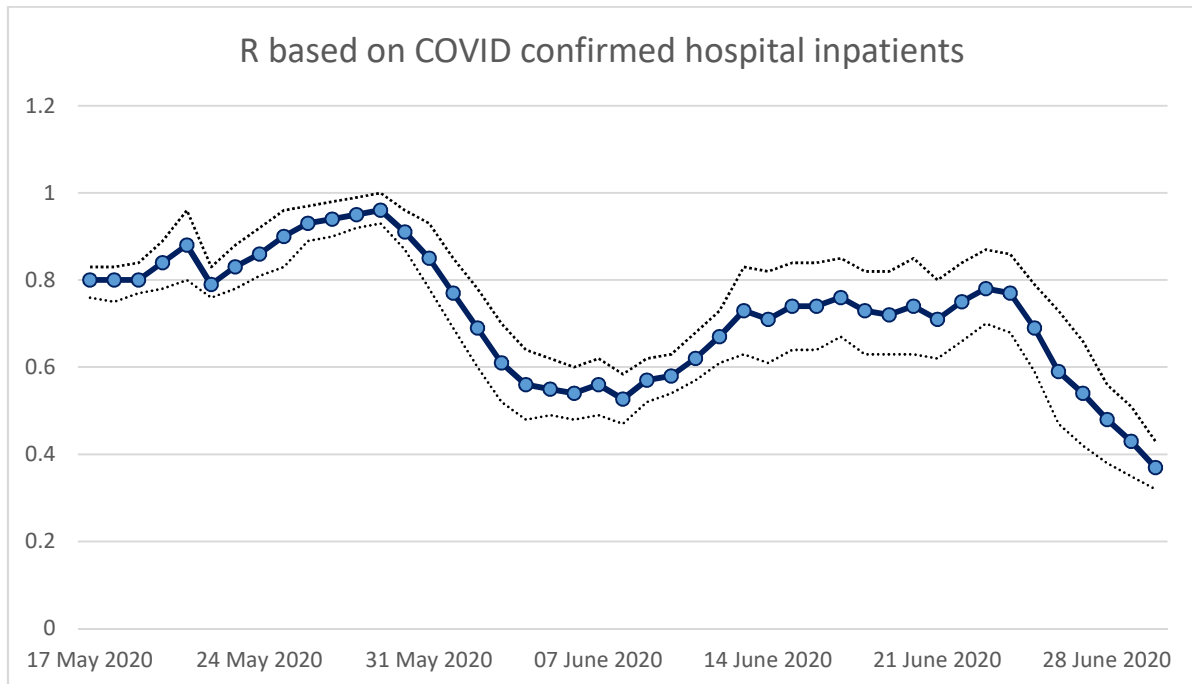
Determining R for NI:

The modelling group determines R each day using a bespoke Northern Ireland SIR model. As its primary input the group uses hospital in-patients with community acquired COVID-19, but also uses a range of other inputs. We therefore have several different values for R each day, each of which has a midpoint value and a lower and upper boundary (95% confidence intervals). In addition a number of academic groups, both in the UK and ROI, model the COVID-19 epidemic and we have access to their estimates of R for Northern Ireland. R can also be determined based on a contact matrix survey, and this approach may be more reliable when levels of community transmission are very low.

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Trends for R for Northern Ireland:

The graph below shows how R has changed over time during the course of the COVID-19 epidemic in Northern Ireland using hospital in-patients with community acquired COVID-19 as an example. The value of R differs somewhat when other inputs are used.



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Number of new COVID 19 cases per day (seven day rolling average):

The graph below shows that the number of new COVID 19 cases continues to fall, but at a declining rate as the trend moves towards zero. Data are taken from the DoH Dashboard report for the previous day.

