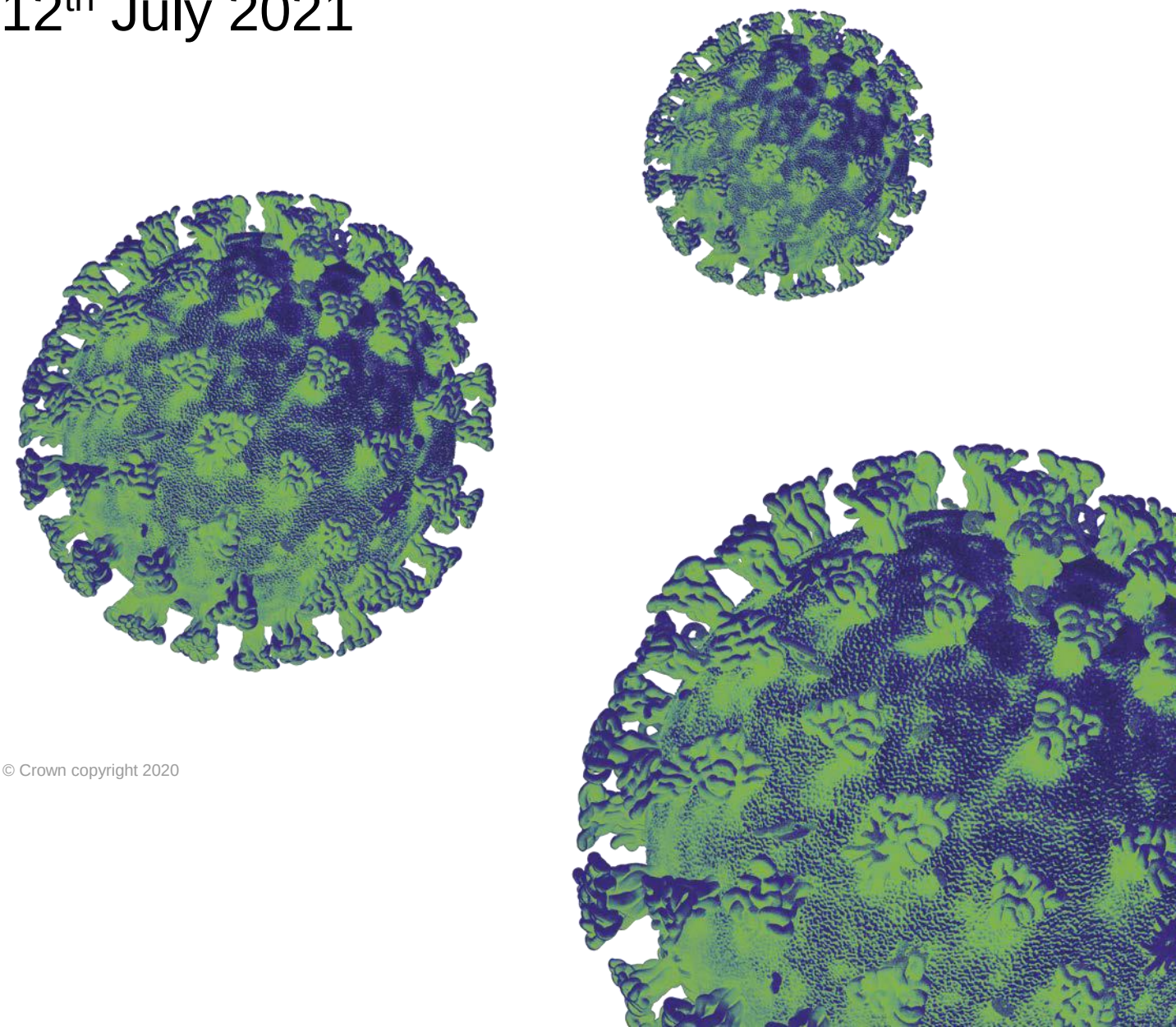
Llywodraeth Cymru
Welsh Government

Technical Advisory Group

Policy modelling update

12th July 2021



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Policy modelling update 12th July 2021

Welsh Government COVID-19 TAG Policy Modelling Subgroup

1. Summary

- This is an update on modelling of the COVID-19 pandemic in Wales.
- A policy modelling update, dated 25 June, outlined some new scenarios for the coming months, wthat included the impact of vaccination Delta variant which has led to increased growth in infections in Wales, at the same time as restrictions being released.
- Evidence has continued to emerge around the effectiveness of vaccines in preventing severe disease. England and Scotland which have seen a significant resurgence in cases, but a much smaller resurgence in hospital admissions and deaths, even when considering spread across age groups and time lags between case onset and severe health outcomes.
- This means that the most pessimistic scenarios for hospital admissions and deaths that were included in the previous modelling are looking increasing unlikely.
- This report includes Swansea University modelling with updated vaccine effectiveness values ,how 'actuals' track to those scenarios, and new modelling from Warwick University.
- Overall there is still a risk of a wave in hospital admissions and deaths, especially as Wales is seeing very rapid growth in cases, but it looks like the vaccination programme is currently holding up in the race with the Delta variant.
- The current increase in cases is mainly in young people, where the risk of long COVID appears to be lower than in older people. It is likely that cases will continue to be high in children and young people unless we reach a point where population immunity effects start to have an impact on transmission.
- With a continued high force of infection, any point where we may expect to see population immunity effects may be overshot by some distance.
- These models are only accurate for the current situation with the Delta variant; if other variants with greater vaccine escape properties become widely distributed, then the models will change.
- Any models are likely to be more accurate for the shorter term than the longer term picture.
- The most recent tracking to the Swansea University modelling suggests we are tracking closer to the 'delta low' scenarios than 'delta high' scenarios – however it does not mean that the transmission advantage of delta is at the

low end, it may be that the impact of vaccinations or reduced contacts is continuing to have an effect.

- The ratio of confirmed cases to hospital admissions is falling, and the ratio of cases to deaths has fallen more dramatically over time. There are some potential biases with these data, as vaccines may increase the proportion of cases with minimal symptoms, and testing behaviour may change over time.
- The Warwick / JUNIPER modelling in this paper suggests more optimistic worst case scenarios than the Swansea University scenarios, with later peaks in early 2022 rather than late summer 2021 as estimated by Swansea models.
- By triangulating actual data and comparing the modelled scenarios, we may surmise that it is likely that Wales is not heading for a bigger wave in hospital admissions and deaths than previous waves, despite the very rapid increase in cases.

2. Objective

The objective of this paper is to update scenarios for COVID-19 in Wales from June 2021 to March 2022, using different assumptions for the impact of new variants, impacts of vaccine effectiveness and individuals' ability to continue to follow restrictions and to continue to adopt protective behaviours (labelled in this paper as "adherence").

This paper focuses only on direct COVID-19 related harms; there are clearly a range of harms related to the pandemic and pandemic response that other groups within Welsh Government are considering.

