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Modelling the COVID-19 epidemic; the Reproduction Number and other indicators

Current estimate of Rt (ICU patients): 0.9 – 1.2 (probably above 1)
Current estimate of Rt (hospital admissions): 0.8 – 1.0 (probably below 1)
Current estimate of Rt (new positive tests): 0.7 – 0.95 (definitely below 1)
Average number of new positive tests per day last 7 days: 582 (down from 790)
7 day incidence based on new positive tests: 215 / 100k (down from 291)
14 day incidence based on new positive tests: 492 / 100k (down from 663)
7 day average of total positive tests (pillar 1 and 2) – 11.3% (down from 13.9%)
Tests per 7 days per 1000 population – 19.7 (down from 21.8)
Number of new positive tests in over 60s in last 7 days – 944 (down from 1044)
Proportion of total positive tests occurring in over 60s - 24.1% (up from 21.1%)
First COVID +ve hospital admission in last week – 235 (down from 242)
Number of community acquired COVID inpatients – 392 (up from 377)
COVID +ve ICU patients – 55 (up from 52)

Over the last week, the number of cases has continued to decline, though at a slower rate than during the previous week. Rt for cases has increased somewhat and is around 0.8 and rising. This remains in line with original estimates. The variation in incidence between different LGDs has reduced, with all areas now between 120 and 260 / 100k / 7 days. Testing has decreased a little further over the last week, reflecting decreased demand in the context of adequate supply. Test positivity has again fallen slightly, though not as quickly as case numbers. It therefore remains possible that the fall in cases numbers in the context of reduced testing may over-estimate Rt and the reduction in community transmission. In relation to this, Rt for the over 60s (where testing has been relative more stable) is currently around 0.9.

The number of cases in individuals aged >60 yrs has fallen modestly in terms of absolute numbers but increased again as a % of positive tests; this is likely to reflect reduced testing and cases in younger people as a result of restrictions on schools and universities, which have not returned to previous levels.

NI now has a lower incidence than either England or Wales, though all indicators in NI remain very high compared with ROI.

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Hospital admissions have continued to decline slowly over the last week but remain at a relatively high level, and have not decreased as quickly as hoped at the outset of this period of restriction. This may be related to the relatively higher value of R_t in over 60's discussed above; cases in this age group are the main driver of hospital admissions. Anecdotal evidence suggests that improved treatments may be improving survival but increasing length of stay compared with wave 1, and we are currently exploring this further.

COVID hospital inpatients have fallen even more slowly than admissions and remain at a high level. This is currently a major concern in terms of hospital capacity. ICU inpatients and deaths remain relatively stable.

Overall, R_t is definitely below 1 for cases and for hospital admissions. It is around 1 for hospital inpatients and likely to be a little above 1 for ICU occupancy. This is likely to reflect the initial impact of the NI wide restrictions.

