Coronavirus (COVID-19): Analysis

Coronavirus (COVID-19): modelling the epidemic in Scotland (Issue No. 10)

Background

This is a report on the Scottish Government modelling of the spread and level of Covid-19. This updates the previous publication on modelling of Covid-19 in Scotland published on the 16 July 2020. The estimates in this document help the Scottish Government, the health service and the wider public sector plan and put in place what is needed to keep us safe and treat people who have the virus, e.g. to decide how many Intensive Care Beds (ICU) we need available for Covid patients.

This edition of the research findings also looks back over the period of the epidemic from February 2020 to the present time.

Key Points

- Modelling by the Scottish Government estimates that on 17 July there were around 40 new infections and 500 people in Scotland who could be infectious with Covid-19. Both of these numbers have fallen significantly in the last week, with daily new infections reducing by 99.8% since the peak of the epidemic.
- The modelling forecasts that the number of infectious people, the number of cases, hospital and ICU use and deaths are all likely to continue to fall over the next two weeks.
- We currently use the value of R to talk about Covid-19 in Scotland. On 22 July, R in Scotland was estimated to be between 0.6 & 0.9.
- These forecasts were based on estimates of moving in to phase 2 guidance, implemented from 18 June. Changes associated with the move to phase 3 will not be fully seen until early August. The longer term forecasts will be closely monitored against actual cases over the next few weeks as the situation changes.

- Since the first modelled cases in February the epidemic has lasted 22 weeks during which an estimated total of 414,000 people have been infected with Covid in Scotland – 7.6% of the population.
- Modelling shows the peak week for the spread of Covid-19 was 16-22 March with an estimated number of 99,000 people becoming infected.
- The peak in hospital occupancy occurred on 19 April, and ICU occupancy on 12 April[1].

Overview of Scottish Government Modelling

Epidemiology is the study of how diseases spread within populations. One way we do this is to use our best understanding of the way the infection is passed on and how it affects people who catch it to create a mathematical simulation. Because people who catch Covid-19 have a the relatively long period in which they can pass it on to others before they begin to have symptoms, and that the majority of people infected with the virus will experience mild symptoms, this “epidemiological modelling” provides insights into the epidemic that cannot easily be measured through testing e.g. of those with symptoms, as it estimates the total number of new daily infections and infectious people including those who are asymptomatic or have mild symptoms.

Modelling also allows us to make short-term forecasts of what may happen with a degree of uncertainty. These can be used in health care planning.

Modelling, based on deaths, suggests that the first infections in Scotland took place around 16 February, and by the time that the first confirmed case was positively identified on 1 March, 890 (400 – 1,650) people had already been infected in Scotland.

Since the first modelled infections in February the epidemic has lasted 22 weeks, during which an estimated total of 414,000 (329,500 – 518,500) people have been infected with Covid in Scotland – 7.6% (6.0 – 9.5%) of the population. This modelling derived estimate forms part of the picture on the number of people who have had Covid in Scotland[2].

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[1] https://www.gov.scot/publications/coronavirus-covid-19-trends-in-daily-data/

[2] A report on a seroprevalence pilot study published by Public Health Scotland is also available. See https://beta.isdscotland.org/find-publications-and-data/population-health/covid-19/enhanced-surveillance-of-covid-19-in-scotland/

The estimated peak week for the spread of the infection was 16-22 March with 99,000 (79,000 – 123,000) people becoming infected. The peak in hospital occupancy occurred on 19 April, and ICU occupancy on 12 April.

Our modelling suggests weekly deaths peaking in the week of 13-19 April, with a simulated 690 (610 – 785) Covid-related deaths occurring during this period. This corresponds closely to the peak seen in the actual data, which occurs in the same week, at 625[3]. The forecast deaths from the model closely followed the trends seen in real data (Figure 1) providing confidence that the model has accurately reflected the progression of the epidemic.

