How Soon Will We See the Benefits of the Vaccination Programme?

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

Summary

The UK government has set a challenging target of immunising over 13 million people by February 15th, representing the most vulnerable groups of society, together with health and care workers (priority groups 1 to 4). This bulletin explores the rate at which we might see the benefits of this programme in terms of the key metrics used to monitor the pandemic.

We expect that the impact of a successful vaccination programme will be most obvious in the hospitalisation and deaths data, with material reductions in hospitalisation starting from mid-February and reported deaths in early March. The impact on cases is expected to be seen sooner, but the reduction is likely to be smaller.

The recent announcement that the second dose of the vaccine will not be administered until twelve weeks after the first, in order to prioritise as many first inoculations as possible, is not discussed in the bulletin.

Introduction

The UK government is aiming to give a first vaccine dose to around 13 million people in the first six weeks of 2021. How soon might we start to see the results of this in the statistics we have been following in recent months?

We know that the various measures have a logical order. Cases precede hospitalisations (and in some cases intensive care), with deaths following. This last metric also has two measurement points – the daily COVID-19 death figures, which are relatively quickly available, and the ONS data on COVID-19 and all-cause death registrations, which involve a further lag of around two weeks.

Added to all these delays, we also need to build in the period before the vaccine becomes effective in preventing illness – we know from the medical trial data that it is possible to be infected up to two weeks after the first shot. The impact of this additional period will be important to understand, as an anxious public waits to see the first positive effects of the vaccination programme.

We set out below these key metrics, together with the factors that will influence the rate of decline, and set out our best estimate of how quickly they might start to improve, on the working assumption that the government's ambitious target is met.

Influencing Factors

Before looking at individual metrics, we need to consider the many other factors that might influence the absolute numbers we will see going forward.

Community Prevalence

The overriding influence is the prevalence of the virus across the UK. All other things being equal, if that level doubles (as indeed has occurred in the last three weeks), then absolute figures will be much higher than they otherwise would have been. To use a simple example, if prevalence doubles but the programmes gives a 50% reduction, the overall figures will be broadly unchanged. For simplicity, we have assumed constant prevalence.

Effectiveness of Vaccine/Take-Up

The vaccination will not be 100% effective, and neither will we see a 100% take-up from those offered the vaccine.

Both these factors will reduce the benefit we see, and mean we are unlikely to see metrics decrease to zero. Vaccine effectiveness will also affect measures in different ways. For instance, an effectiveness of 70% may only reduce cases by that amount, but would hopefully reduce serious illness and death by a much greater percentage.

In contrast, the take-up rate will affect each measure in a consistent and intuitive way. However, as we are concentrating the early phases on the most vulnerable, and those who are caring for them, it is reasonable to assume that there will be a relatively high take-up rate – certainly greater than would typically be seen with the annual flu vaccination programme.

Community and Government Response

Whether at individual level (typified by the "how soon can I hug my grandchildren" question), or at a wider level in terms of the degree of non-pharmaceutical interventions applied, it is inevitable that in due course the programme will start to change behaviour in a way that increases infections. (That in itself is not a bad thing of course – one of the objectives is to return to as much normality as we can as soon as we can.)

Elapsed Time Delays from Vaccination

We now consider how long it is likely to be before we start to see an effect in the various reported statistics. It should be noted that these are estimated average delay periods. In reality there is a spread of actual delays around the mean. This means we will see some benefit slightly earlier than set out below, but we will not see the full benefits below until later than we have estimated.

Cases

Allowing for the two-week period after vaccination before protection kicks in, a further three to four days is typical for the first symptoms to occur, and we should allow another two to three days for a test to be taken and the results to be reported in the data published. **Assume 20 days**

Hospitalisations (and ICU)

Added to the two-week effectiveness delay, following infection there is typically a 10-day period before admission to hospital, plus two days for reporting. **Assume 26 days**

Deaths (Hospitals)

These will be on average six to eight days after hospitalisation, so a full month after vaccination. Hospital death reporting delays are around three days. **Assume 34 days**

Deaths (ONS – used for excess deaths analysis)

ONS reports registrations weekly, with a 10 to 16 (average 13) day lag from registration, to which the period between death and registration should be added. This latter delay can be very variable, and extend into many weeks in some instances. However, given that the majority of deaths are recorded within a week, we shall assume a further delay of 3 days. Adding this to the 31 days from the hospital deaths estimate above gives a total period of nearly nine weeks. **Assume 47 days**

These are summarised in this table.

