Note added for release

Please note that the paper "Reasonable worst-case planning scenario – 21 May 2020", also released under SAGE 38, was amended shortly after SAGE, in order to reflect actions agreed within the meeting. Where there are conflicting figures with that paper, those from the "Reasonable worst-case planning scenario – 21 May 2020" should take precedence.

SPI-M-O: Planning and reasonable worst-case scenarios

Date: 20th May 2020

Summary

1. Five theoretical modelling scenarios were agreed between SPI-M-O, SAGE, Cabinet Office's Civil Contingencies Secretariat.

2. Three scenarios assumed R remains approximately equal to 1 from three dates (18th May, 1st June, and 1st July), and all showed a flat line at different levels of incidence for all metrics of interest (infections, new patients admitted to hospital and ICU, beds occupied in hospital and ICUs, and deaths).

3. Two scenarios assume increases in R up to 1.7, reflecting an easing of social distancing measures from either 1st June or 1st July, after which R remained at 1.7 for four weeks. At this point, R reduced to 0.7 to represent the reimplementation of behavioural and social interventions (BSIs) until incidence decreased to levels comparable to those seen on either 1st June or 1st July when R returns to approximately 1 for the rest of 2020.

4. Four modelling groups submitted reports looking at these two scenarios; Bristol / Exeter, Imperial, LSHTM, and Warwick and all groups showed similar profiles across the time period. All groups felt an increase of R to 1.7 was plausible and could be reached through several different combination of relaxing BSIs. One of the models for the scenario where R increased to 1.7 for four weeks from 1st June was chosen as the reasonable worst-case scenario (RWCS).

5. Key general messages:

    a. Incidence at the date R increases above 1 largely determines the magnitude of the subsequent peak. The lower incidence can be driven down, the smaller any second peak will be.

    b. If R increases substantially above 1 from 1st June for several weeks, the resulting peak will be of a similar magnitude to that seen between March and May 2020; this is because, despite mitigations, the starting population incidence is much higher than it

was in March. While R may not be as large as it was in March, the initial infection rate is much higher so the peak in hospitalisations and deaths scales accordingly.

c. LSHTM's more pessimistic assumptions about the decline of cases from mid-May until 1st June or 1st July illustrate the importance of starting levels of incidence. Higher incidence on June 1 and July 1 lead to much larger peaks if R increases above 1 and LSHTM's metrics scale accordingly.

Planning Scenarios

6. HM Government requires scenarios of the future progression of the epidemic that allow for short, medium, and longer-term planning for a range of operational considerations, including NHS capacity. It is impossible to model this with any degree of precision as it will be highly dependent on the timing and nature of policy decisions that are taken and the behaviour of individuals over the time range considered. It will also be affected by random fluctuations, which will become more significant when incidence is low. To reflect these fundamental uncertainties, it is important to consider a range of scenarios covering a reasonable set of assumptions.

7. **It is important to note that these scenarios are not forecasts or predictions. They do not represent the full range of possible outcomes and no likelihood is attached to any of these scenarios at this stage. The precise timings and scales of peaks in infection and demand on healthcare, in particular, are subject to significant uncertainty.**

8. Planning scenarios are not designed to be reflect the possible impact of any specific changes but reflect the overall aim of gradually relaxing behavioural and social interventions (BSIs) while attempting to maintain R at or below 1. Scenarios under consideration will model forward incidence based on the current R until:

    i. Change of messages in mid-May pushed R to 1 and remains at R=1 for the rest of 2020

    ii. BSI easing at 1 June pushes R to 1 and remains at R=1 for the rest of 2020

    iii. BSI easing at 1 July pushes R to 1 and remains at R=1 for the rest of 2020

    iv. BSI easing at 1 June pushes R to 1.7 for four weeks, at which point reversal of BSI easing brings R down to 0.7 until incidence levels are similar to those at 1 June, and R returns to 1 for the rest of 2020

v. BSI easing at 1 July pushes R to 1.7 for four weeks, at which point reversal of BSI easing brings R down to 0.7 until incidence levels are similar to those at 1 July, and R returns to 1 for the rest of 2020

9. Scenarios i-iii represent situations where incidence remains broadly stable, with no significant growth or decline in infections, once R=1. In scenarios iv and v, R returns above 1 leading to a second peak in infections (either because of behavioural changes, or because the impact of a policy change leads to more transmission than anticipated).

10. SPI-M-O and the Cabinet Office have agreed that scenario iv will be used as a revised reasonable worst-case scenario (RWCS). It is good resilience practice for Government and local planners to use a RWCS for planning purposes. Such a scenario lays out a plausible scenario which is stretching and challenging, and if planned against, should ensure readiness for most potential manifestations of the risk. **However, we cannot rule out future incidence and, as a result future demand, being higher than this.**

11. Scenarios i and ii were considered in a previous iteration of this document and used the SPI-M-O consensus short-term forecasts to project forward to 18th May and 31st May. After these dates, the assumption that R=1 and remains constant will lead to an approximate flat line epidemic curve and thus similar to the levels predicted by the short-term forecasts. **More details on these scenarios can be found in Annex A.**