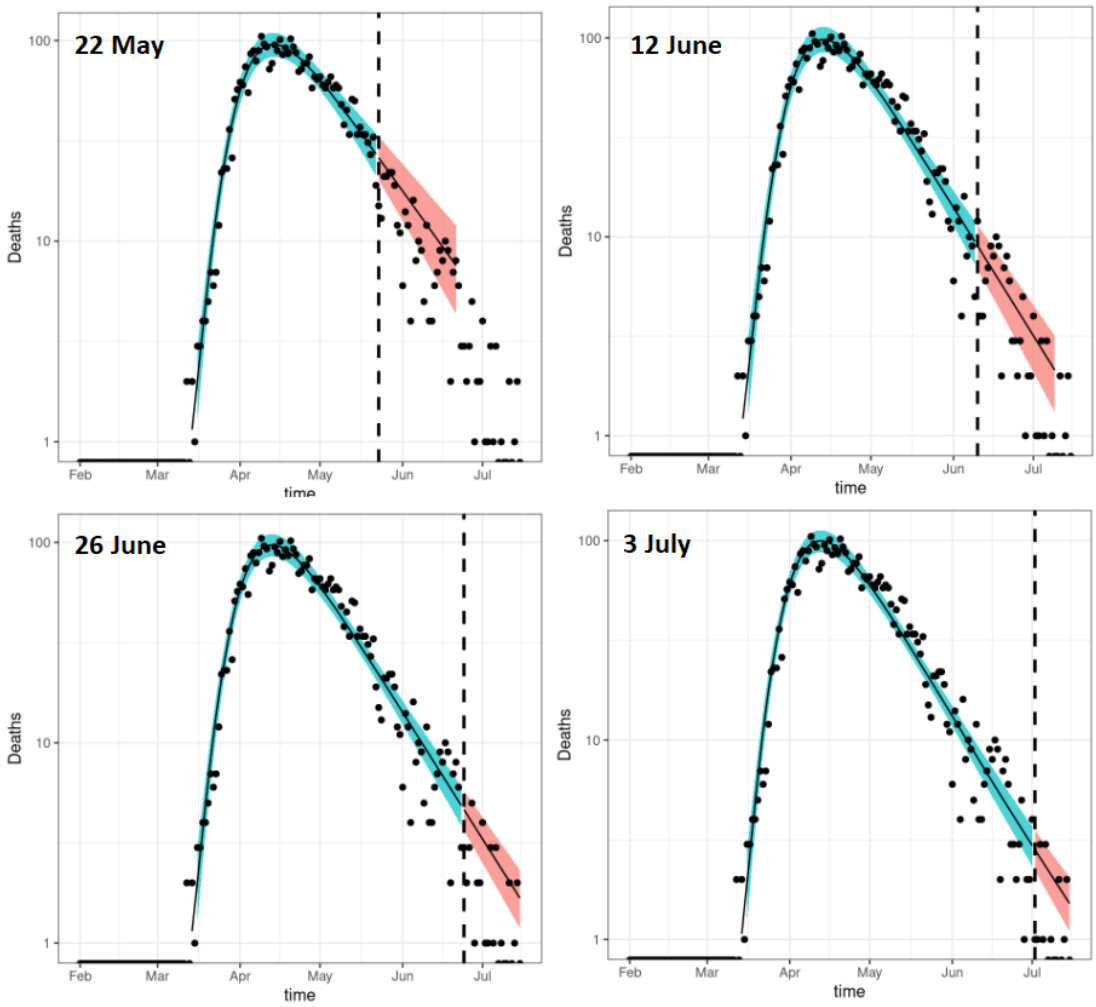


Figure 1. Results from the model over four weeks, showing estimated deaths (blue) forecast deaths (pink) closely followed what was seen in the actual data (dots).