3. Background

Wales went into Level 4 restrictions on 20th December 2020 following the identification of the new Variant of Concern 202012/01 (B.1.1.7, now known as Alpha), increasing rates of confirmed COVID-19 case rates, and pressure on the NHS.[1] Over 70% of the population of Wales have now received at least one dose of a vaccine. This includes over 95% of over 80 year olds and more than 89% of 50-54 year olds, the final group in the top nine priority groups Welsh Government targeted, and achieved, to offer a first dose of the vaccine to by 15 April 2021. Vaccination is now open for all those aged 18 year olds and over, and more than 72% of 18-29 year olds have received a first dose as at 7 July 2021. However, uptake of a first vaccine dose has plateaued in recent weeks. Wales has led the way in terms of vaccination coverage in countries with populations above three million people. This vaccination uptake will produce a reduction in hospitalisations and deaths in vaccinated individuals compared to non-vaccinated individuals.

The case rate as of 6 July 2021 for Wales is around 100 confirmed cases per 100k (7 day rolling sum), positivity is around 6%, and case rate and positivity are continuing an upward trend that started at the end of May. In addition, prevalence is 0.22% (as measured by the ONS COVID Infection Survey[2] in the week to 26 June 2021) and antibody prevalence was 91.8% in the week to 20 June 2021 (as measured by the COVID Infection Survey), indicating that a high proportion of people have antibodies present either following natural infection or vaccination.

4. Updated modelling scenarios from Swansea University

Swansea University produced a range of modelled scenarios for the time period up to end of March 2022. The methods have been described previously.[3]

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[1] Written Statement: Alert level four restrictions
[2] Coronavirus (COVID-19) Infection Survey, antibody and vaccination data, UK - Office for National Statistics
[3] https://gov.wales/sites/default/files/publications/2021-03/technical-advisory-cell-modelling-update-12-february-2021.pdf

Model Run	05/07/21 'Slowed 2' Slowed scenario, increased uptake, increased efficacy assumptions following PHE Vaccine Surveillance Report Week 26 (01/07/21)

Level of restrictions in place across Wales

The Welsh Government has set out four alert levels for public response to threat levels that require measures designed to control the spread of the virus and protect people's health.[4] The first phase of the move to alert level 1 took place in Wales on 7 June 2021.[5]

In the Swansea University model, the levels of restrictions are currently planned to be eased according to the following schedule in 2021:

Opening Schedule	
12 April	School Return plus level 3.5
03 May	Alert level 3
17 May	Alert level 2
7 June	Alert level 1.5
19 July	Alert level 1
01 Aug	Alert level 0.5
01 Dec	Alert level 0

[4] Coronavirus Control Plan: Alert levels in Wales (14 December 2020).
[5] First Minister confirms phased move to alert level one | GOV.WALES

Effectiveness of vaccines

A range of vaccine efficacy levels was chosen to reflect general 'low', 'medium' and 'high' efficacy scenarios based on current knowledge. This is a development from previous model runs in that the model separates out effectiveness in preventing cases from effectiveness in preventing hospital/ICU, and preventing deaths, with vaccines being more effective at preventing the most severe outcomes.

Vaccine Efficacy (3 scenarios representing uncertainty in each variant ribbon plot)			
Scenario	Test positive	Hospital / ICU	Death
Low	70%	93% (VEclin = 0.77)	94% (VEclin = 0.8)
Mid	80%	97% (VEclin = 0.85)	98% (VEclin = 0.90)
High	90%	98% (VEclin = 0.80)	99% (VEclin = 0.90)

Uptake of vaccines was as follows:

Vaccine Uptake (maximum at end of roll out)	
40+ years	95%
30-39 years	90%
18-29 years	85%

Levels of 'adherence'

Each of the scenarios modelled in this paper is presented with differing 'adherence' levels in these scenarios are modelled on the assumption of both:

- 'Good adherence' (where 'adherence' is at a level equivalent to what was seen during the autumn firebreak in Wales)
- 'Low adherence' (where 'adherence' is at a level equivalent to what was seen during December 2020 in Wales).

In this analysis, low or good adherence is in reference to individual's numbers of

contacts, which may change as a result of motivation to comply, but also depending on ability to comply, for instance if workplaces require them to return to working on-site.

Impact of Variants

Current analysis from England suggests that the Delta variant is 40-80% more transmissible than the previously dominant Alpha variant. On the charts below, 'low delta' and 'high delta' are the lower and higher estimates respectfully of the new dominant Delta variant. These represent scenarios where Delta is 30% and 80% more transmissible than Alpha respectfully. In this case 30% was chosen rather than 40% as a lower bound because this would represent a mixture of Delta and Alpha.

In addition some other variants were modelled as shown below, but are not shown in all charts as we have cut down to the most relevant scenarios.

Variant Assumptions	
Blue	Original (m = 1)
Red	Original + 20% (early Alpha assumption) (m = 1.2)
Green	Alpha = Original + 40% (Alpha) (m = 1.4)
Purple	Delta = Alpha + 30% (low estimate) (m = 1.9)
Orange	Delta = Alpha + 80% (high estimate) (m = 2.7)

5. Swansea results and tracking

So far the actuals data for confirmed cases is tracking around the middle of the 'Delta high, good adherence, high vaccine effectiveness' and the 'Delta low, low adherence, low vaccine effectiveness'. Hospitalisations and deaths are still very low and have not really taken off so far in the third wave which makes tracking them to any specific scenario very difficult, but they are closest to the most optimistic of scenarios. These results also show in the top panels the previous 'Accelerated 2' scenario which had a move to Alert level 1 earlier, on 7th June, for comparison. These scenarios produce a more elongated peak in cases than the updated 'Slowed 2' scenario. The left and right panels show good adherence and low adherence. For most scenarios, adherence makes a much smaller difference than vaccine effectiveness and transmissibility; adherence only makes a big difference when combined with low vaccine effectiveness and high Delta transmission advantage.

Figure 1. Results from Swansea University model, with actual trend in COVID-19 confirmed cases.

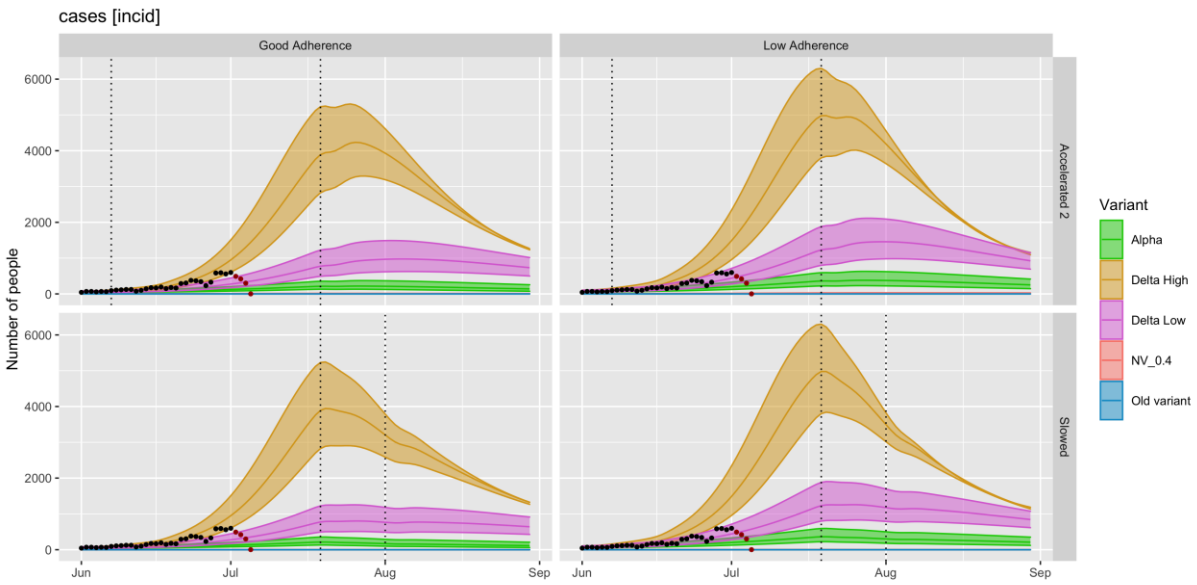


Figure 2. Results from Swansea University model, with actual trend in COVID-19 hospital admissions.