	Vaccine effectiveness	Period of 'manifestation'	Reporting delay	**Total delay**
Cases	14	3	3	**20 days**
Hospitalisation/ICU	14	10	2	**26 days**
Hospital deaths	14	17	3	**34 days**
ONS deaths	14	17	16	**47 days**

Initial Population Vaccinated

The stated aim is to vaccinate around 13m people by mid-February, with 1m having already had their first shot by the New Year. This broadly equates to the 13.4m in priority groups 1 to 4 which are set out in our bulletin Vaccine Priorities (covid-arg.com); nearly 90% of all deaths recorded in the first wave were people in these priority groups.

Priority groups 1 and 2 consist of the most vulnerable and those caring for them in hospitals and care homes. These make up around half of the 13m, but two thirds of overall deaths. Of these we estimate 3.5m to be over 80 and/or care home residents, with around 3m being carers. After that, priority groups 3 and 4 consist of 75 to 79 year olds, and 70 to 74 year olds together with the most clinically vulnerable.

Modelling

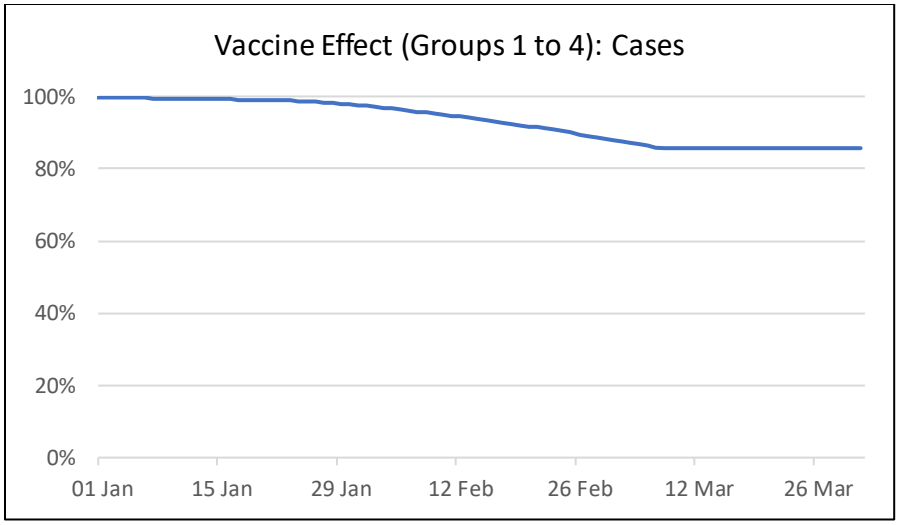
For our modelling we have assumed that the current approach of vaccinating both groups 1 and 2 in parallel continues, but after that the groups are vaccinated in strict order. The practicalities associated with the complex rollout are likely to mean that there will be some divergence from this, but we don't expect such divergence to materially affect our conclusions.

As noted earlier, we expect take-up of the vaccine to be highest in the oldest and most vulnerable groups and also for health and care staff. For simplicity, we have assumed full take-up, although we know this will be an over-estimate. In terms of vaccine effectiveness we have assumed 70% in terms of suppressing cases, but 100% effectiveness at preventing serious illness and death. Two alternative scenarios are set out later in the report.

We have assumed that the future rate of vaccination starts at the current level of around 200k per day in line with an announcement in the media by the Secretary of State for Health & Social Care on 10th Jan that vaccinations had reached that level. Only a gradual daily increase in numbers vaccinated (circa 6,000 per day) is needed from that point to achieve the target. Any shortfall in this rate of increase of vaccination will have an intuitive effect in the rate of decline seen in the various metrics.