Insights from modelling

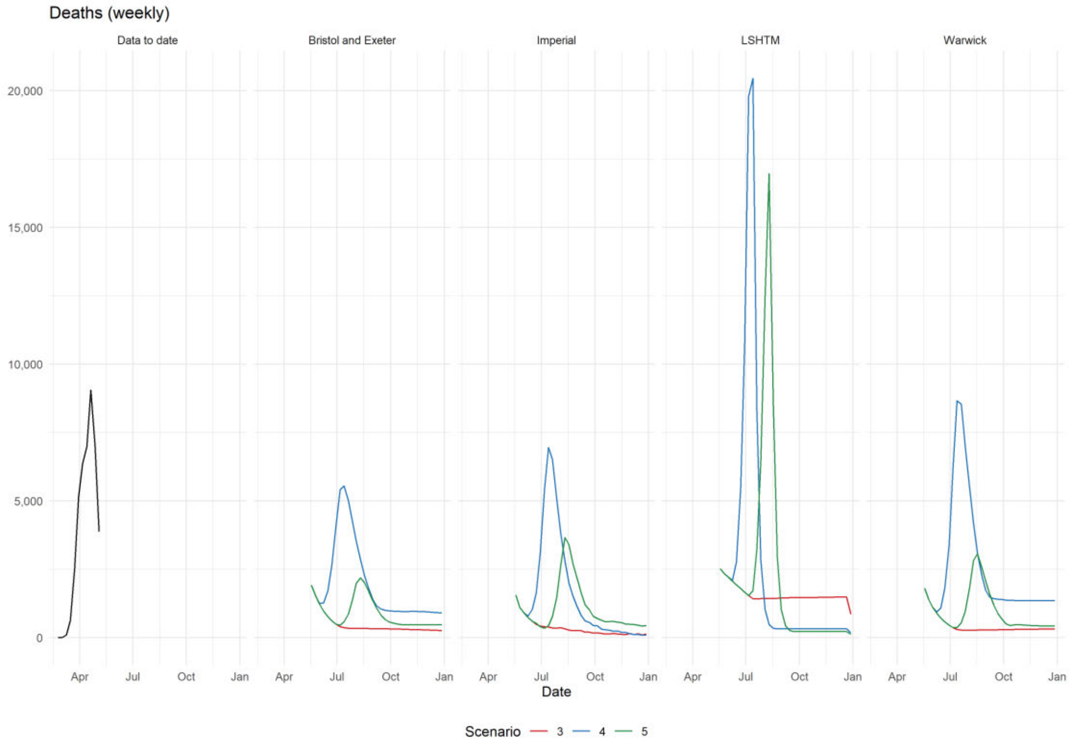
12. Four academic groups (Bristol and Exeter; Imperial; London School of Hygiene and Tropical Medicine [LSHTM]; Warwick) considered how scenarios iii-v impacted on the numbers of infections, new patients hospitalised, new patients admitted to ICU, hospital bed occupancy, ICU bed occupancy, and deaths from 18th May 2020 until the end of the year.

13. All models showed similar patterns for metrics under each scenario but of differing magnitudes.

    a. Scenario iii led to flat incidence from around mid-July for all metrics in all models with no second peak of infections observed, with up to around 1,400 deaths a week in the most pessimistic model (LSHTM).

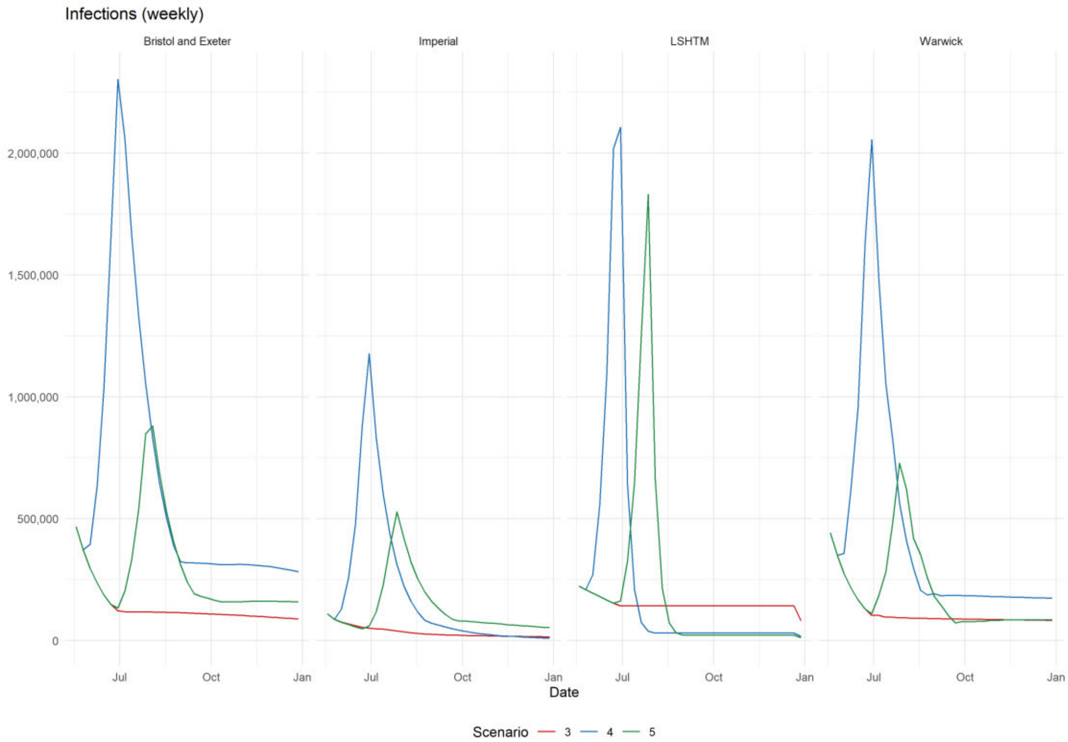
    b. Scenario v led to smaller peaks than scenario iv in all models and for all sensitivity analyses of R for all metrics (**Figure 1**).

