

Counterfactual for FDF: UK and US

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Consider a simple calculation of how many lives would be saved if the second dose vaccinations were replaced with first doses, without any need to expand capacity.

For now let us ignore epidemiological externalities and consider reduction in individual risk only. As of 2021-03-08, in the UK 33.28% people received first dose and 1.74% received both doses of the vaccine.¹ In the US 17.94% people received first dose and 9.42% were fully vaccinated. If we assumed that the first dose of the vaccine reduces mortality risk following infection by $e_1 = 80\%$ and the second doses reduces it by $e_2 = 95\%$, then, using basic algebra, the overall number of lives saved in the US by replacing second doses by additional first doses would be 1.39 times higher.

However, this simple calculation cannot tell us how many lives were saved. It also ignores the time dimension. The reduction in mortality risk for someone vaccinated at time t is proportional to, one, risk of death following infection and, two, the risk of infection between time t and now. Thus early vaccinations are more important since they cover the longer time periods. Therefore we repeat the counterfactual calculation by defining infection risk in each day, $i(t)$, as well as vaccinations with first and second doses in each day ($v_1(t)$ and $v_2(t)$, respectively) and then summing over all days since start of mass vaccination programs. The number of deaths averted in the observed scenario is

$$b = \sum_t [v_1(t)e_1 + v_2(t)(e_2 - e_1)]i(t)\text{IFR}_v,$$

while the number of deaths averted under the counterfactual is

$$b^* = \sum_t (v_1(t) + v_2(t))e_1 i(t)\text{IFR}_v.$$

We define IFR_v as follows: since the vaccines have been prioritised for the elderly, the infection fatality risk (IFR) for a typical vaccinated patient is higher than the average IFR in the population. However, we have to account for the fact that many of the early doses are given to health care workers and some of the other key workers. By late February 2021, in the UK around 55% of the vaccines went to people over 70 and over 95% of that age group has been vaccinated. In the US, however, while 55% of vaccines went to people over 65, close to 30% went to people younger than 50.² We calculated IFR_v as an approximate weighted mean of age-specific infection mortality risks, using a meta-analysis estimate in Manheim *et al.*, 2021.³

Applying this IFR_v approach to real-world distributions of vaccine distribution, for UK we obtained 4.7% and for the US 3.2%, a remarkable difference. In other words, **despite delivering twice the number of doses (and “running out” of highest risk individuals to vaccinate), a single dose of vaccine in the UK was still used 50% more effectively than in the US.** (It should be noted, however, that the UK has a slightly older population than the US.)

¹We use data on numbers of: deaths, confirmed cases, vaccinated with first dose, fully vaccinated from Our World In Data.

²For NHS data see <https://www.england.nhs.uk/statistics/statistical-work-areas/covid-19-vaccinations/> and for the US see <https://covid.cdc.gov/covid-data-tracker/#vaccination-demographic>

³For example, since the IFR in 80+ year olds is 12% and in 70-80 it's 4%, then distributing 50% of doses to 70-79 and 50% to 80+ year olds would have IFR_v of 8%.

Next, we calculated the number of lives saved by observed vaccination policy b and the no-second-doses counterfactual b^* . We found that in the UK 7,575 deaths were averted by vaccination campaign up to 2021-03-08, compared to 15,014 in the US. That corresponds to, respectively, 114 and 46 deaths averted per million people. It's important to note that this reduction occurred over a very short period of time, with an average vaccinated person being protected only for a few weeks – both of these numbers will of course increase over time. As we mentioned above, the almost 3-fold difference is not only due to higher capacity in the UK but also due to better targeting of available doses.

The reductions that could be achieved by replacing the second dose visits with first doses (thus requiring no additional capacity) are additional 349 deaths averted in the UK and 3,242 in the US. That corresponds to 22% additional deaths that could have been avoided in the US, even if we assume a drop in efficacy to 80% and ignore the effect of vaccine on breaking the transmission.