Are we experiencing a second wave?

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By Stuart McDonald for

COVID-19 Actuaries Response Group – Learn. Share. Educate. Influence.

Summary

With COVID-19 case numbers again rising rapidly in the UK we examine various public data sources and discuss what these suggest about the recent spread of the SARS-CoV-2 virus.

Whilst rising case numbers in isolation might initially have been explained-away by more and better targeted testing, it is now clear that there is a genuine rise in infections.

It has been argued that a rise in infections is not necessarily cause for concern if it is contained within the young and healthy segment of the population, and hence does not result in a marked increase in hospitalisations and deaths. We do not share that view given the unknown long-term consequences of infection. In any event, we present evidence that hospital admissions with COVID-19 are rising sharply and we use these to estimate that R was around 1.6 at the end of August. Crucially, there are signs that COVID-19 deaths in hospitals may now also be beginning to rise.

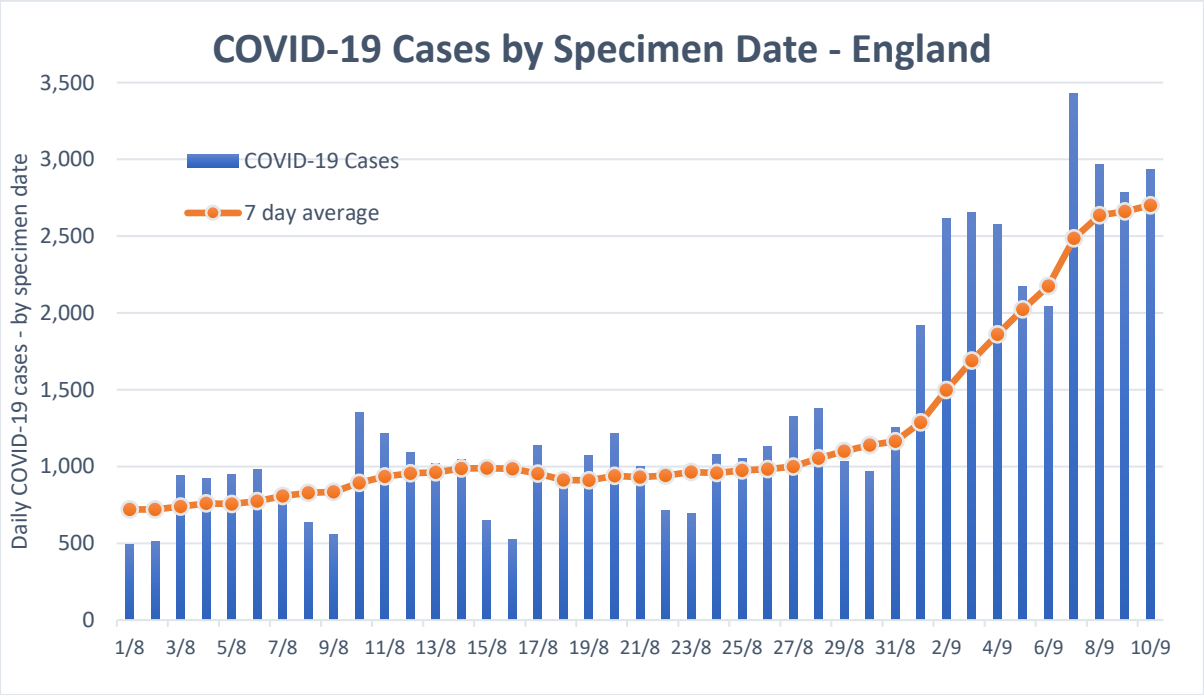
Case Numbers

We use data from: https://coronavirus.data.gov.uk/cases (updated, Tue 15 September, 3:58pm).

For consistency with the rest of this report we use England data rather than the UK as a whole.

We use data by specimen date (the date when the sample was taken from the person being tested) rather than reporting date. This avoids artificial distortions and reporting delays. Genuine patterns remain however, such as fewer tests being conducted at weekends.

We disregard the most recent four days as these are observed to change significantly as new data is reported (for example, of the 2,075 cases reported so far from 11 September, just 34 were reported on the first day, rising to 532 on the second day and so on).



We note a gradual rise through August, with rapid acceleration from 31 August to 8 September.

Other things being equal, the rise in confirmed cases suggests a rapid increase in infections over the last couple of weeks. More and better targeted testing may have driven part of this increase, although the recent rate of growth is too fast for this to be the full explanation.

We take a little comfort from the flattening of the curve in the last few days, though this may be driven at least in part by limitations in the availability of community testing.