Cases

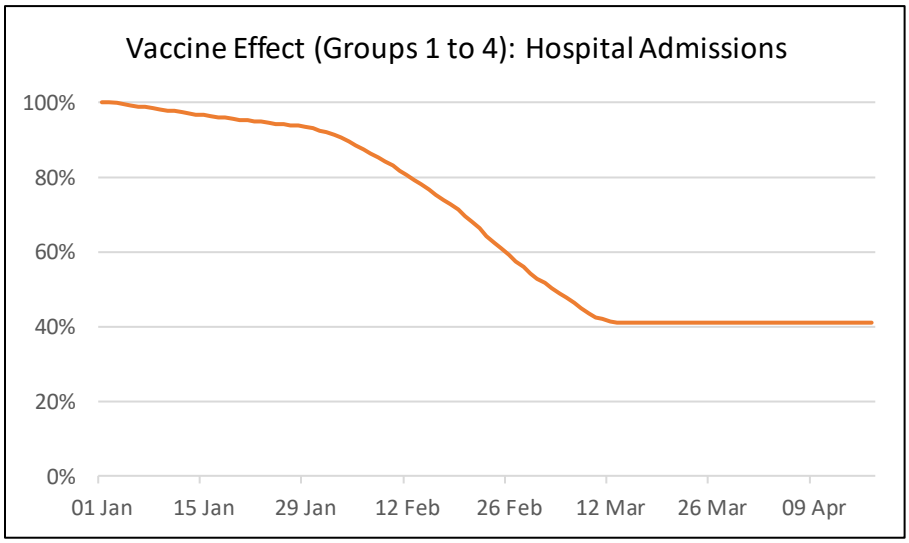
We should expect any reduction in cases to be broadly consistent with the proportion vaccinated as a percentage of the *total* population. In due course, if vaccination is found to reduce transmissibility then a second-order effect will emerge. In the immediate future, which is our primary interest, this second-order reduction will be relatively small (because the majority of the population will not be vaccinated). This proportionate effect contrasts markedly with the benefits we will see from the other metrics.



Hospital admissions (non-ICU)

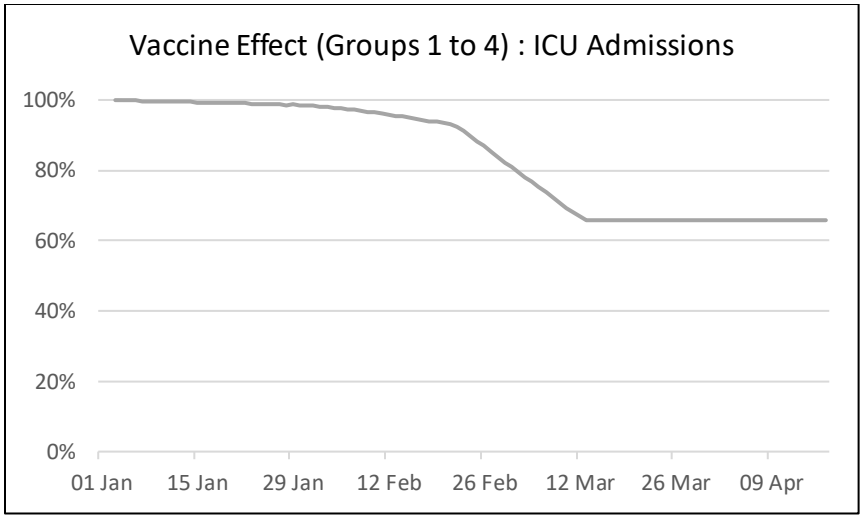
With hospital admissions, we start to see the targeted nature of the vaccine roll out come into play. Because the virus has a much greater effect on the elderly, prioritising older people will have a large impact on the numbers hospitalised.

The initial gradual decline in hospitalisations is a function of the relatively slow start to the roll out in December, and the fact that in this initial period a high proportion of those vaccinated are health and care staff. Carers will typically have a high risk of infection due to their roles but not a very high risk of hospitalisation as they are not the oldest or most vulnerable in the population.