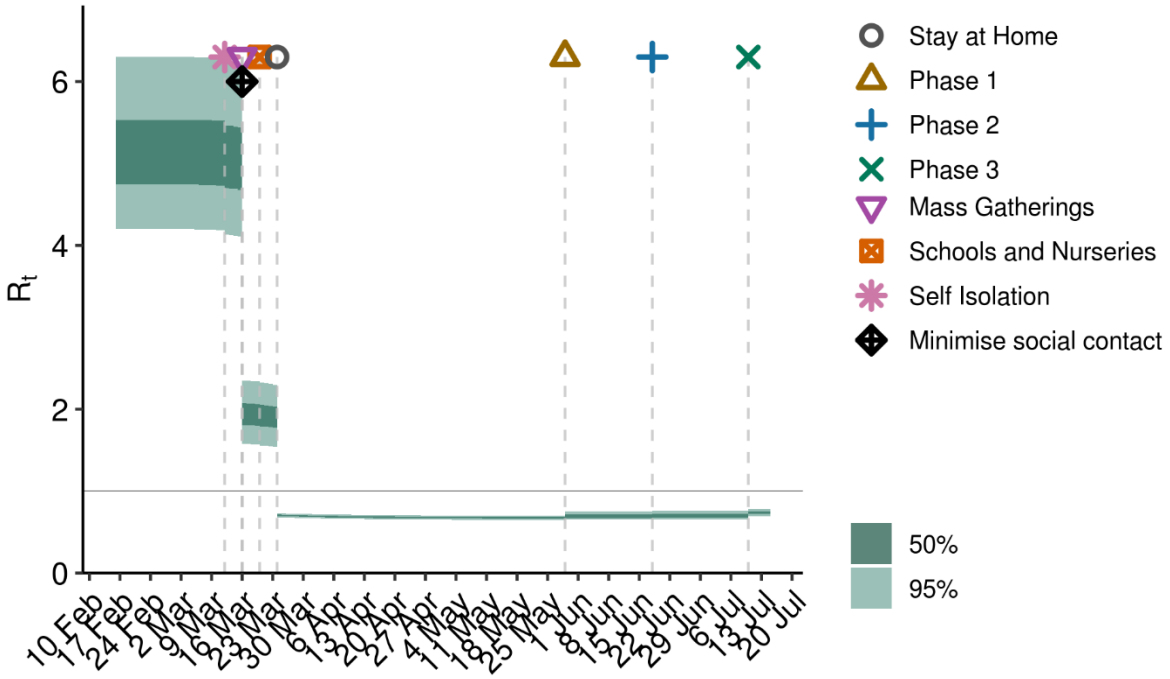
[3] https://www.nrscotland.gov.uk/covid19stats

The current period of modelling shows we are seeing a low level of infections in Scotland, not seen since late-February. Based on modelling, an estimated 5 million people in Scotland have not yet been infected with Coronavirus - the majority of the population. This is why measures such as physical distances as laid out in "Coronavirus (Covid-19): Scotland's route map through and out of the crisis" are so critical to maintain, particularly as we move towards autumn and winter, when people are likely to be inside more, and light levels and temperature are lower. It is also why continuing to modelling the epidemic, and continually improve how we do this, is a crucial part of how we monitor our progress and what might happen next.

What the modelling tells us

Figure 2 shows how R_t has changed since February. Before the "stay at home" restrictions were put in place R_t was above 1, and most likely to have been between 4 and 6 before any interventions were put in place.

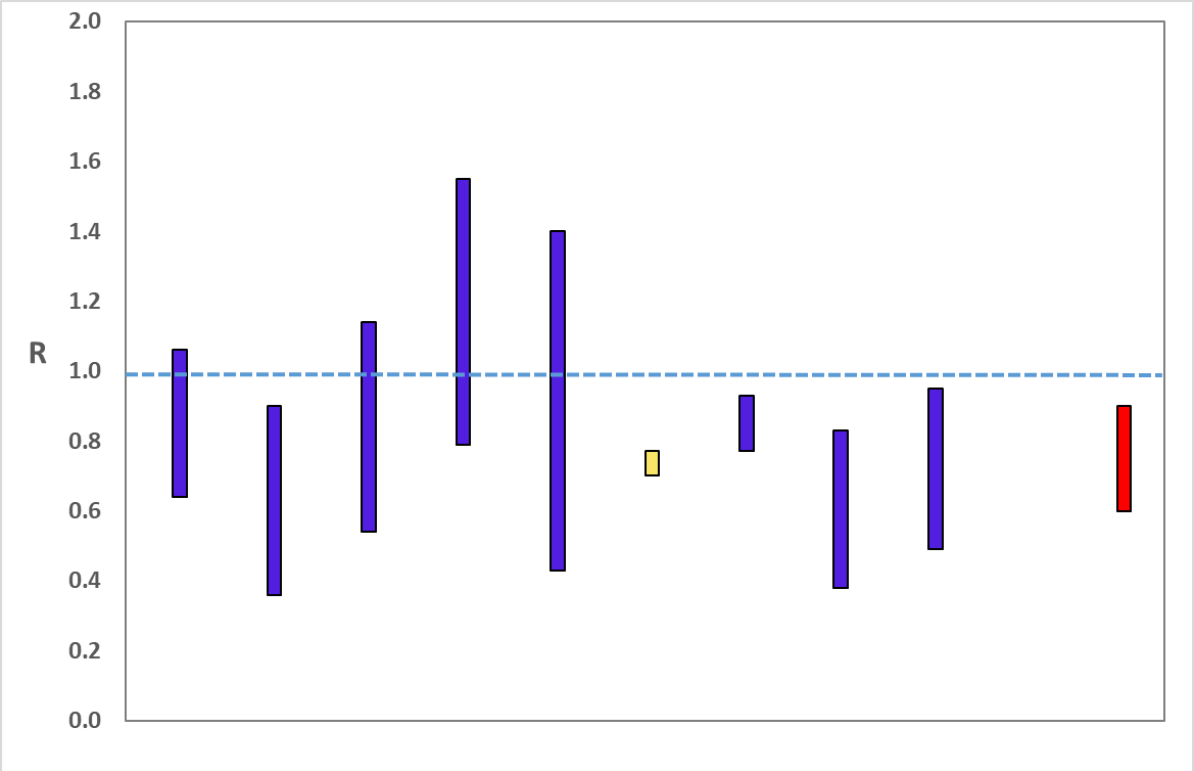
Figure 2: Trends in R_t for Scotland, 2020