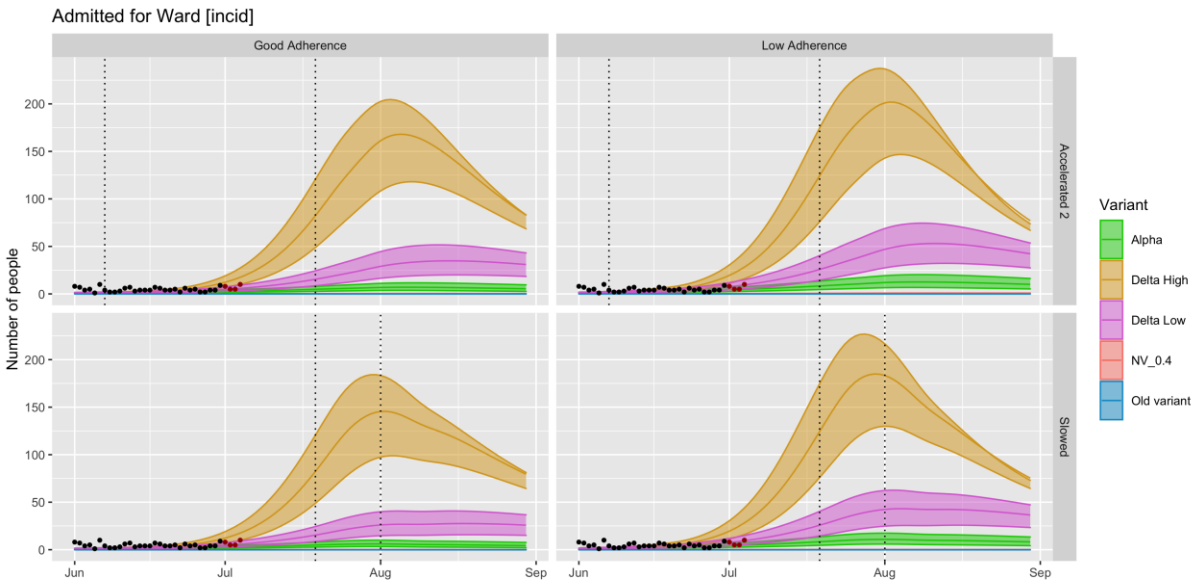


Figure 3. Results from Swansea University model, with actual trend in COVID-19 ICU admissions.

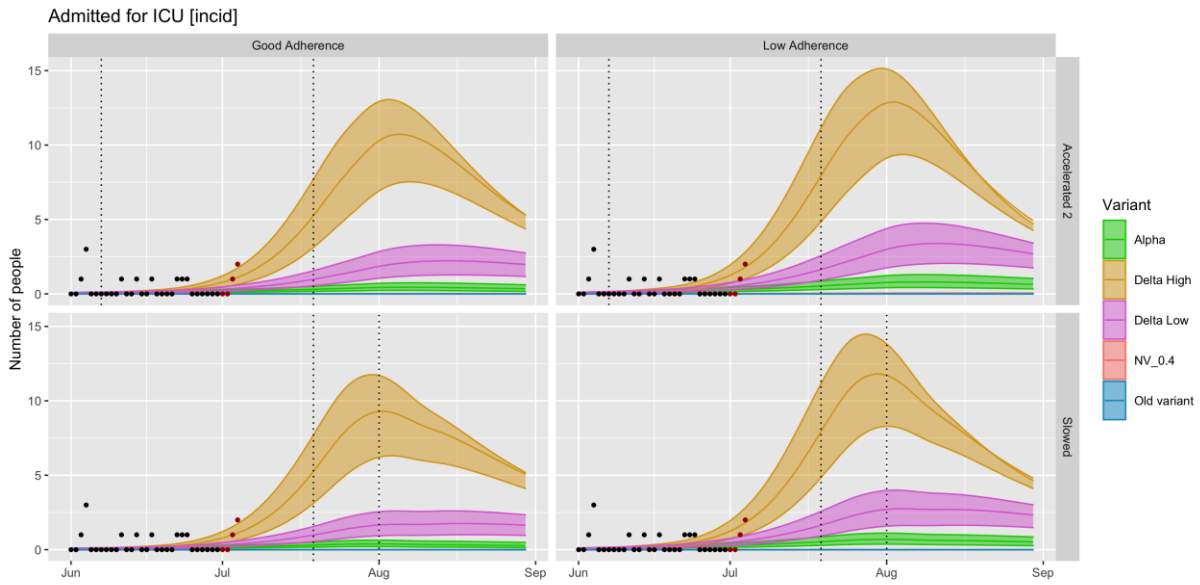
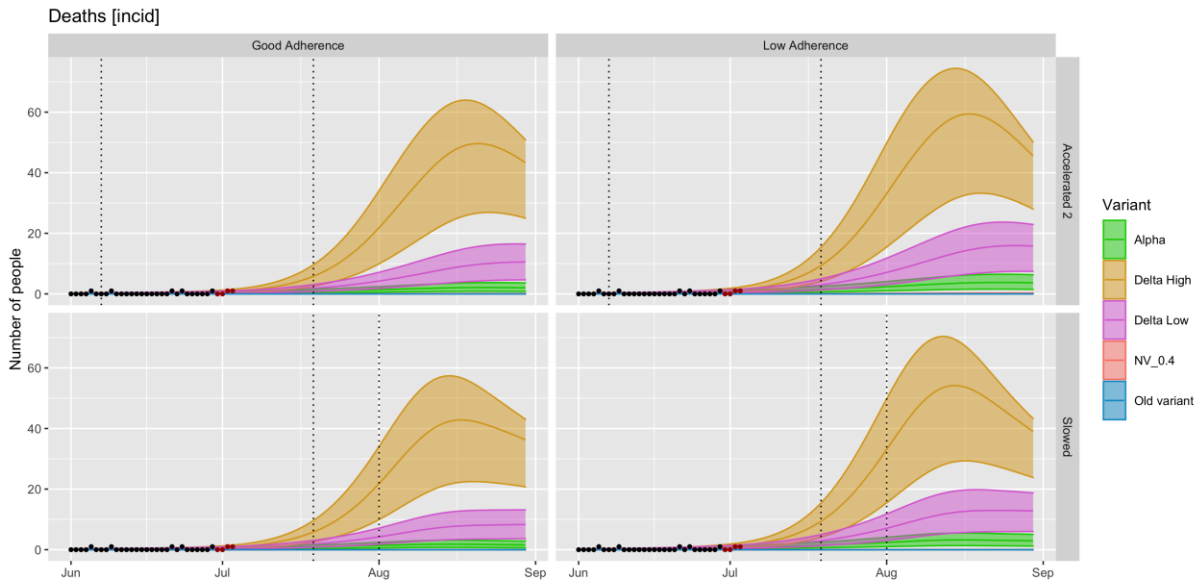


Figure 4. Results from Swansea University model, with actual trend in COVID-19 deaths.