Figure 1: Numbers of deaths per week to date and in scenarios 3 (iii), 4 (iv), and 5 (v) for four models and actual data to date



c. Three of the four models showed similar levels of infections across each scenario and sensitivity analyses conducted (**Figure 2**).

Figure 2: Numbers of infections per week in scenarios 3 (iii), 4 (iv), and 5 (v) for four models



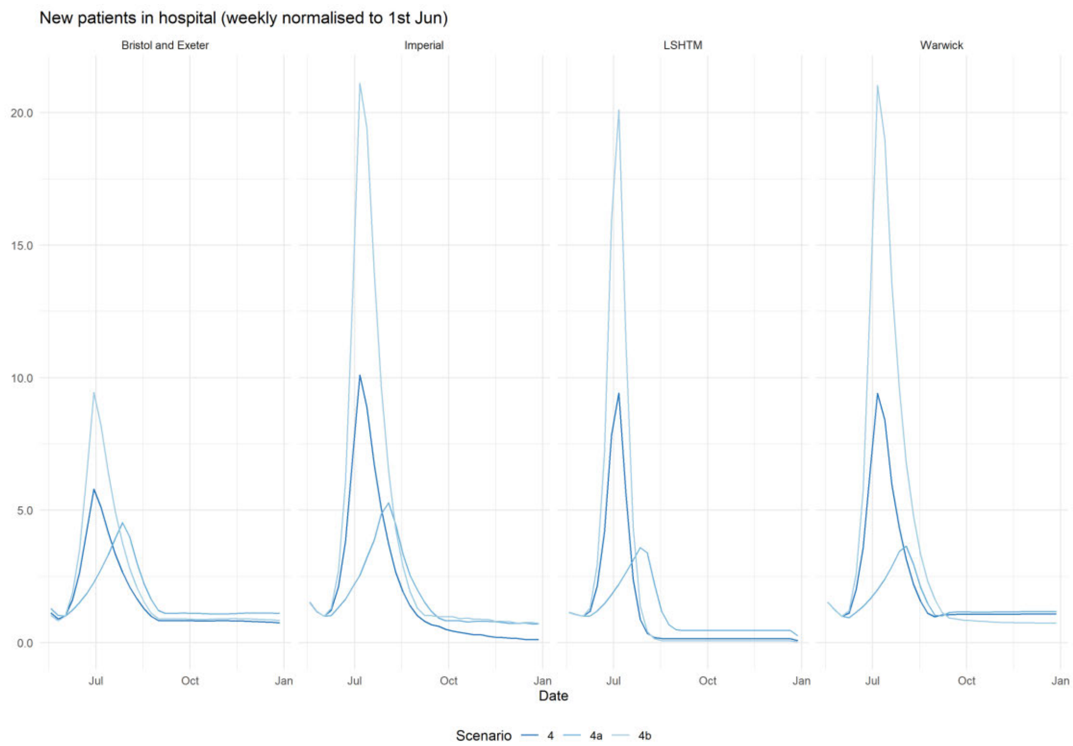
14. LSHTM's model has comparatively higher volumes for most metrics once the R value increases due to their assumed higher incidence of hospitalisations and deaths on 1st June or 1st July. Note that there is considerable variability between groups in the number of infections at these dates as the link between infection (estimated) and hospitalisations (observable) remains uncertain.

15. These differences between models and the differences between scenarios iv and v, show how important the starting level of incidence is when R increases (**Table 1**). If data is normalised to the point at which BSIs are released, the similarities in the models are evident (**Figure 3**).

Table 1: numbers of hospitalisations and deaths per week comparisons between the models (rounded to the nearest 10)

	Weekly hospitalisations		**Weekly deaths**	
Group	w/c 1 June 2020	w/c 29 June 2020	w/c 1 June 2020	w/c 29 June 2020
Bristol and Exeter	5,520	1,850	1,250	490
Imperial	2,030	970	910	420
LSHTM	5,440	4,010	2,210	1,670
Warwick	2,480	1,020	1,120	460

Figure 3: Numbers of new hospitalisations per week, normalised to data as at 1st June 2020 for scenario iv (4) with sensitivity analysis for R rising to 1.2 (4a) and 2.0 (4b).



16. It is possible that the current rate of decline in incidence in the UK population is slowing, leading to a flatter trend of incidence from mid-May into June, meaning the data as at 1st June could be **higher than any of these models predict. If this is the case, the size of second peaks will scale accordingly**.