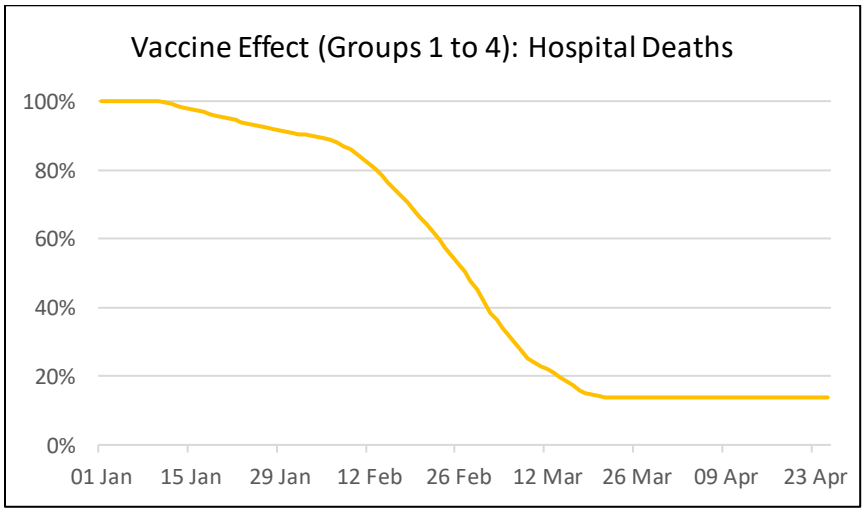
Intensive Care (ICU) Admissions

Here the pattern is different again. Relatively few admissions to ICU are over 80, as a result of the clinical and patient considerations that are taken into account in deciding whether an admission is appropriate. Accordingly, these first phases of vaccination will have relatively little impact on the pressure in ICUs. This is an important consideration, as the stresses that ICUs are under are one of the key aspects of the NHS's ability to manage the peak flow of patients that is expected in the coming weeks.



Hospital Deaths

The profile for hospital deaths is similar to that for hospital admissions, but the gradient is even more pronounced, as we expect a higher mortality rate for older lives. This chart starts to give an indication of when we might start to see a reduction in the daily total of death figures, with any meaningful reduction now pushed back well into the middle of February.



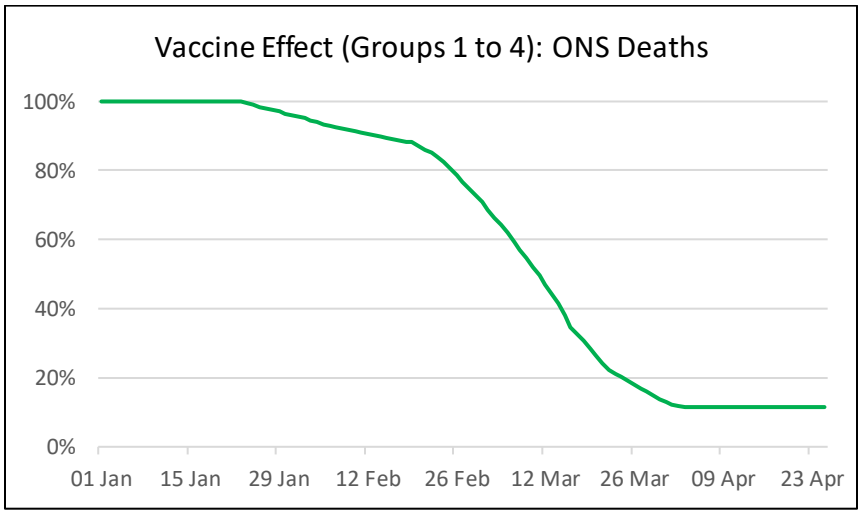
Overall death figures from COVID are likely to exhibit a similar profile, although we may see a slightly greater acceleration as the impact of vaccinations on care home mortality should be greater than the impact on hospital mortality (because the average age of care home residents is higher).

ONS Deaths

Finally, we show the expected trend for the ONS reported deaths. As well as giving us total deaths where COVID is mentioned on the death certificate, this enables us to calculate the number of excess deaths.

As excess deaths reflects the balance of several different factors, it should not be assumed that this measure will fall in line with the profile shown. However, if non-COVID deaths remain below expected levels (as we have seen in recent months), we would see a much quicker reduction in the overall excess.

The delay in ONS death reporting will be the greatest. Even if roll-out is as rapid as planned, it will be late February before there is a significant reduction, meaning we are likely to see a further six to seven weeks of very high mortality and excess deaths reported, particularly if the current high levels of community infectivity are sustained despite the latest lockdown – given the apparent increased transmissibility of the new variant, this must be a possibility.