6. Warwick / JUNIPER consortium modelling results for Wales

This section is taken from a paper provided to Welsh Government by Sam Moore, Matt J. Keeling, Louise Dyson, Edward Hill, Mike Tildesley from JUNIPER (Joint UNIversities Pandemic and Epidemiological Research, *https://maths.org/juniper/*). We are very grateful to JUNIPER for carrying out this analysis for Wales.

Methodology and key uncertainties

This work uses the model that has been developed in Warwick over the past year and matched to a variety of epidemiological data. The model operates and is fitted to data from the seven NHS regions in England and the three devolved nations (Wales, Scotland and Northern Ireland) between the start of the pandemic in 2020 up until the 25 June 2021. The results of this model have been presented to SPI-M and SAGE on a number of occasions, and the model has been used to examine short-term and medium-term projections as well as reasonable worst case scenarios. More recently, the model has been extended to include vaccination, initially to investigate priority ordering and subsequently increased in complexity to include two-dose schedules and multiple actions of vaccine protection.

Vaccine uptake within the model to date mirrors the recorded data in terms of dose and age of those vaccinated in each region separately. Projecting forwards, Warwick follow the JCVI priority ordering for both Phase 1 and Phase 2, though include a small amount of noise in this to reflect adherence to the ordering to date. The uptake of vaccines so far has been far higher than initially anticipated, exceeding 95% in many areas and age-groups. Here, it is assumed that uptake in those 40 and over is determined by historical uptake, while for those 18-39 the uptake level is set at 80%.

Numbers of doses delivered are projected forward in line with recent delivery rates (at the daily rate average of the past 2 weeks for each region), this gives completion dates for vaccinating all adults with two doses between late August and early September for each region.

The effect of seasonality is assumed to reduce transmission in summer months, with a trough of -15% (default) or -5% (lower) in mid-August followed by a peak with no reduction in February.

Variants

Modelling includes estimated prevalence of variants to date, with the Alpha variant becoming dominant in January 2021, succeeded by Delta variant dominance in May/June. The Delta variant is estimated to have a transmission advantage over the Alpha strain of approximately 56%, though sensitivity to this estimate is included in the analysis.

The modelling has not accounted for the possibility of other future variants emerging that may evade the vaccine protection provided by the presently available vaccines

or have further increased transmissibility which could undermine the huge gains that have been achieved by the vaccination programme to date and should be monitored accordingly.

Vaccine action

Having been vaccinated, the protection generated can affect multiple components of the infection, illness and transmission process. This has been updated from the original calculations and now considers five elements separately: efficacy against infection; efficacy against disease (which also affects transmission, as the default assumption is that asymptomatic infections transmit less than symptomatic infections); efficacy against onward transmission; efficacy against hospital admission and death. Warwick are also basing their central estimates of vaccine efficacy on the data that are slowly being generated on protection observed in the UK population and elsewhere (see Table 1). These estimates are getting tighter all the time and as such, the bounds are likely to change.

Three vaccines are now in use in the UK (Pfizer, AstraZeneca and Moderna). The efficacy for Moderna is not currently well defined therefore the assumption is made that Moderna and Pfizer are equivalent given their single mode of action. The three vaccine efficacies are combined by taking the weighted average for each age group within the model based on the amount of the three vaccines used to date in the UK; and in the ratio 60% (AstraZeneca), 30% (Pfizer), 10% (Moderna) in the future for those above 40 and 0% (AstraZeneca),75% (Pfizer), 25% (Moderna) in remaining adults below 40.

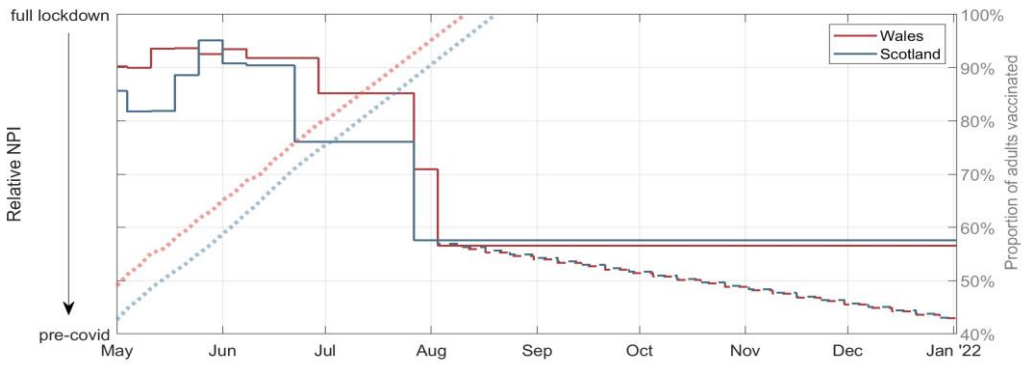
Table 1. Vaccine efficacies against the Alpha variant (blue) and Delta variant (red) as given by current PHE estimates (https://www.gov.uk/government/publications/covid-19-vaccine-surveillance-report). Here central estimates are given as well as a (bracketed) lower and higher estimate.

	Pfizer/Moderna		AZ	
	1st Dose	**2nd Dose**	**1st Dose**	**2nd Dose**
Efficacy against Infection	63% (55-70%) 45% (38-50%)	80% (70-90%) 71% (62-80%)	65% (60-70%) 46% (43-50%)	73% (60-85%) 65% (53-75%)
Efficacy against Symptoms	63% (55-70%) 45% (38-50%)	88% (75-90%) 78% (75-80%)	65% (60-70%) 46% (43-50%)	78% (65-90%) 69% (58-80%)
Efficacy against hospitalisation/death	80% (75-85%) 80% (75-85%)	95% (90-99%) 95% (90-99%)	80% (75-85%) 80% (75-85%)	91% (85-97%) 91% (85-97%)
Efficacy against Transmission	45% (35-55%) 45% (35-55%)	45% (35-55%) 45% (35-55%)	45% (35-55%) 45% (35-55%)	45% (35-55%) 45% (35-55%)

Controls

For each nation, Warwick model the relaxations to date by fitting to available data and considering the impact of the remaining relaxation steps as outlined in current policy for each nation. Following official removal of restrictions, they assume mixing behaviour will not immediately revert to pre-Covid levels, but instead levels of caution will remain and systems such as track and trace will continue to have an impact for some time. Warwick additionally consider a scenario where mixing is allowed to gradually return to pre-Covid levels over a 12 month period, though significant uncertainty makes such long term predictions unreliable. An illustration of each scenario is shown in Figure 5.