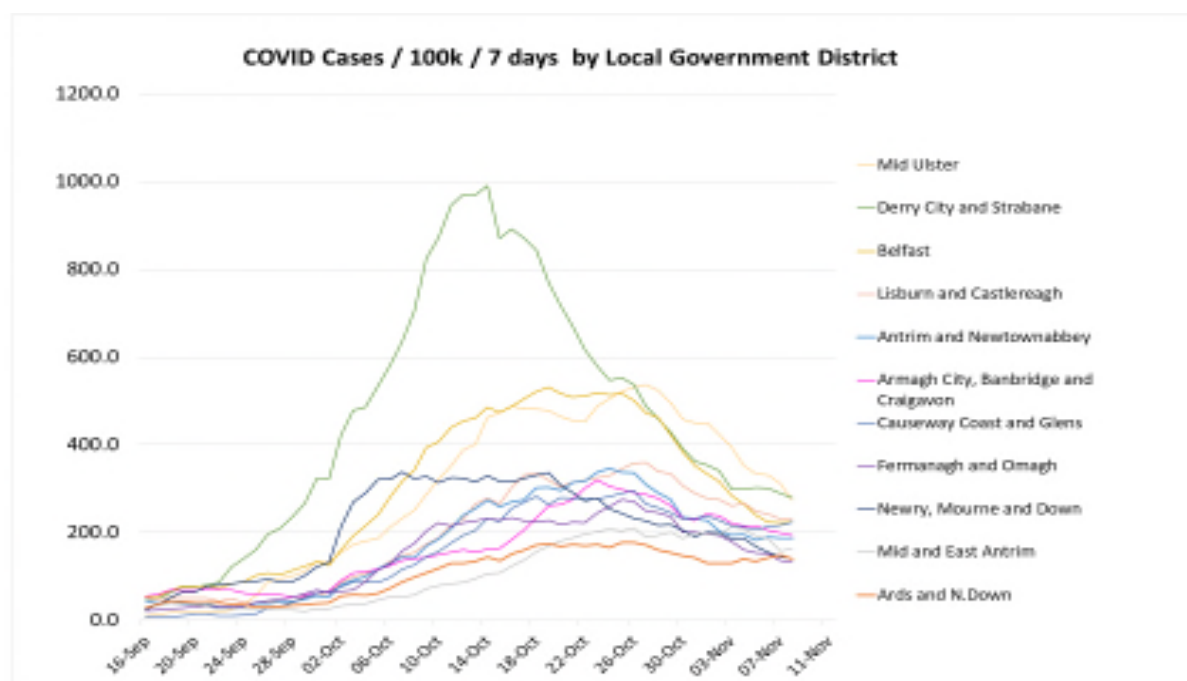
As we approach the end of the current period of restrictions, it remains likely that there will be around 500 cases per day and over 350 inpatients with COVID-19 on 13th November. We anticipate that these numbers will decline further for at least 1 week following any decision to relax restrictions, and depending on decisions it is then likely that upward pressure will resume from a relatively high baseline. The rate of increase will depend on how much R_t increases above 1. Of note, it is unlikely that hospital inpatient numbers will fall to the level they were on 16th October before upward pressure resumes and there is likely to be very limited headroom for relaxation without quickly reaching the point where the hospital system is at the point of being overwhelmed.

Community transmission remains widespread, associated with multiple small clusters rather than a small number of larger outbreaks.

Regional variation in cases:

Variation in LGD has decreased, but all remain over 100/100k over the last 7 days. Most LGDs continue to show a slow decline in cases; the exceptions in general are those with the lowest incidence.

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Determining the value of R_t :

The most common approach to determining R_t during an epidemic is to use mathematical modelling, in particular a compartmental model using a SIR (susceptible-infectious-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_t is also influenced by the choice of input variable. R_t calculated for new COVID-19 cases will not be the same as R_t calculated for hospital admissions, or ICU occupancy, or deaths. There may be a significant lag (2-3 weeks) before a fall in R_t is apparent depending on the input variable(s) used.

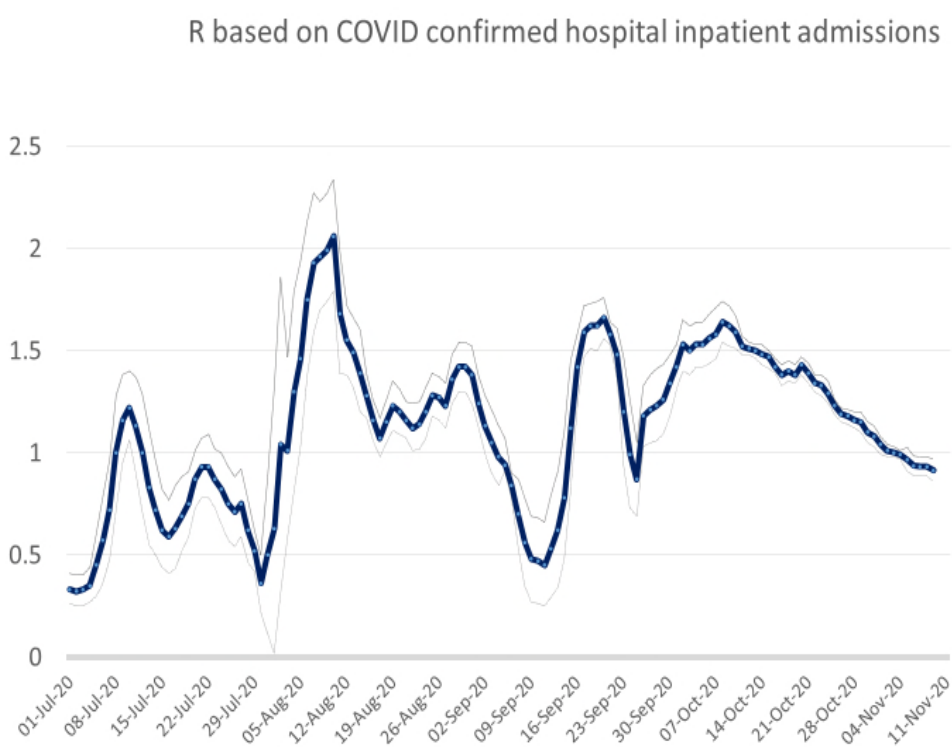
Once the activity of the epidemic is at a low level marked fluctuations in R_t may be observed over short periods of time as a result of localised outbreaks or clusters. Local measures to address the cluster or outbreak will represent the most appropriate response in those circumstances, rather than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