It has been argued that a rise in infections is not necessarily cause for concern if it is contained within the young and healthy segment of the population, and hence does not result in a marked increase in hospitalisations and deaths. We do not share that view given the unknown long-term consequences of infection. Nonetheless, we now consider the tangible short-term consequences of infection.

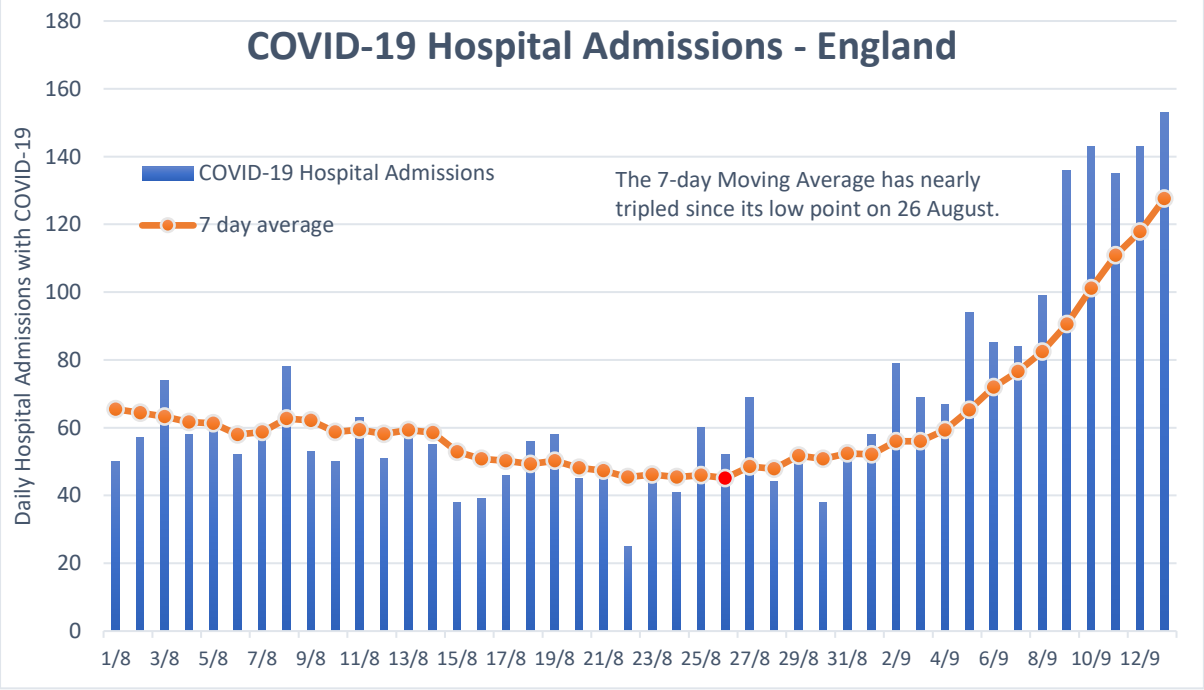
Hospitalisations

We use data from: https://coronavirus.data.gov.uk/healthcare (updated, Tue 15 September, 3:58pm).

We note that the data from Wales is inconsistent with the other nations of the UK (as Wales includes suspected COVID-19 cases, while the others only include confirmed cases). Hence, we work with England rather than UK data. The data includes people admitted to hospital who tested positive for COVID-19 in the 14 days prior to admission, and those who tested positive in hospital after admission.

We use admissions data rather than the total number in hospital as this gives us a clearer picture of recent infections, and hospital capacity is not a concern in the short term while numbers are low.

Hospital admissions are quite effective as a leading indicator, with admission typically occurring between one and two weeks after infection. Whilst this is less up to date than case data, we have greater confidence that observed changes in admissions are a direct consequence of changes in infection numbers. Admissions data is less susceptible to changes in practice than case data. Whilst it is possible that admission criteria are amended if hospitals are under extreme pressure, we are unaware of any such changes during the period in question.