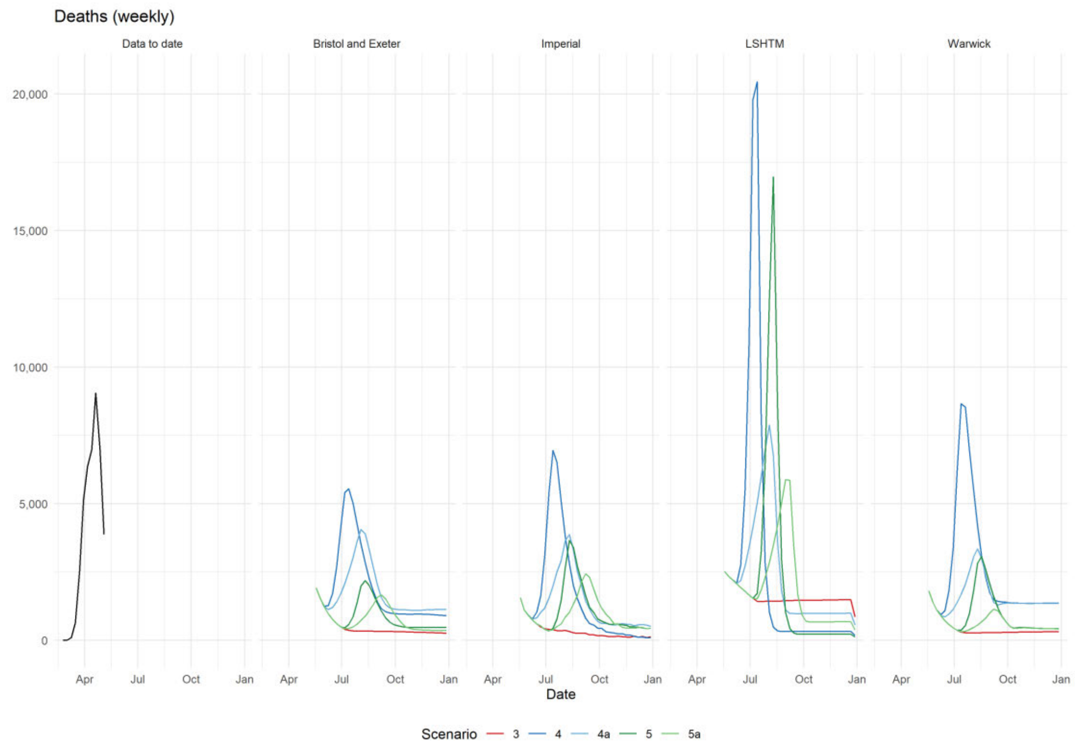
Sensitivity analysis

17. Groups also provided sensitivity analysis for scenarios iv and v where R increased to 2.0 and 2.4 for four weeks before reintroduction of BSIs to reduce R, as well as where R increased to 1.2 for eight weeks before reintroduction of BSIs.

18. There was consensus from all four modelling groups that the scenario iv and v sensitivity analyses where R rises to 2.4 on either 1st June or 1st July was unrealistic to such an extent that it was highly unlikely or almost certain not to happen. It was agreed, however, that R could potentially rise to 2.0 under certain circumstances.

19. In the Imperial and Warwick models, R increasing to 1.2 from 1st June with subsequent BSIs implementation after 8 weeks leads to a similar profile as scenario v (**Figure 4**).

Figure 4: Weekly deaths by scenarios iii (3), iv (4), iv with R increasing to 1.2 at 1st June for 8 weeks (4a), v (5), and v with R increasing to 1.2 at 1st June for 8 weeks (5a)



20. Three of the four models suggest that weekly deaths under **scenario iv would lead to a similar peak in weekly deaths between June and September than that seen from March to May 2020**. By contrast, the peak in weekly deaths under scenario v, where incidence is held lower for longer to 1st July, is closer to 2,500 per week in these three models (see **Figures 1 and 4**).

21. It is possible that the initial increase in incidence under this smaller increase in R to 1.2 may be more difficult to detect and thus take longer to react against. If in this scenario the time taken to react is longer than assumed then the impacts could be considerably larger.

Choice of the scenario for the reasonable worst case

22. Three of the four models appear to have very similar peaks in multiple metrics, and all suggest a second peak under scenario iv of a similar scale to that earlier in the year. The larger values seen in LSHTM model (double the others) arise because of its assumed initial conditions.

23. Bristol and Exeter's model is very similar to both the Imperial and Warwick models, but its simpler composition means it cannot provide the various breakdowns necessary for the RWCS.

24. Warwick's model is slightly more pessimistic than the Imperial one and so has been chosen for the revised RWCS, while also able to provide both geographical breakdowns and the severity estimates needed to support other cross government modelling.

25. Warwick estimates that a second peak could last 8 weeks, if R reaches 1.7. Over the course of the first 16 weeks of the RWCS, another 59,000 deaths, 134,000 new and newly confirmed patients admitted to hospital, and, at the peak, almost 4,000 ICU beds occupied.

26. Although the LSHTM modelling results were more pessimistic, it was agreed that because the scenario modelled was extremely negative largely due to the initial conditions, Warwick's outputs should be used as a RWCS.

Assumptions

27. All models cover the whole of the UK

28. All models use either PHE line list data (Imperial, LSHTM, Warwick), or NHS sitrep data (Bristol/ Exeter) for data on deaths (and equivalent figures for devolved administrations). PHE line list death data is the number of confirmed COVID-19 deaths for hospitals, care homes and the community and it does not include deaths which are not captured in those

headline data. Results here do not include other COVID-19 deaths, or excess deaths from other causes. They are being modelled separately by ONS.

29. The changes in R have been modelled in a policy-neutral way, i.e. they do not reflect any specific assumptions about how contact patterns change in specific settings in the future. Modellers agreed that several different combinations of factors as part of relaxation of BSIs could easily lead to an R of approximately 1.5-1.7. This could be any mix of non-essential retail and more people returning to work, or minimal school reopening with extensive increase in leisure contacts.