Source: Scottish Government modelled estimates using Imperial College model code; actual data from https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/general-publications/weekly-and-monthly-data-on-births-and-deaths/deaths-involving-coronavirus-covid-19-in-scotland

The R_t value estimated by the Scottish Government falls within the range of values estimated by other modelling groups and considered by SPI-M and SAGE (Figure 3). SAGE's consensus view, as of 22 July, was that the value of R_t in Scotland was between 0.6 and 0.9.

Figure 3. Estimates of R_t for Scotland, as of 22 July, including 90% confidence intervals, produced by SAGE. The estimate produced by the Scottish Government is the 6th from left (yellow), while the SAGE consensus range is the right-most (red).



Source: Scientific Advisory Group for Emergencies (SAGE).

The Scottish Government's epidemiological model estimates that on 17 July there were around 40 new cases of Covid-19 in Scotland (see Table 1), while the number of people in Scotland who could be infectious on this date was around 500 (see Table 2). Our estimates indicate this number is declining by around 25% each week, and will continue to decline at a similar rate over the next two weeks.

Table 1: Estimated daily number of new Covid-19 cases in Scotland.

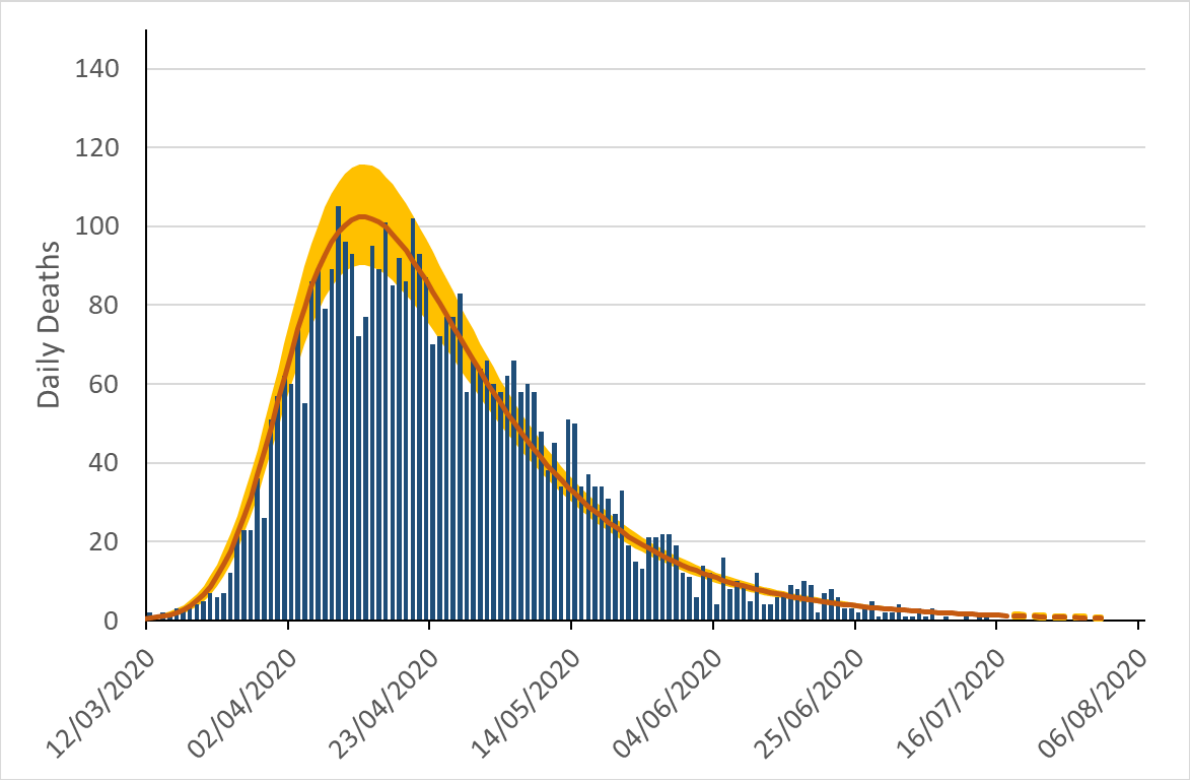
Estimated new daily infections			
Date	Mid	Lower	Upper
15 May	800	650	1,000
22 May	560	440	700
29 May	400	310	500
05 June	280	210	360
12 June	200	150	260
19 June	140	100	200
26 June	100	70	150
03 July	70	50	110
10 July	60	40	80
17 July	40	30	60
24 July	30	20	50
31 July	20	10	40