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The modelling group determines R_t each day using a bespoke Northern Ireland SIR model. As its primary input the group uses hospital in-patient admissions with community acquired COVID-19, but also uses a range of other inputs. We therefore have several different values for R_t 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_t for Northern Ireland. R_t 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.

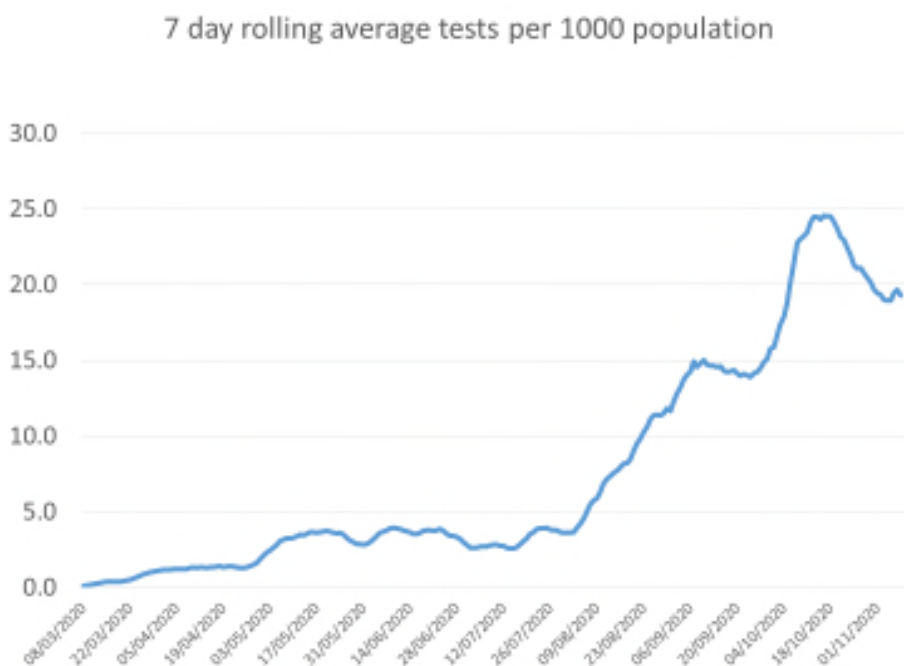
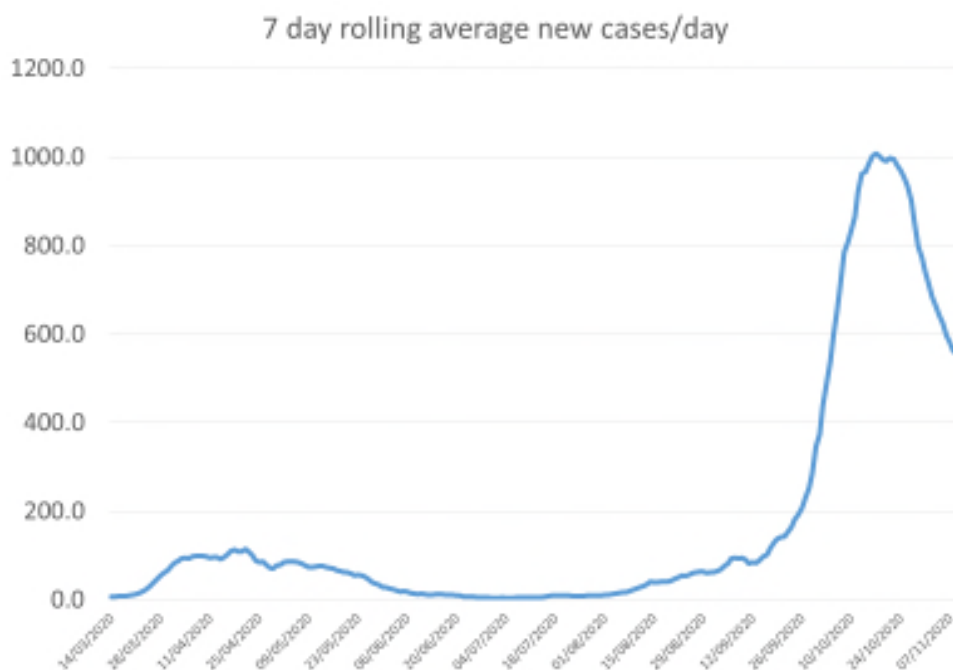
Trends for Northern Ireland:

The graph below shows how R_t has changed over time during the course of the COVID-19 epidemic in Northern Ireland using hospital admissions with community acquired COVID-19 as an example. The value of R_t differs somewhat when other inputs are used, and is currently below 1 for cases (around 0.8), around 0.9 for hospital admissions and above 1 for ICU patients.



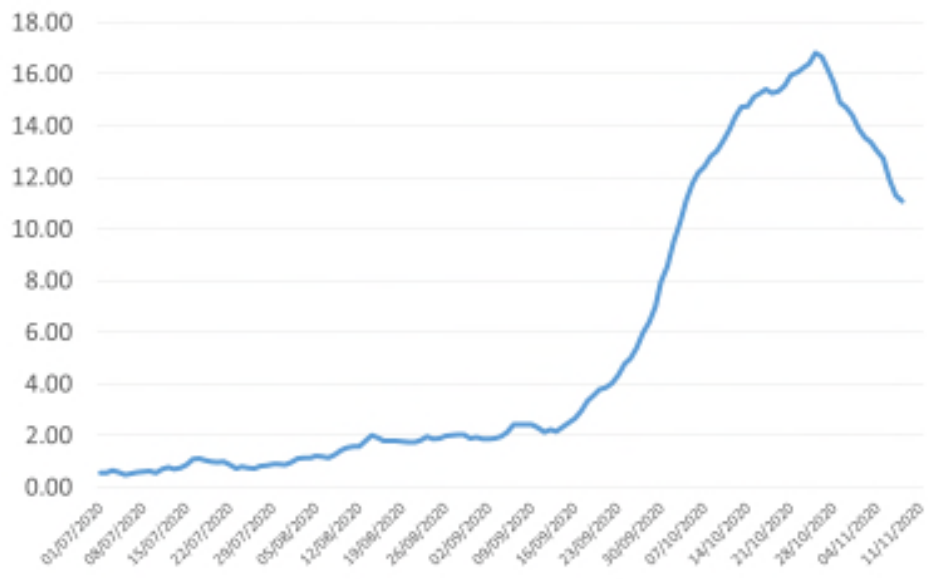
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The graphs below shows that the number of new COVID 19 cases is now declining. Testing has also declined, as a consequence of reduced demand in the context of adequate supply, but now appears to be stabilising. There has been a modest decrease in test positivity, but this is falling more slowly than cases.