Figure 5. NPI assumptions for different nations together vaccination levels. Darker lines show estimated NPI effects by date for each nation with solid lines representing a scenario with maintained NPI levels and dashed lines waning NPIs. Paler dotted lines show progress of the vaccination program for each nation with 100% completion corresponding to 2 doses of vaccine having been offered to everyone above the age of 18.



Wales

Warwick consider three scenarios: firstly, with a low level of NPI maintained steadily into the future (Figure 6); secondly, with NPIs reducing gradually to near pre-Covid levels over a 12 month period (Figure 7); and a final scenario as the first but with reduced seasonal advantage (Figure 8). Warwick expect the second scenario to most closely resemble realistic behaviour, though with a large amount of uncertainty surrounding long term forecasts, accurate predictions of future waves of infection incurred by behaviour going into 2022, is likely to be unreliable.

For each scenario, Warwick show sensitivity to vaccine efficacy assumptions (with high and low estimates given by PHE in (Table 1), mixing behaviour following release of NPI measures and transmissibility of the Delta variant.

Due to the advanced progress Wales' vaccination program and previous infection levels, Warwick predict only minimal future waves to be likely in all scenarios, though a notable further wave of infection may occur once pre-Covid behaviour is resumed (Figure 7) . Waning immunity or further future variants of concern have not been considered which may act to disrupt this however.

Figure 6. (Anticlockwise from the top) predicted daily hospital admissions, infections, hospital occupancy and deaths for Wales in scenarios with a steady low level of NPIs maintained into the future following final relaxations. Moderate seasonal effects are assumed. Each line represents the mean of 100 separate simulations drawn from a parameter set (including uncertainties in age dependent transmissibility, infectivity and mixing behaviour for each region) fitted to reported data to date. The solid black line shows default assumptions for this scenario. Sensitivity to: vaccine assumptions is shown by the blue lines with cross and circle markers showing mean values for more higher and lower efficacy estimates as detailed in table 1; mixing assumptions is shown by the green lines with cross and circle markers showing mean values for 25% higher and lower NPI effects immediately following released restrictions; transmission advantage of the Delta variant is shown by the red lines with cross and circle markers showing mean values for a 20% more or less transmissible variant.

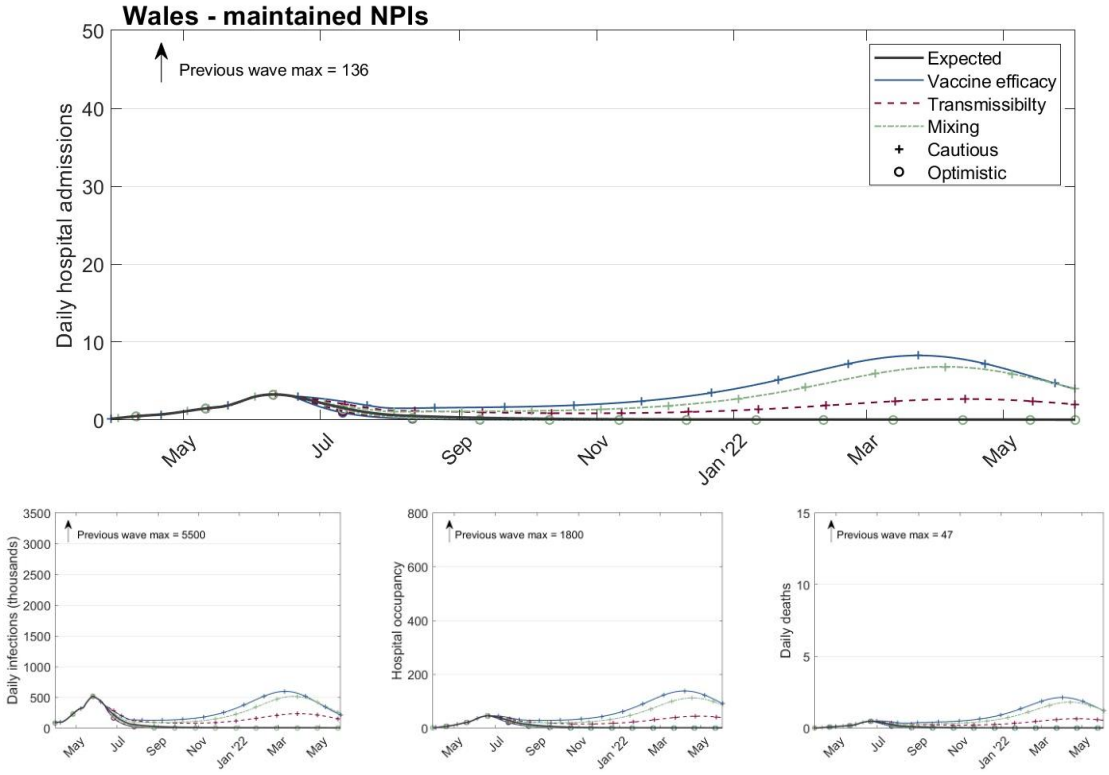


Figure 7. (Anticlockwise from the top) predicted daily hospital admissions, infections, hospital occupancy and deaths for Wales in scenarios with waning NPIs gradually reducing to near pre-Covid levels 12 months after the lifting of final relaxations. Moderate seasonal effects are assumed. Each line represents the mean of 100 separate simulations drawn from a parameter set (including uncertainties in age dependent transmissibility, infectivity and mixing behaviour for each region) fitted to reported data to date. The solid black line shows default assumptions for this scenario. Sensitivity to: vaccine assumptions is shown by the blue lines with cross and circle markers showing mean values for the higher and lower efficacy estimates as detailed in table 1; mixing assumptions is shown by the green lines with cross and circle markers showing mean values for 25% higher and lower NPI effects immediately following released restrictions; transmission advantage of the Delta variant is shown by the red lines with cross and circle markers showing mean values for a 20% more or less transmissible variant.