Table 2: Estimated number of people in Scotland who could be infectious.

Estimated Infectious Pool				
Date	Mid	Lower	Upper	Percentage Weekly Change
15 May	10,400	8,400	12,800	-
22 May	7,200	5,700	8,900	-31%
29 May	5,000	3,900	6,300	-31%
05 June	3,500	2,700	4,500	-29%
12 June	2,500	1,900	3,500	-29%
19 June	1,800	1,300	2,400	-29%
26 June	1,300	900	1,800	-28%
03 July	900	600	1,300	-28%
10 July	700	400	1,000	-28%
17 July	500	300	800	-25%
24 July	400	200	600	-25%
31 July	300	200	400	-25%

Figure 4 shows the epidemiological model forecasts of daily deaths produced by the Scottish Government, given the present set of interventions. This measure of the epidemic has declined to a very low level.

Figure 4: Scottish Government short-term forecast of the number of deaths from Covid-19 in Scotland, based on actual data (17 July).



Source: Scottish Government modelled estimates using Imperial College model code; actual data from https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/general-publications/weekly-and-monthly-data-on-births-and-deaths/deaths-involving-coronavirus-covid-19-in-scotland

The short-term forecast of hospital beds required by Covid 19 patients in Scotland over the next two weeks is not included this week, as the numbers have fallen to a low level. Should these numbers begin to rise significantly this forecast will be reintroduced.

The medium term forecasts presented here will continue for the time being, and are fitted to trends in the historical data. Because it takes time for infected people to develop symptoms, require hospitalisation, and either die or recover, we will not fully see the effect of moving into phase 3 in our modelling until early August.