30. The values for R chosen after the easement BSIs have been agreed, both amongst SPI-M-O epidemiological modelling experts and in collaboration with SAGE and the Cabinet Office.

31. Estimates of R in the community may have been as low as 0.5-0.6. Under the assumption that a second lockdown would have lower adherence than the first, a higher R of 0.7 after reimplementation of BSIs was chosen. An R of below 1 is required after a peak in infections to induce a decrease in the incidence of infections and relieve pressure on the health and care system before any further relaxation of measures might allow a plateauing of cases and R returning to approximately 1.

ANNEX A: Scenarios i and ii, and estimates of length of stay and severity

33. Scenarios i and ii use the SPI-M-O consensus short-term forecasts are used to project forward to 18th May and 31st May respectively. After these dates, the assumption that R=1 and remains constant will lead to an approximate flat line epidemic curve and thus similar to the levels predicted by the short-term forecasts at these dates.

34. The values in Table 2 below represent SPI-M-O's consensus view on 11th May 2020, with 90% confidence bounds presented in brackets.

Table 2: Forecast for hospitalisations (new and newly confirmed cases in hospital) by nation of the UK and region of England (rounded to the nearest 10)

	Numbers of new hospitalisations when R=1	
Nation of the UK	**18th May** (Scenario i)	**31st May** (Scenario ii)
England	660 (430 – 980)	430 (220 – 940)
Scotland	70 (26 – 110)	60 (10 – 90)
Wales	50 (30 – 70)	40 (20 – 60)
Northern Ireland	50 (10 – 110)	40 (0 – 110)
Region of England		
East of England	80 (40 – 140)	60 (20 – 140)
London	100 (50 – 190)	60 (20 – 190)
Midlands	120 (60 – 200)	90 (30 – 200)
North East and Yorkshire	130 (70 – 230)	90 (30 – 230)
North West	140 (80 – 220)	110 (40 – 210)
South East	80 (40 – 140)	60 (20 – 140)
South West	40 (10 – 70)	30 (0 – 90)

35. It is recommended that any operational modelling conducted using scenarios i and ii for planning is based on these new hospitalisation forecasts.

36. By combining these data with mean length of stay and severity estimates (see Annexes A and B), it is possible to calculate a range of metrics for the time period in each of these scenarios, such as predicted numbers of infections and hospital mortality rate.

37. Figures in these subsequent tables are provided by each modelling group and will differ as they are fitted to various underlying data and the models use different methodologies. Values presented here are the range of parameter estimates based on all returns. They do not represent the parameters for the RWCS but illustrate the range of current estimates used by SPI-M modellers.

38. Estimates for the length of stay were produced by several groups independently, based on different models and using different data sources. Data sources included COVID-19 Hospitalisation in England Surveillance System (CHESS), COVID-19 Clinical Information Network (CO-CIN), NHS situation reports, and data sourced directly from a specific hospital site.

39. While average numbers are presented here, there is a broad distribution with total stays potentially extending to many weeks.

Table 3: Average length of stay for COVID-19 hospitalisation phases

Period	**Mean length of stay (days)**
Hospital (non-ICU) admission to transfer to ICU (HDU/ITU)	1.7 – 2.6
Hospital (non-ICU) admission to death *without* an ICU (HDU/ITU) admission	9.8 – 11.0
Hospital (non-ICU) admission to discharge *without* an ICU (HDU/ITU) admission	7.6 – 12.8
ICU (HDU/ITU) admission to death	7.6 – 12.8
ICU (HDU/ITU) admission to discharge†	9.7 – 15.7

† Does not include any step-down care in hospital (non-ICU) following ICU stay but prior to discharge.

40. While there is a wide range in the estimated proportion of patients dying in different settings within the hospital the overall risk of death is more consistent between the groups in the range 37 – 42%.

Table 4: Severity estimates for stages of COVID-19

Risk	Proportion
Proportion of infections which have symptoms	65 - 90% [a]
Infected hospitalised	1.2 – 2.7%
Hospitalised (non-ICU) patients transferring to ICU (HDU/ITU)	14 – 20%
Hospitalised (non-ICU) patients dying *without* an ICU (HDU/ITU) admission	30 – 39%
ICU (HDU/ITU) patients dying	40 – 68%
All hospitalised patients dying	37 – 42%
Overall infection fatality rate	0.5% – 1.0%

a) NERVTAG range estimate of asymptomatic carriers of SARS-CoV-2. The best current estimates of some members of SPI-M-O is that a higher proportion of asymptomatic carriers is possible, including the group whose results are used in this scenario.

41. Severity estimates by five-year age group have been produced by three separate SPI-M-O groups independently based on their models. Table 5 shows the similarities and differences between the groups for the infection hospitalisation rates, rates of ICU if a patient is hospitalised, and infection mortality rates in hospital.

42. These rates can be used with the new and newly confirmed cases in hospital data (Table 2) to calculate metrics, such as numbers of patients from a particular age group in ICU, or the number of likely infections. To do this, **only one group's set of severity estimates should be used** to maintain the relevant model's internal logic.