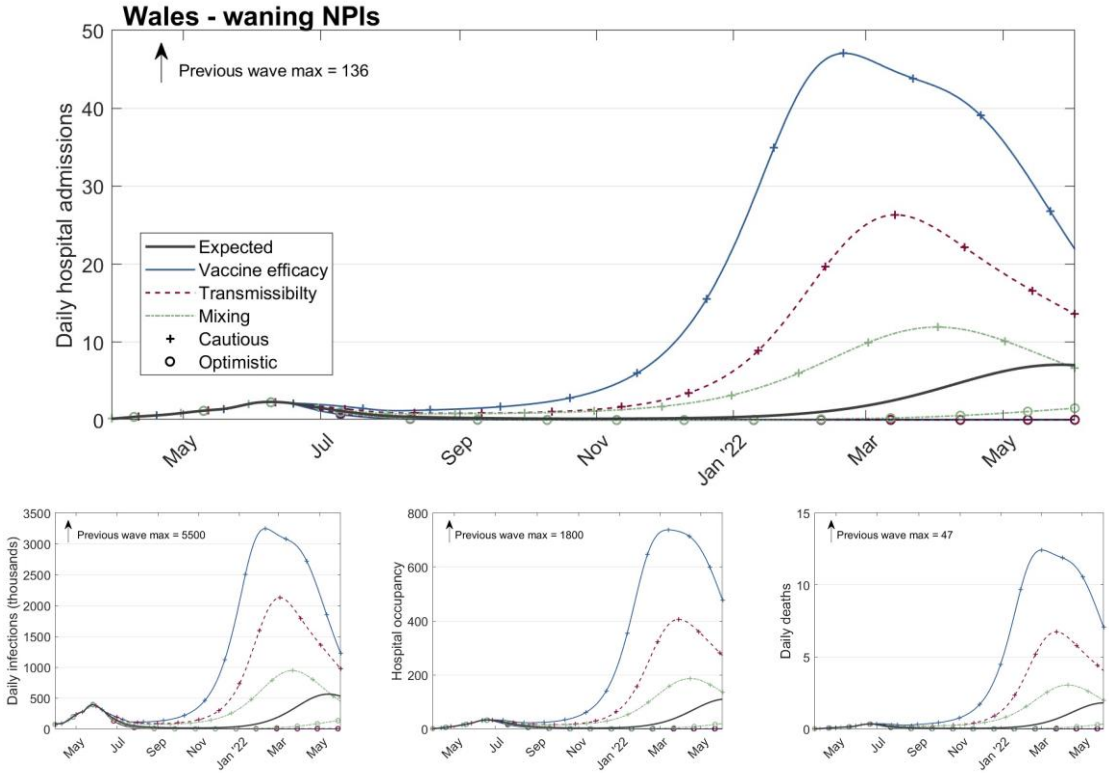
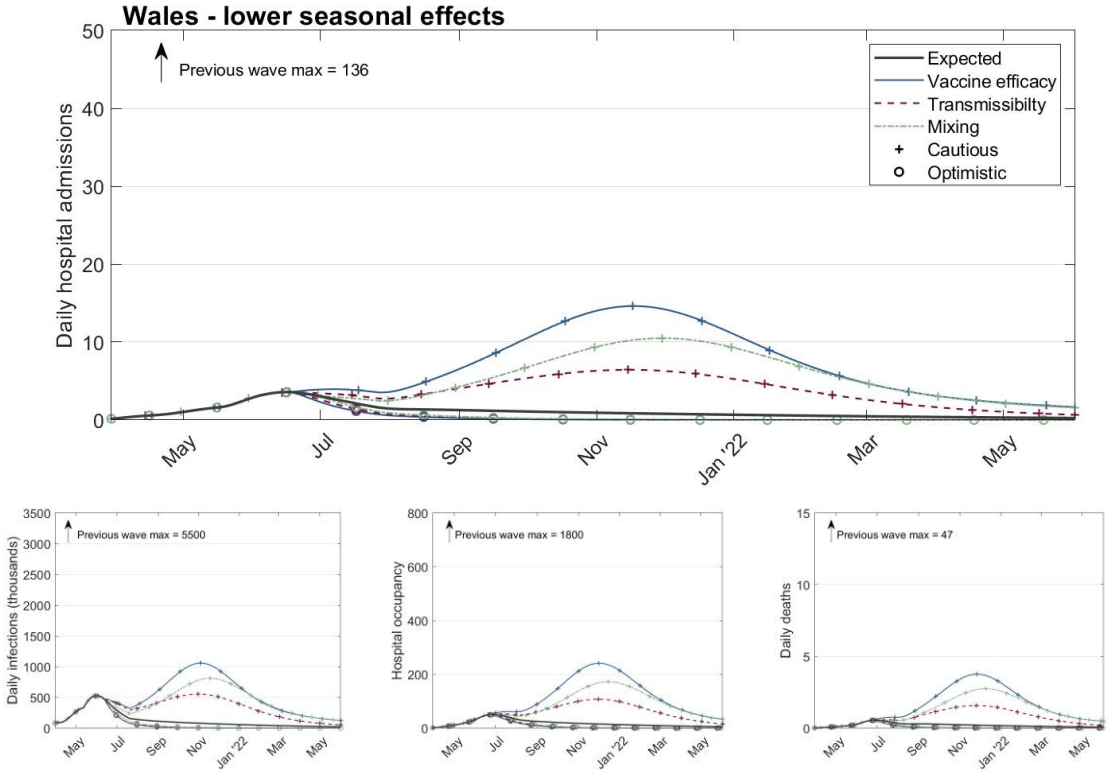


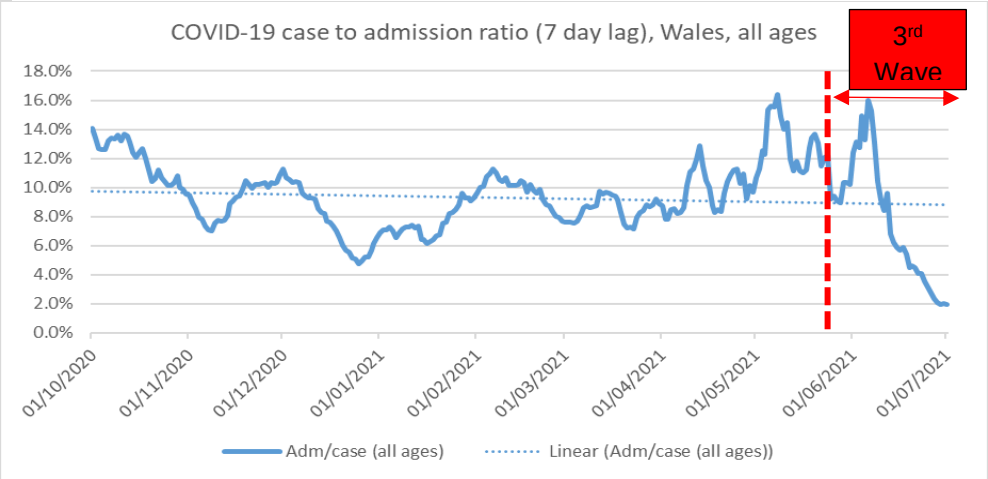
Figure 8. (Anticlockwise from the top) predicted daily hospital admissions, infections, hospital occupancy and deaths for Wales in scenarios with a steady low level of NPIs maintained into the future following final relaxations though with lower seasonal effects at a 5% summer transmission reduction. Each line represents the mean of 100 separate simulations drawn from a parameter set (including uncertainties in age dependent transmissibility, infectivity and mixing behaviour for each region) fitted to reported data to date. The solid black line shows default assumptions for this scenario. Sensitivity to: vaccine assumptions is shown by the blue lines with cross and circle markers showing mean values for the higher and lower efficacy estimates as detailed in table 1; mixing assumptions is shown by the green lines with cross and circle markers showing mean values for 25% higher and lower NPI effects immediately following released restrictions; transmission advantage of the Delta variant is shown by the red lines with cross and circle markers showing mean values for a 20% more or less transmissible variant.