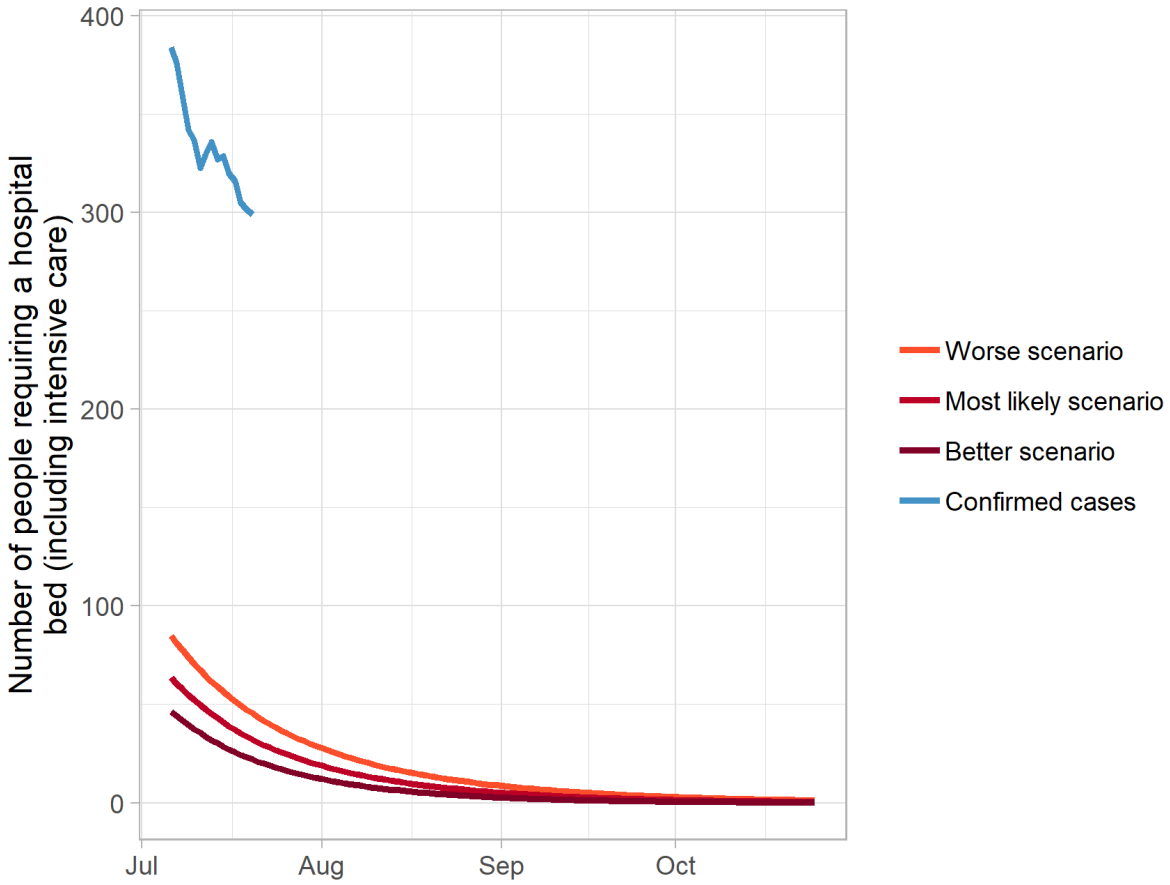
The medium-term forecasts produced by the Scottish Government (Figure 5 and 6) using the logistics model show a steady decline in the number of people requiring hospitalisation from Covid-19. The logistical model also provides us with a medium term forecast of the number of ICU beds which may be required (Figures 7 and 8).

The three scenarios presented in Figures 5 and 6 for hospital demand and Figure 7 and 8 for ICU demand are for different levels of daily infections. In each case, we translate these into logistical forecasts which are used for planning purposes.

The Worse and Better scenarios should not be considered an upper and lower bound respectively. It is important to note, in particular, that for planning reasons many of the assumptions used are deliberately precautionary, and so it is reassuring that actual case data are lower than the modelled estimate in the past, as is the case with the ICU admissions demand forecast in figures 6 and 8.

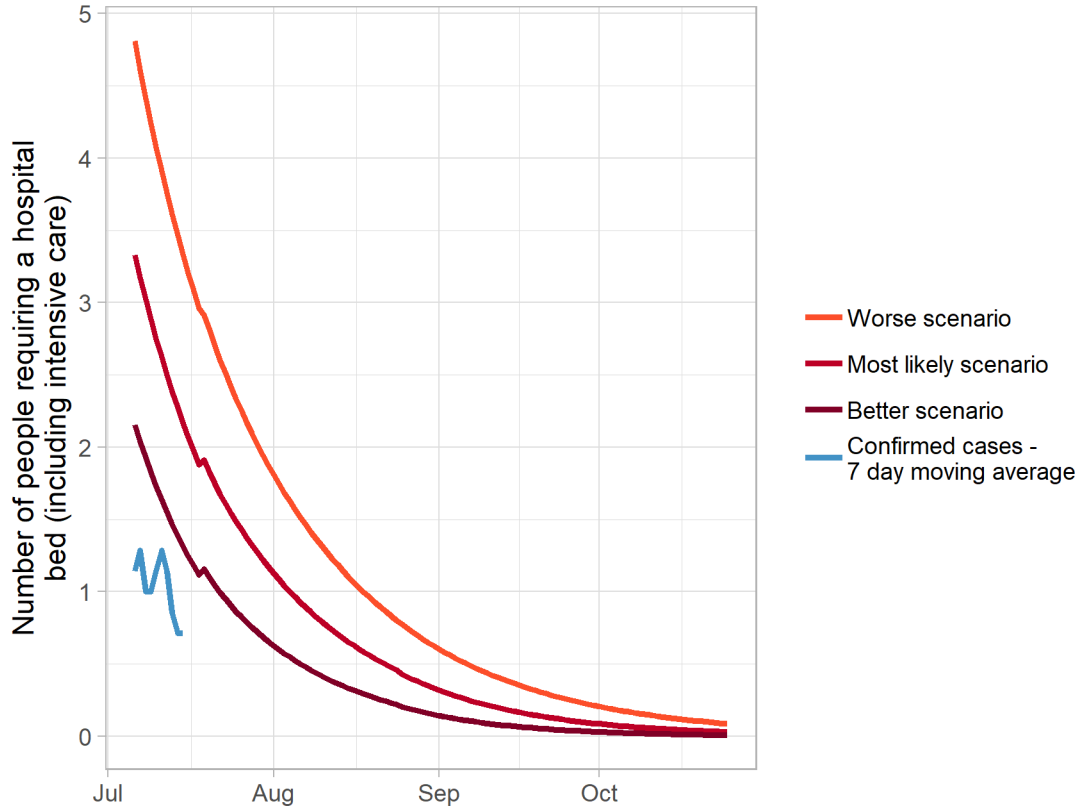
The number of hospital beds in use (Figure 5) is tracking above the worse scenario. This is likely to be due to Covid patients remaining in hospital for longer than expected.