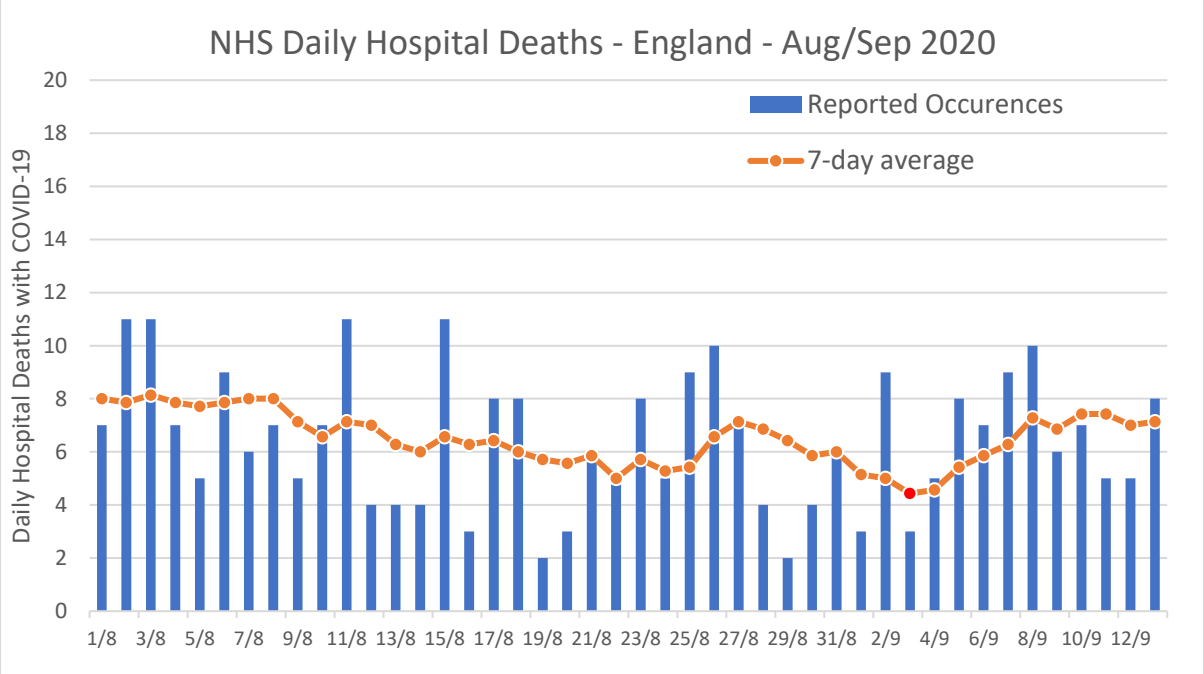
On 26 August, the 7-day moving average reached a low point of 45 admissions per day. Since then it has almost tripled, reaching 128 on 13 September. It is very clear that admissions are rising, and not just reported cases.

Hospital Deaths

We use data from: https://www.england.nhs.uk/statistics/statistical-work-areas/covid-19-daily-deaths/ (COVID 19 total announced deaths 15 September 2020).

Reporting is by date of death rather than date of notification, so we avoid distortions caused by weekends and public holidays.

The data includes patients who have died in hospitals in England and either tested positive for COVID-19 or where no positive test result was received for COVID-19, but COVID-19 was mentioned on their death certificate.



Public Health England reporting was updated in August to include only deaths within 28 days of a positive test for COVID-19. This NHS England data does not include that restriction. The impact on the daily numbers is small and it does not materially bias the trend, which is what we are examining here. The NHS England data is used because we have the full historic record of both date of death and date of reporting. This is important when estimating deaths which have not yet been reported.

The 7-day moving average for deaths in English hospitals appeared to reach a minimum on 3 September and has risen since, though numbers remain low and the average has not exceeded levels seen in August. However, this is not the whole picture.

Incurred but not Reported (IBNR) Deaths

Only around one in five deaths is typically reported the day after it occurs. Most of the others are reported over the following week, with a small number taking longer to be reported. Since we wish to be as up to date as possible with our analysis we can estimate the total number of deaths which occurred on recent days, based on the number which have been reported so far.