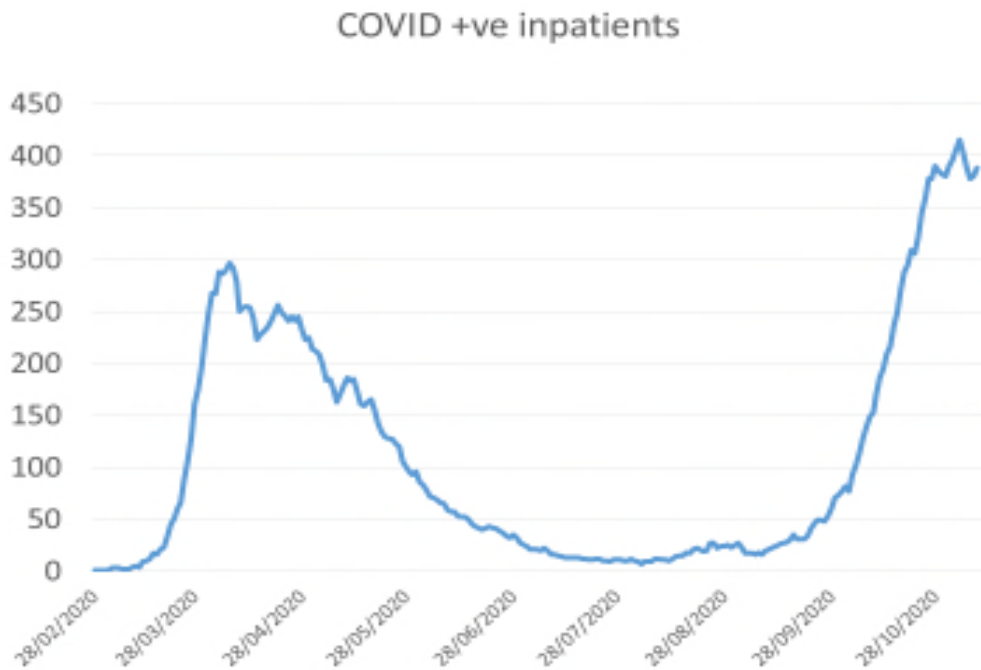
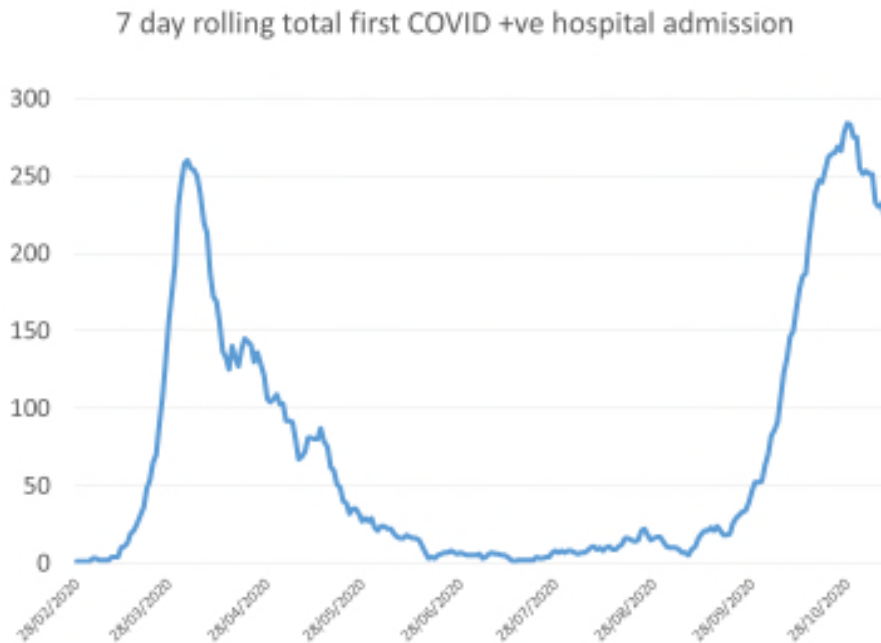
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7 day rolling average test positivity (%)