Figure 5: Logistical model medium term forecast of the total number of people requiring a hospital bed from Covid-19 in Scotland, 17 July. Capacity is around 4,000.



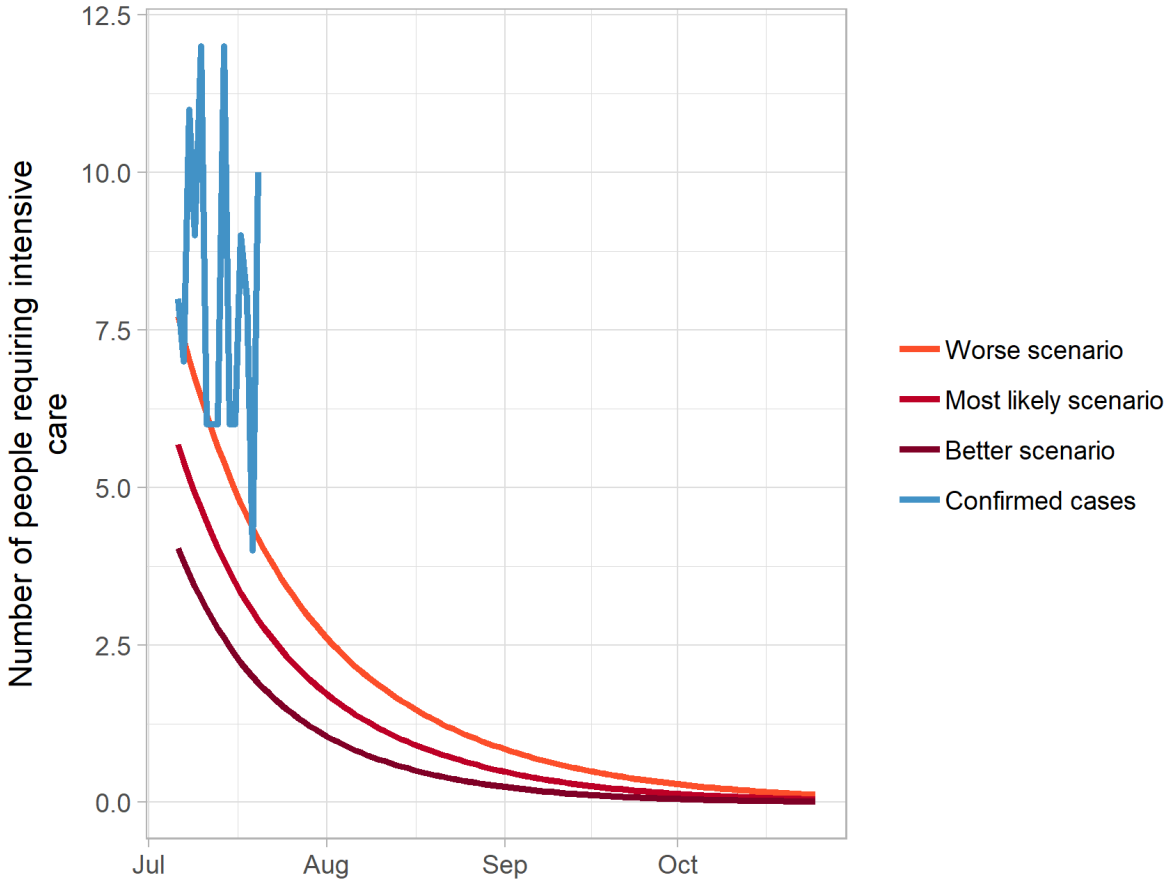
Source: Scottish Government modelled estimates using outputs from the Imperial College model code,
Source: Actual data from https://www.gov.scot/publications/coronavirus-covid-19-trends-in-daily-data/

Figure 6: Logistical model medium term forecast of admissions of people requiring a hospital bed from Covid-19 in Scotland, 17 July.