7. Ratios of COVID-19 cases to admissions and deaths, Wales

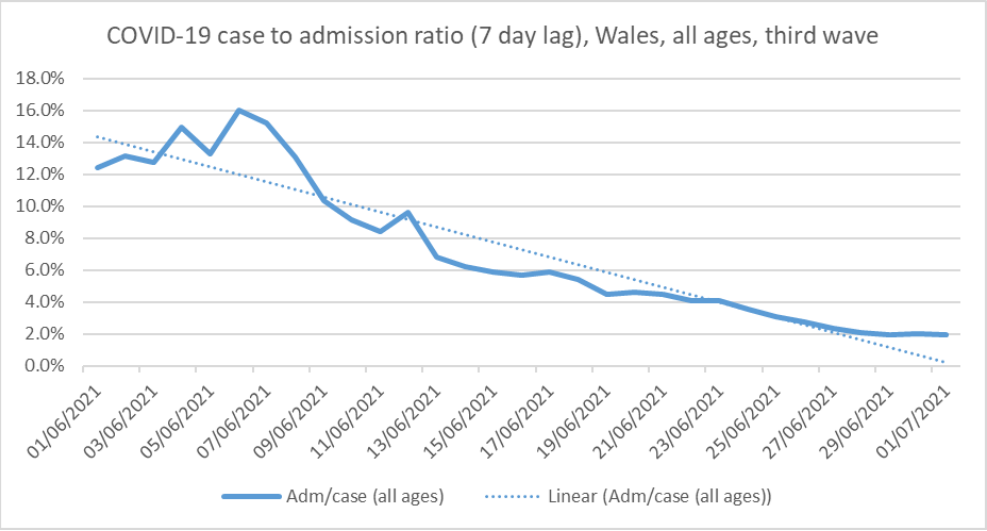
The percentage of confirmed COVID-19 cases resulting in hospitalisation has decreased from around 10% in December 2020, before the introduction of COVID-19 vaccines, to 2% on 1st July 2021. When considering the third wave alone, which began at the start of June 2021, when cases started to increase, the decrease in the case to admissions ratio is much more pronounced. This could be due the effects of the highly transmissible delta variant taking hold, particularly in the younger, unvaccinated individuals who are likely mixing more following easing of restrictions. This would lead to an increase in cases that are unlikely to lead to many hospitalisations. It could also be due to vaccinated adults being protected against COVID-19 hospitalisations.

Figure 9. Covid confirmed case to hospital case ratio (using 7 day time lag)



Source: PHW ICNet. Ratios are calculated using 7 day rolling averages of cases and admissions and applying lags.

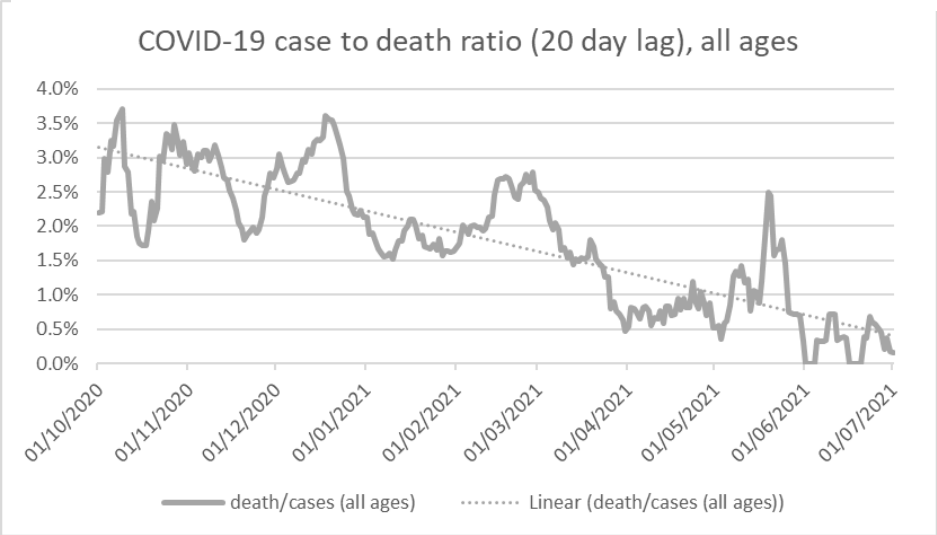
Figure 10. Covid-19 confirmed case to hospital case ratio in June 2021.



Source: PHW ICNet. Ratios are calculated using 7 day rolling averages of cases and admissions, and applying lags.

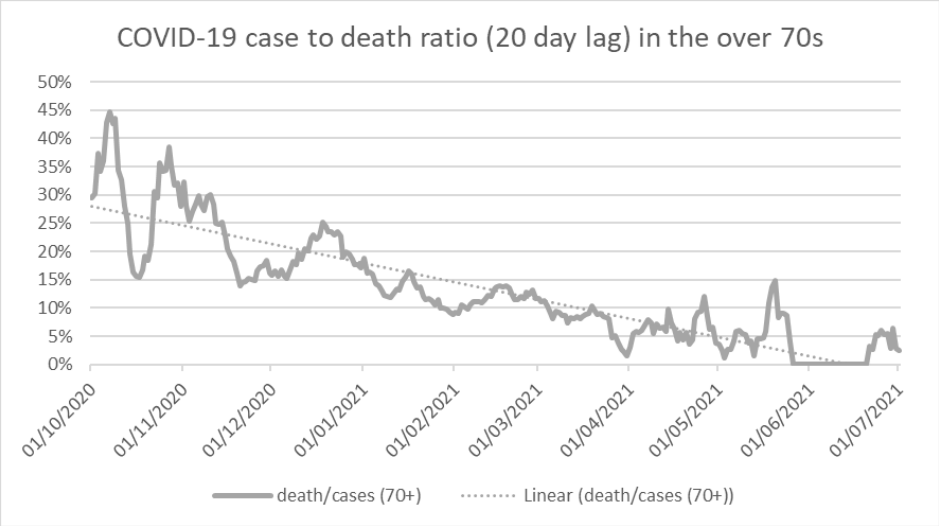
The over 70s show a large reduction in the percentage of COVID-19 deaths produced on average from COVID-19 cases. Overall, the ratio of deaths in all ages has decreased following the introduction of COVID-19 vaccines from 3.5% in December 2020 to 0.2% on 1st July 2021. This is mostly driven by the over 70s where the ratio of cases to deaths has reduced from 24% in December 2020 to 2% on 1st July 2021. This is likely due to the effects of the COVID-19 vaccines.

Figure 11. Covid-19 confirmed case to death ratio (using 20 day time lag)



Source: PHW ICNet. Cases by specimen date and deaths by date of death are used. Ratios are calculated using 7 day rolling averages of cases, admissions and deaths and applying lags

Figure 12. Covid-19 confirmed case to death ratio in people aged over 70



Source: PHW ICNet. Cases by specimen date and deaths by date of death are used. Ratios are calculated using 7 day rolling averages of cases, admissions and deaths and applying lags

Using linked data with cases, hospital and deaths may allow us to improve these estimates. There are potential biases with comparing cases to admissions and cases to deaths over time; if vaccines move individuals down a ladder of severity, then some symptomatic cases may move a step down the ladder and become asymptomatic or not detected; so the ratios may not be comparing the same type of cases over time. Using measures like ONS infection survey may negate some of these issues as it picks up all infections, although the numbers of infections in the survey are currently quite low and subject to uncertainties, especially when splitting by age group.