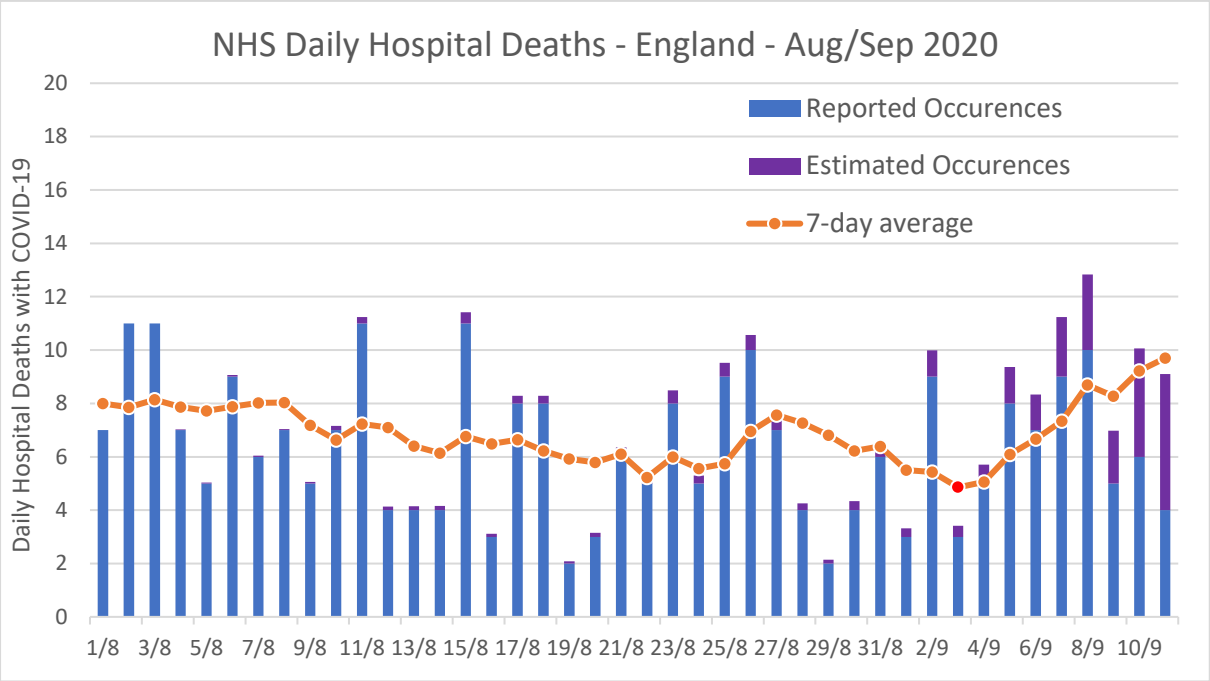
We apply a standard actuarial approach to this problem. For each of the last 60 dates of death we calculate what proportion of the eventual daily total had been reported t days after that date.

Averaging these we find that 18% of the eventual total are typically reported on day one, 26% on day two, 16% on day three, 12% on day four and the rest later.

The cumulative total reported by each day is as per the table below.

Day t	1	2	3	4	5	10	15	20	25	30	35	40
% reported	18%	44%	60%	72%	79%	88%	93%	94%	96%	96%	99%	100%

Using this approach, we can adjust for underreporting of recent deaths to better estimate the real daily totals. We exclude the most recent two days where the scaling up factor is so large as to introduce volatility to the estimates.



The increase in the 7-day moving average is now clearer, with daily hospital deaths having doubled since the low point on 3 September. The increase seems to be following admissions, with a lag of just over a week. Again, we emphasise that the daily death numbers remain low, below July levels, but we expect this to follow the trend in admissions in the short term.

Estimating R – the Rate of Reproduction

As a reminder, key to understanding the spread of a virus is the reproductive rate, "R".

R varies over time so we refer to the rate at time t as R_t (R_0 is the R value at the start of the epidemic).

R is fundamental to the spread of any virus. When it is above 1.0 then each infected person infects more than one other person, and the infectious population grows; below 1.0 and it falls.