Table 5: Severity parameters for each SPI-M-O modelling group by five-year age group

Age group	Group 1			Group 2 (RWCS group)			Group 3		
	Proportion of infections hospitalised	Proportions of hospitalisations requiring ICU	Proportions of infections hospitalised and then dying	Proportion of infections hospitalised	Proportions of hospitalisations requiring ICU	Proportions of infections hospitalised and then dying	Proportion of infections hospitalised	Proportions of hospitalisations requiring ICU	Proportions of infections hospitalised and then dying
0-4	0.1%	28.4%	0.0%	0.4%	1.1%	0.0%	0.1%		0.1%
5-9	0.0%	13.5%	0.0%	0.1%	0.0%	0.0%	0.1%		0.1%
10-14	0.1%	8.7%	0.0%	0.0%	0.0%	0.0%	0.1%		0.0%
15-19	0.1%	7.1%	0.0%	0.1%	16.6%	0.0%	0.1%		0.0%
20-24	0.1%	7.2%	0.0%	0.1%	9.6%	0.0%	0.2%		0.1%
25-29	0.2%	8.6%	0.0%	0.1%	26.8%	0.0%	0.2%		0.1%
30-34	0.3%	11.3%	0.0%	0.2%	23.9%	0.0%	0.2%		0.1%
35-39	0.5%	16.0%	0.0%	0.3%	19.1%	0.0%	0.2%		0.1%
40-44	0.8%	23.0%	0.0%	0.4%	23.6%	0.0%	0.5%		0.2%
45-49	1.2%	32.2%	0.1%	0.7%	18.8%	0.1%	0.5%		0.2%
50-54	1.8%	41.8%	0.2%	1.1%	25.1%	0.2%	1.7%		0.7%
55-59	2.7%	47.9%	0.6%	1.5%	31.7%	0.4%	1.7%		0.7%
60-64	4.0%	46.5%	1.2%	2.1%	26.0%	0.6%	5.8%		2.3%
65-69	6.0%	36.4%	2.2%	5.1%	19.7%	1.9%	5.8%		2.3%
70-74	8.9%	21.9%	3.7%	5.8%	15.7%	3.2%	18.0%		7.2%
75-79	13.1%	9.7%	5.9%	4.9%	7.1%	3.1%	18.0%		7.2%
80+	26.6%	1.4%	13.9%	7.7	1.5%	5.7%	18.0%		7.2%
Average	**2.7%**	**19.2%**	**1.0%**	**1.2%**	**14.2%**	**0.6%**	**2.4%**	**17.0%[a]**	**0.9%**

Proportion of hospitalisations requiring ICU: a) Group 3 do not use an age breakdown so only an average has been provided

43. Short-term forecasts are produced specifically for planning purposes and provide the SPI-M-O's consensus forecast of how the epidemic will develop over the near future (i.e. within the next month). They have been informed by the available data and **implicitly assume that social distancing measures from before 11th May remain in place until the end of May**.

44. SPI-M-O forecast the following key metrics and indicators of pressure on the health service:

    a. **ICU occupancy:** The number of individuals in ICU each day that have confirmed COVID-19.

    b. **Hospital bed occupancy:** The number of individuals in hospital beds, including in ICU, that have confirmed COVID-19.

    c. **Hospital and community deaths, by date of death:** The number of deaths in hospital and the community due to COVID-19 by date of death. Note the coverage of deaths in the short-term forecasts differs from the figures quoted in Table 3 above, which relate to the proportion of hospitalised cases which go on to die.

    d. **New and newly confirmed patients in hospital:** The number of new admissions that tested positive, new admissions that were tested positive prior to admission, and existing patients that tested positive for COVID-19.

45. Each SPI-M-O modelling group produce their own set of forecasts for these four metrics. These are combined by fitting a normal distribution to each prediction and aggregating with equal weights to produce a consensus forecast. Different data definitions across the four nations mean that **it is not possible to sum data for England, Wales, Scotland and Northern Ireland to obtain a UK forecast.**

46. SPI-M-O does not produce consensus forecasts for the number of daily infections due to the amount of uncertainty around the proportion of asymptomatic infections and a lack data to compare the accuracy of forecasts to. In some cases, it would be possible to infer the number of infections using the forecasts for the number of new and newly confirmed patients in hospital and the proportion of infections which are asymptomatic, proportion of symptomatic individuals requiring hospital treatment, and the known time lags.

Table 6: Daily forecasts for the four UK nations for general and ICU bed occupancy, new hospitalisations, and deaths by date of death at 18th and 31st May (rounded to the nearest 10).

		Day when R=1	
	Metrics	**18th May** (Scenario i)	**31st May** (Scenario ii)
England	Total beds occupied	6,690 (5,440 – 8,380)	4,240 (3,140 – 5,970)
	Total ICU beds occupied	1,290 (880 – 1,650)	840 (440 – 1,150)
	New and newly confirmed patients in hospital	660 (430 – 980)	430 (220 – 940)
	Hospital and community deaths, by date of death	260 (140 – 390)	160 (60 – 270)
Scotland	Total beds occupied	910 (560 – 1,090)	680 (430 – 850)
	Total ICU beds occupied	90 (50 – 150)	70 (40 – 120)
	New and newly confirmed patients in hospital	70 (30 – 110)	60 (0 – 90)
	Hospital and community deaths, by date of death	30 (10 – 90)	30 (0 – 180)
Wales	Total beds occupied	550 (320 – 730)	440 (250 – 640)
	Total ICU beds occupied	70 (40 – 140)	60 (40 – 120)
	New and newly confirmed patients in hospital	50 (30 – 70)	40 (20 - 60)
	Hospital and community deaths, by date of death	20 (10 – 70)	20 (0 – 280)
Northern Ireland	Total beds occupied	250 (90 – 720)	210 (60 – 630)
	Total ICU beds occupied	30 (1 – 50)	20 (10 – 50)
	New and newly confirmed patients in hospital	50 (10 – 110)	40 (0 – 110)
	Hospital and community deaths, by date of death	10 (0 – 40)	10 (0 – 40)

47. The ICU occupancy forecasts for Northern Ireland include both confirmed and suspected COVID-19 cases. Data limitations mean the other forecasts for Northern Ireland have not been informed by data. As a result, these forecasts need to be treated with caution and represent SPI-M-O's best assessment using the available data from other parts of the UK.