Sensitivities

The main sensitivities are around the vaccine effectiveness and take up rate. Our base scenario assumes 70% effectiveness for cases, and 100% for hospitalisations and deaths, together with a 100% take up rate. Two alternative scenarios are presented below in terms of the final reduction achieved from 100%.

Scenario	Cases	Hospital admissions	ICU Admissions	Hospital Deaths	ONS Deaths
Base	86%	41%	66%	14%	12%
Take up: 90% Effectiveness: 70% cases, 95% admissions and deaths	87%	50%	71%	26%	24%
Take up: 90% Effectiveness: 60% cases, 90% admissions and deaths	89%	52%	72%	30%	28%

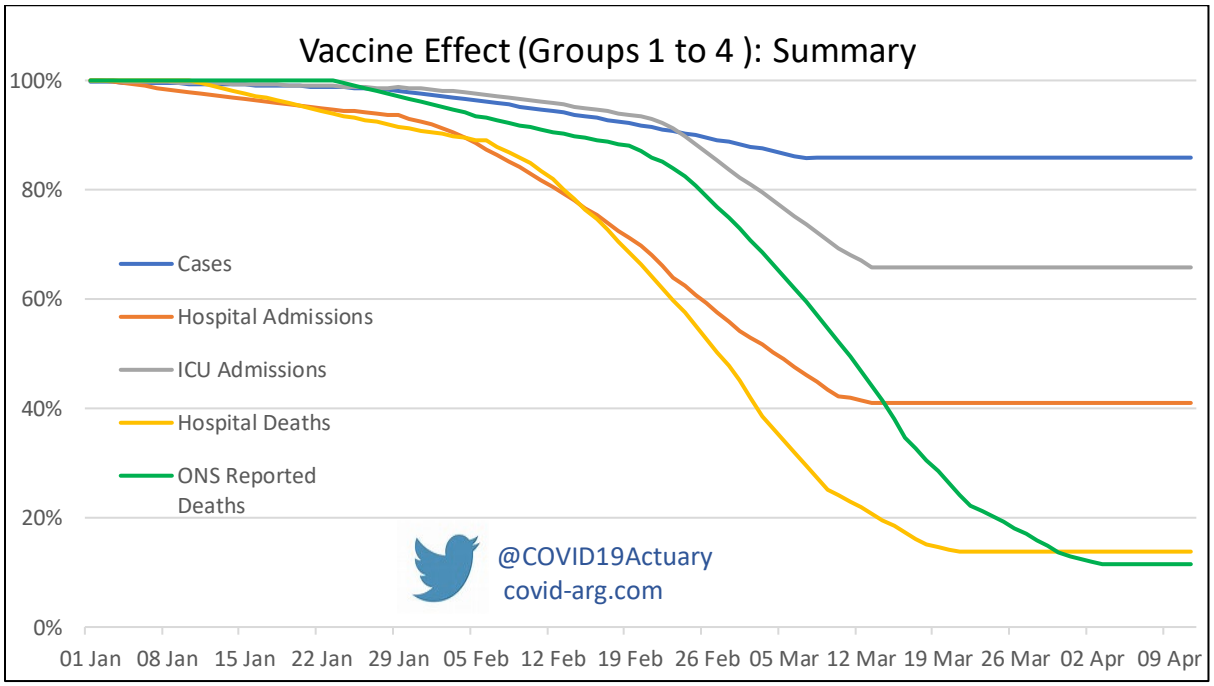
Conclusion

There are many variables which will impact the actual benefits that we see as the vaccine rolls out, most notably the speed of the roll-out, but also the vaccine effectiveness and the take-up in the various groups offered the vaccine. The other factor is the overall infectivity in the country – all of the results we show are expressed as proportional reductions from any given starting point, rather than as absolute figures.

Nevertheless, if the programme goes reasonably to plan it can be expected that there will be an 85% to 90% reduction in COVID-19 deaths by the middle of March, although the reporting of this will take a little longer to emerge completely.

However, the stresses on the health service, and particularly ICU units, will not be completely addressed by this first phase - the need to manage this through some degree of continuing non-pharmaceutical interventions will undoubtedly be a challenge as society will increasingly be looking for a return to some degree of normality.

We shall monitor progress in the coming weeks, and will be offering timely insight as the situation unfolds through regular updates on our Twitter account [@COVID19Actuary.](@COVID19Actuary)



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