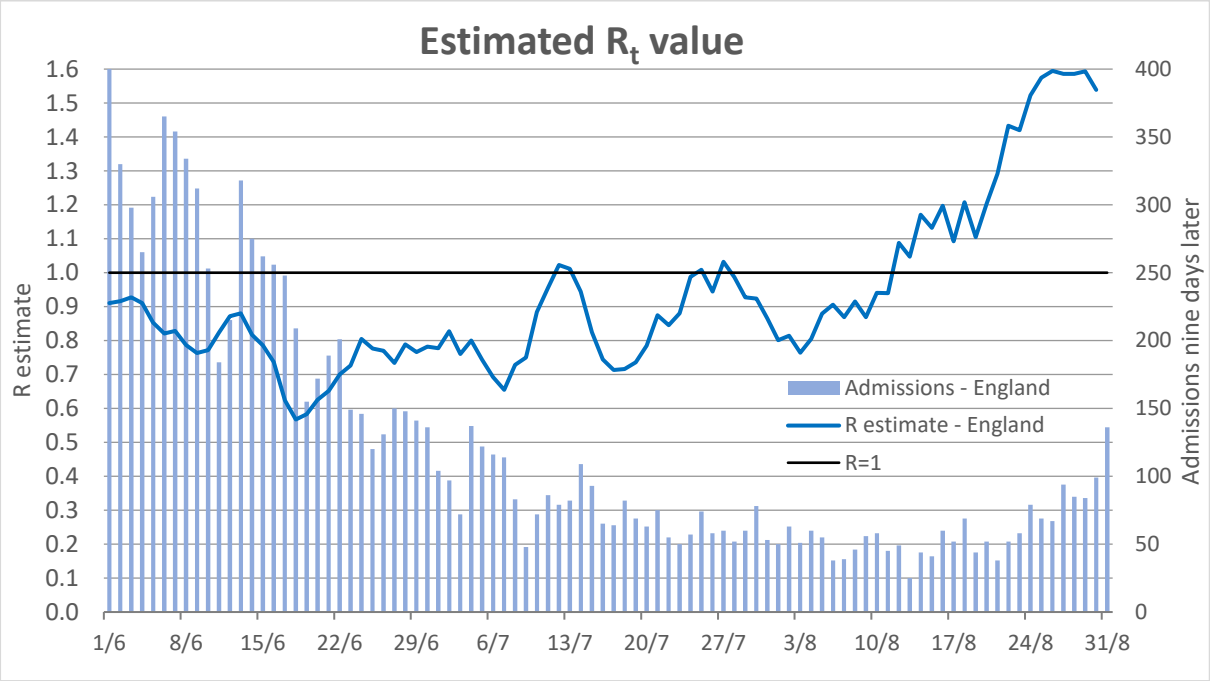
To measure R_t in real time requires extremely widespread testing at a scale which has not been consistently available in the UK. However, we can estimate it by looking at the variation in the rate of events such as hospital admissions and deaths over time.

Here we estimate R_t by examining how the number of hospital admissions is changing, after allowing for the average interval between infection and admission. We assume a 9-day interval between infection and admission, consistent with the recent Royal Society paper on methods of R estimation. A different interval assumption would not change our estimates, only the date to which they apply.

R is a function of the ratio between the number of new admissions and the equivalent number at an earlier point. We use a measurement interval of five days. We average over a seven-day period to reduce the volatility of our estimate caused by random fluctuations.

We believe admissions is currently the best figure to use for such estimation. Case numbers are too open to distortions by external factors, the recent difficulties in accessing community testing being one example. Hospital deaths data, whilst consistent enough to be reliable, is too late in the cycle to be useful, particularly given delays in reporting deaths. Death numbers are also currently very low, which introduces significant volatility unless we assume R is stable over a longer period. Admissions data is consistent, appears to be reliably updated by the government, and will allow a trend to emerge approximately two weeks earlier than for data based on deaths.

Estimated R_t values are illustrated in the following chart.



The number of admissions plotted on the secondary axis are those which occurred nine days after the date shown, i.e. those which have been used in deriving the R estimate. These are shown to give a sense of our confidence in the R estimate – with fewer admissions the estimate is more uncertain.

It appears that R in England may have been above 1.0 from around mid-August. More precise timing is not possible to discern from our method, as explained in our earlier bulletin on R estimation.

Conclusion

Sharp increases in case numbers and COVID-19 hospital admissions imply that R has risen quickly since early August. We estimate that it was around 1.6 during the last week of August, the last point we can estimate from admissions data. We note that this is similar to the estimate of 1.7 (from 22 August to 7 September) from the Imperial College REACT survey, published 11 September.

As well as the now well-documented rise in cases and hospitalisations we note that COVID-19 hospital deaths have also begun to rise in September, albeit from a very low base. This becomes clearer when we apply an allowance for deaths which have occurred but not yet been reported.

Should R remain above 1.0 then the expected trajectory of the pandemic will result, over the coming months, in a return to intense pressure on our health services and a significant increase in mortality.

Whilst it is clear that infections and hospitalisations have been rising, it is not inevitable that they will continue to do so. Changes to public behaviour may be sufficient to reduce R back below 1.0 so that the infectious population begins to fall again.

Such behaviour change might be voluntary, as concern about the growing epidemic increases, or may result from targeted measures like local lockdowns and more general restrictions such as the "rule of six" we have seen introduced in recent days.

Crucially, R appears to be lower than was observed in February and March, so there should be more time to test the effectiveness of various interventions, potentially avoiding the need for a second lockdown.

Stuart McDonald
15 September 2020

References

Estimating R for the UK

https://royalsociety.org/-/media/policy/projects/set-c/set-covid-19-R-estimates.pdf

https://www.imperial.ac.uk/medicine/research-and-impact/groups/react-study/real-time-assessment-of-community-transmission-findings/