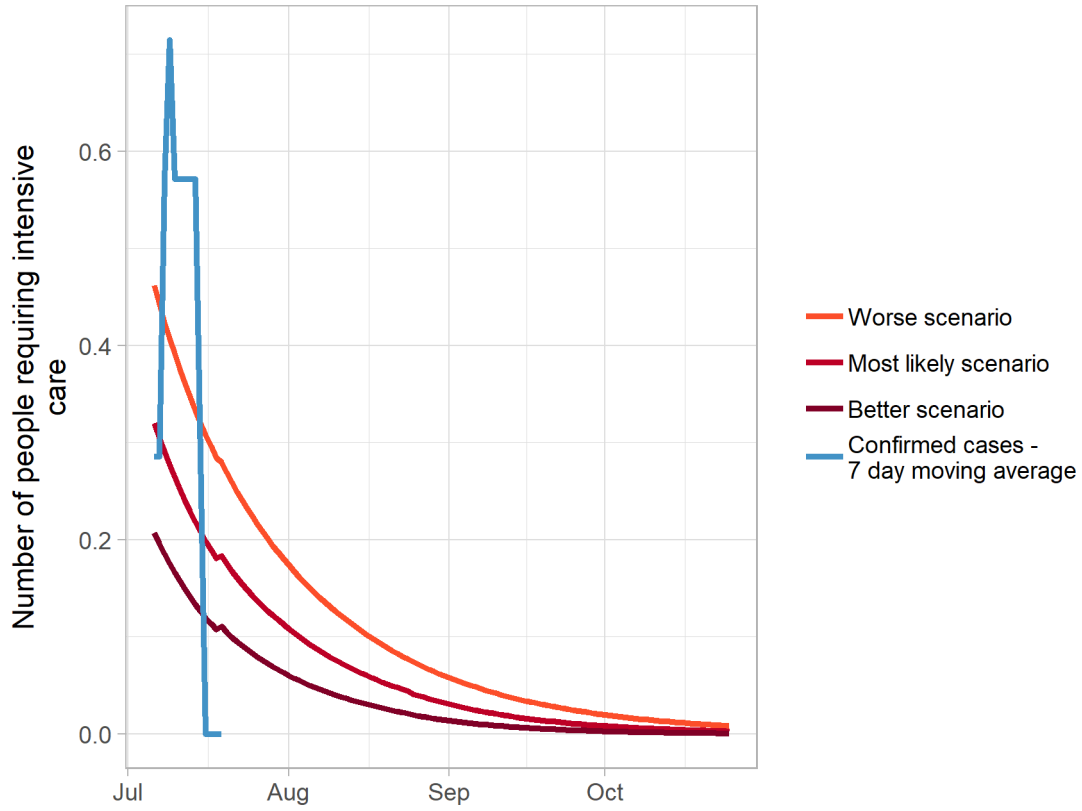
Source: Scottish Government modelled estimates using outputs from the Imperial College model code,
Source: Actual data from https://www.gov.scot/publications/coronavirus-covid-19-trends-in-daily-data/

Figure 7: Logistical model medium term forecast of total number of people requiring an intensive care bed from Covid-19 in Scotland, 17 July. Capacity is around 700.



Source: Scottish Government modelled estimates using outputs from the Imperial College model code,
Source: Actual data from https://www.gov.scot/publications/coronavirus-covid-19-trends-in-daily-data/

Figure 8: Logistical model medium term forecast of admissions of people requiring an intensive care bed from Covid-19 in Scotland, 17 July.



Source: Scottish Government modelled estimates using outputs from the Imperial College model code,
Source: Actual data from https://www.gov.scot/publications/coronavirus-covid-19-trends-in-daily-data/

What next?

The modelled estimates of the numbers of new cases and infectious people, along with how this relates to hospital and ICU requirements will be published each week. Where appropriate, R_t will also be provided. Further information can be found at https://www.gov.scot/coronavirus-covid-19

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