48. The bed occupancy forecasts depend on the distribution of lengths of stay, which are estimated separately for the different models from different data sources.

Table 7: Daily forecasts for the regions of England for general and ICU bed occupancy, new hospitalisations, and deaths by date of death at 18th and 31st May (rounded to the nearest 10).

		Day when R=1	
	Metrics	**18th May** (Scenario i)	**31st May** (Scenario ii)
East of England	Total beds occupied	750 (610 – 1,090)	540 (400 – 1,050)
	Total ICU beds occupied	150 (70 – 220)	110 (30 – 210)
	New and newly confirmed patients in hospital	80 (40 – 140)	60 (20 – 140)
	Hospital and community deaths, by date of death	40 (10 – 70)	30 (0 – 70)
London	Total beds occupied	1,160 (690 – 1,450)	650 (420 – 840)
	Total ICU beds occupied	340 (220 – 460)	190 (110 – 280)
	New and newly confirmed patients in hospital	100 (50 – 190)	60 (20 – 190)
	Hospital and community deaths, by date of death	30 (0 – 60)	10 (0 – 60)
Midlands	Total beds occupied	1,070 (760 – 1,410)	670 (480 – 1,000)
	Total ICU beds occupied	180 (110 – 260)	110 (50 – 180)
	New and newly confirmed patients in hospital	120 (60 – 200)	90 (30 – 200)
	Hospital and community deaths, by date of death	50 (20 – 90)	30 (0 – 70)

	Metrics	Day when R=1 **18th May** (Scenario i)	**31st May** (Scenario ii)
North East and Yorkshire	Total beds occupied	1,220 (990 – 1,780)	860 (670 – 1,690)
	Total ICU beds occupied	180 (100 – 260)	120 (50 – 260)
	New and newly confirmed patients in hospital	130 (70 – 230)	90 (30 – 230)
	Hospital and community deaths, by date of death	60 (20 – 100)	40 (10 – 100)
North West	Total beds occupied	1,410 (1,100 – 1,930)	980 (750 – 1,670)
	Total ICU beds occupied	180 (11 – 260)	130 (60 – 230)
	New and newly confirmed patients in hospital	140 (80 – 220)	110 (40 – 210)
	Hospital and community deaths, by date of death	50 (20 – 90)	40 (10 – 90)
South East	Total beds occupied	850 (670 – 1,180)	560 (430 – 940)
	Total ICU beds occupied	160 (110 – 220)	110 (50 – 180)
	New and newly confirmed patients in hospital	80 (40 – 140)	60 (20 – 140)
	Hospital and community deaths, by date of death	30 (10 – 60)	20 (0 – 60)
South West	Total beds occupied	310 (240 – 450)	200 (130 – 370)
	Total ICU beds occupied	50 (30 – 80)	30 (20 – 60)
	New and newly confirmed patients in hospital	40 (10 – 70)	30 (0 –90)
	Hospital and community deaths, by date of death	10 (0 – 50)	10 (0 – 80)

Table 8: Data sources used to inform the short-term forecasts

Metric	Nation	Source
ICU bed occupancy	England	NHSE SitRep (all NHS trusts), field "Number of confirmed COVID-19 patients in HDU/ITU at 0800 (Total)".
	Scotland	NHS Scotland SitRep, field "Total number of confirmed COVID-19 inpatients in ICU at midnight"
	Wales	NHS Wales SitRep (all hospitals), field "Total number of confirmed COVID-19 patients in invasive ventilated beds".
	Northern Ireland	NI SitRep, field "ICU Occupancy". Note these are confirmed and suspected cases.
Hospital bed occupancy (including ICU beds)	England	NHSE SitRep (all NHS trusts), field "Total number of beds occupied with confirmed COVID patients at 08:00 (Total)"
	Scotland	NHS Scotland trends in daily COVID-19 data, field "COVID-19 patients in Hospital (including those in ICU) – confirmed".
	Wales	NHS Wales SitRep (all hospitals), field "Total number of confirmed COVID-19 patients in hospital beds".
	Northern Ireland	N/A
Deaths by date of death	England	PHE CHESS line list of deaths (*death_type* is "confirmed").
	Scotland	NHS Scotland deaths line list, file is circulated alongside the Sitrep and called "Scottish COVID-19 deaths".
	Wales	Public Health Wales dashboard. "Suspected COVID-19 deaths in lab confirmed cases" field.
	Northern Ireland	N/A

Metric	Nation	Source
New and newly confirmed cases in hospital	England	NHSE SitRep (all NHS trusts), sum of fields "Number of inpatients diagnosed with COVID-19 in last 24 hours (Total)" and "Number of patients admitted with COVID-19 in last 24 hours (Total)".
	Scotland	"Scotland Tested Positive in Hospitals" file, sum of fields "N.Positive.In.Hospital" and "N.Positive.On.Admission".
	Wales	"SPI-M Wales Hospital Data" file. Hospital admissions with confirmed COVID-19, "All admissions" sheet.
	Northern Ireland	N/A

ANNEX B: Scenario iii

49. Scenario iii follows a similar profile to scenarios i and ii, with R is assumed to equal 1 from 1st July. As this change goes beyond the time period covered by SPI-M-O's consensus short-term forecasts, this scenario was modelled by each of the four academic groups, as outlined in **Insights from modelling**. All models showed a decline in incidence following recent trends from 18h May to 1st July, after which point R is assumed to equal 1. This leads to a flat line epidemic.