8. Triangulating the current data and the modelling – implications for MLS and RWC

By triangulating the current data, and the modelling from Swansea University and Warwick, it looks like there are, and will continue to be, fewer seriously ill patients from COVID-19 than in previous waves. The most pessimistic scenarios from the Warwick modelling are similar to the more optimistic 'Delta low' scenarios from Swansea University modelling, which may indicate that, despite the evidence accumulating for the increased transmissibility of the Delta variant, the 'Delta low' type scenarios might be the best fit for the current trajectory. It might be that a new most likely scenario should be something like Delta low plus high vaccine effectiveness, while a new Reasonable Worst Case (RWC) should be something like Delta high plus high vaccine effectiveness. However since none of the Warwick scenarios are as pessimistic as the best of the 'Delta high' scenarios, it might be most appropriate to use a more optimistic, 'Delta low' scenario for the new RWC.

Figure 13. Comparison of Warwick/JUNIPER model scenarios, Swansea university scenarios, for COVID-19 infections in Wales.

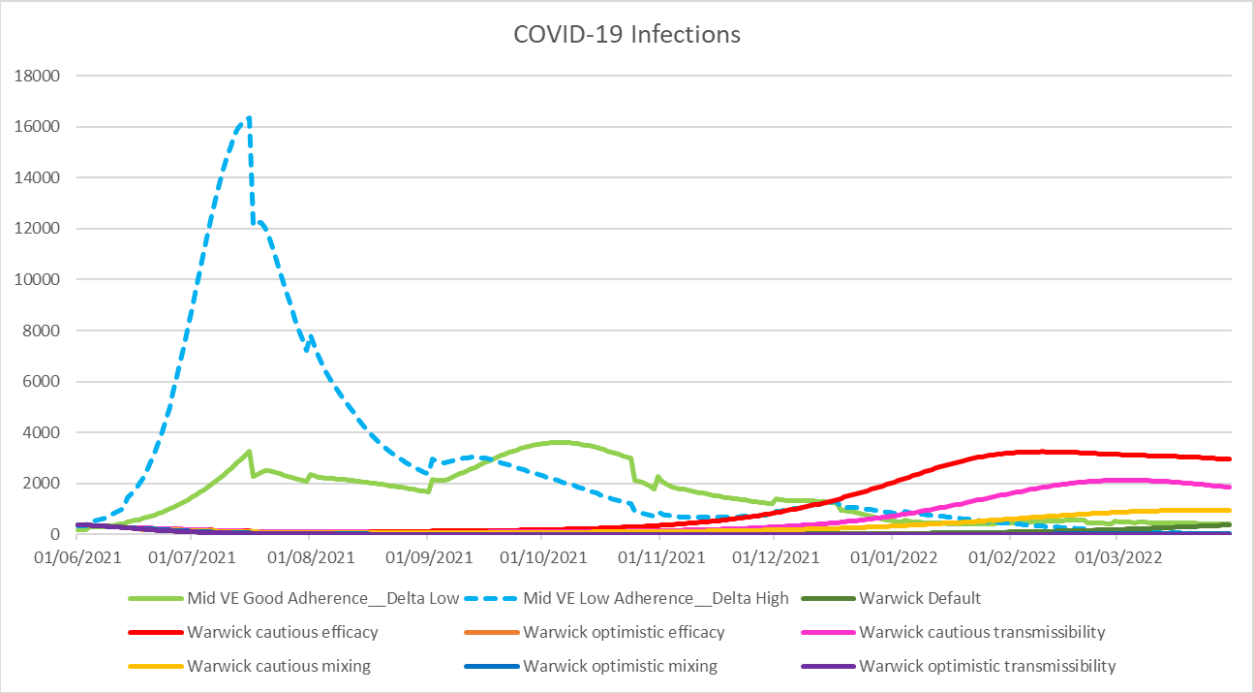


Figure 14. Comparison of Warwick/JUNIPER model scenarios, Swansea university scenarios, and actuals for COVID-19 hospital admissions in Wales.

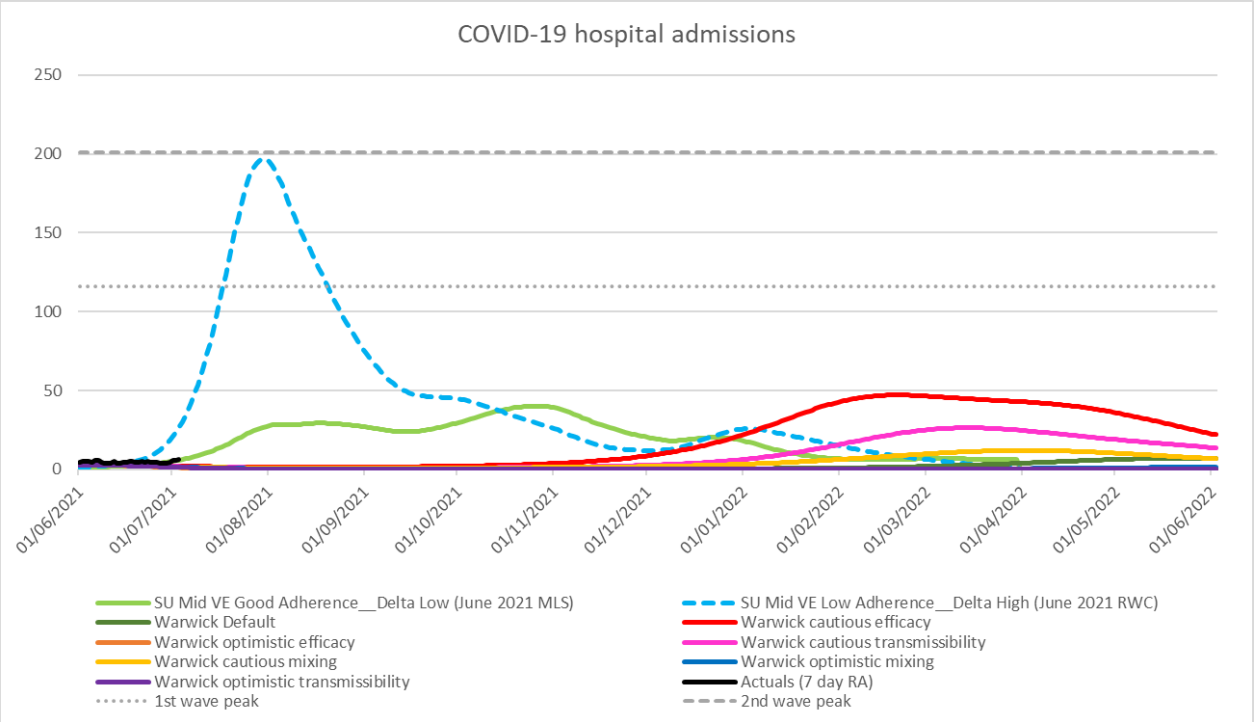


Figure 15. Comparison of Warwick/JUNIPER model scenarios, Swansea university scenarios, and actuals (source: PHW ICNet) for COVID-19 deaths in Wales.