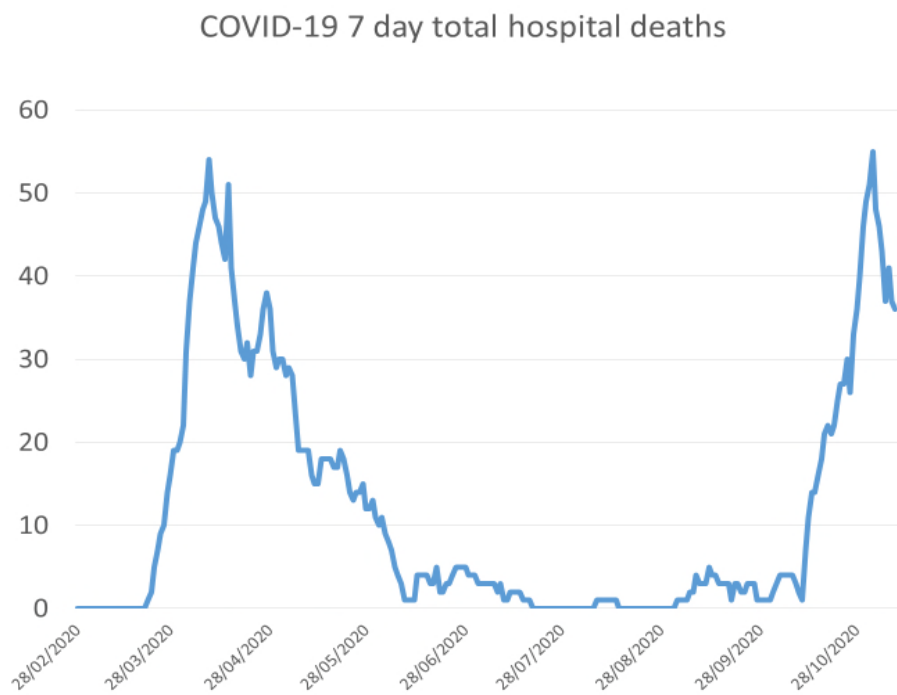
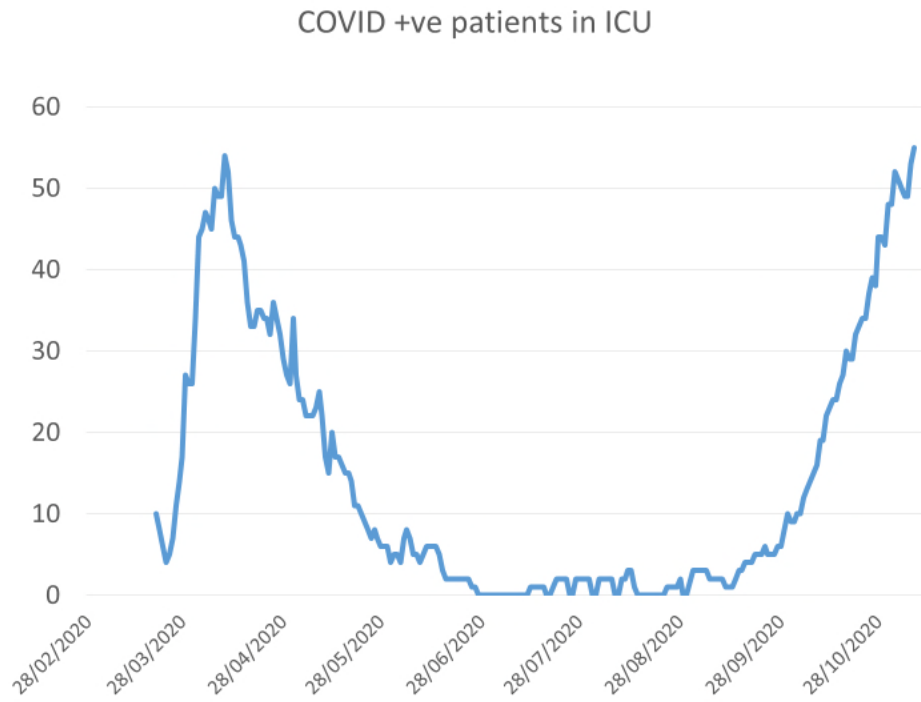


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The following graphs show first hospital admission of COVID +ve patients over a rolling 7 day period and the number of hospital inpatients. Admission numbers are declining slowly. Hospital inpatients remain plateaued around peak, higher than wave 1. This is likely to reflect longer hospital stays due to more effective treatments which reduce mortality. ICU patients and deaths are roughly stable at a high level.



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NI, UK, ROI comparison:

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The following chart shows cases per 7 days / 100 k population across the Common Travel Area. NI now has a lower incidence than either England or Wales, though significantly higher than ROI.