50. As with the other scenarios and sensitivity analyses discussed earlier in this document, the level of disease incidence is critical in the absolute values for numbers of infections, general and ICU hospital beds occupied, new hospital and ICU admissions, and deaths (see Table 9).

Table 9: Differences in metrics between scenario ii and iii in the week when R=1 (rounded to the nearest 100)

Metrics	Infections		New hospitalisations		New ICU admissions	
	w/c 1 June (scenario ii)	w/c 29 June (scenario iii)	w/c 1 June (scenario ii)	w/c 29 June (scenario iii)	w/c 1 June (scenario ii)	w/c 29 June (scenario iii)
Bristol and Exeter	296,600	121,700	4,000	1,600	-	-
Imperial	76,100	50,900	2,000	1,100	-	-
LSHTM	194,300	142,200	5,400	4,000	1,000	700
Warwick	274,400	103,600	2,500	1,000	400	100

Metrics	Total beds occupied		ICU beds occupied		Deaths	
	w/c 1 June (scenario ii)	w/c 29 June (scenario iii)	w/c 1 June (scenario ii)	w/c 29 June (scenario iii)	w/c 1 June (scenario ii)	w/c 29 June (scenario iii)
Bristol and Exeter	3,300	1,300	-	-	1,200	500
Imperial	2,200	1,000	700	300	900	400
LSHTM	6,400	4,800	1,100	800	2,200	1,700
Warwick	5,300	2,200	1,000	400	1,100	500

ANNEX C: Scenario iv and v

51. Comparisons between scenarios iv and v have been discussed in more detail earlier in this document. Both assume increases in R up to 1.7, reflecting easing of social distancing measures from either 1st June (scenario iv) or 1st July (scenario v), after which R remains at 1.7 for four weeks. At this point, R reduces to 0.7 to represent the reimplementation of BSIs until incidence decreases to levels comparable to those seen on either 1st June or 1st July when R returned to approximately 1 for the rest of 2020.

52. As seen with scenarios ii and iii (Table 9), the different initial levels of incidence at 1st June and 1st July respectively affect the magnitude of the metrics for the rest of the scenarios. This is even more apparent for the peaks observed in the scenarios iv and v that occur when R increases (see Table 10) – the peak in scenario iv is around two to three times larger than that in scenario v for three of the four models.

Table 10: Weekly peak metric values for scenarios iv and v from the four modelling groups (rounded to the nearest 100)

Weekly Metrics	Infections		New hospitalisations		New ICU admissions	
	Scenario iv (R increase at 1st June)	Scenario v (R increase at 1st July)	Scenario iv (R increase at 1st June)	Scenario v (R increase at 1st July)	Scenario iv (R increase at 1st June)	Scenario v (R increase at 1st July)
Bristol and Exeter	2,302,500	880,600	32,00	11,900	-	-
Imperial	1,176,900	528,000	20,500	10,500	-	-
LSHTM	2,106,700	1,830,900	51,300	39,300	9,200	7,000
Warwick	2,055,200	727,700	23,300	8,200	3,200	1,100

Weekly Metrics	Total beds occupied		ICU beds occupied		Deaths	
	Scenario iv (R increase at 1st June)	Scenario v (R increase at 1st July)	Scenario iv (R increase at 1st June)	Scenario v (R increase at 1st July)	Scenario iv (R increase at 1st June)	Scenario v (R increase at 1st July)
Bristol and Exeter	19,000	7,500	-	-	5,500	2,200
Imperial	16,300	8,400	4,200	2,200	7,000	3,700
LSHTM	49,600	37,900	8,300	6,300	20,400	17,000
Warwick	27,300	9,900	3,800	1,600	8,700	3,100

53. The Warwick model under scenario iv has been chosen as the reasonable worst-case scenario and a 16-week period from 18th May to 6th September 2020 inclusive is used for cross-government planning. Table 11 shows what this scenario's impacts would be over this time.

Table 11: Warwick model scenario iv (RWCS) headline data over 16-week period used for cross government planning

Number of direct COVID-19 deaths From 18th May to 6 h September 2020 This is the number of **confirmed** COVID-19 deaths per the PHE line list (and equivalent for DAs), for hospitals, care homes and the community. It does not include deaths which are not captured in those headline data, additional COVID-19 deaths that could occur due to lack of NHS capacity, or other excess deaths	**59,000** (to the nearest 1,000) **Weekly direct covid-19 deaths over 3,000** for 7 weeks (**Peak 8,500** - nearest 100 - in mid-July 2020) **The peak weeks are from end of-June until mid-August, with a slower decline than increase** in the RWCS.
Number of cases requiring hospitalisation From 18th May to 6 h September 2020	**130,000** (to the nearest 10,000)
Number of cases requiring ICU admission From 18th May to 6 h September 2020	**19,000** (nearest 1,000), peaking at 3,000 admissions per week