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Cost-effectiveness of Vaccines Targeting Infectious Diseases — Has COVID-19 Changed the Landscape?

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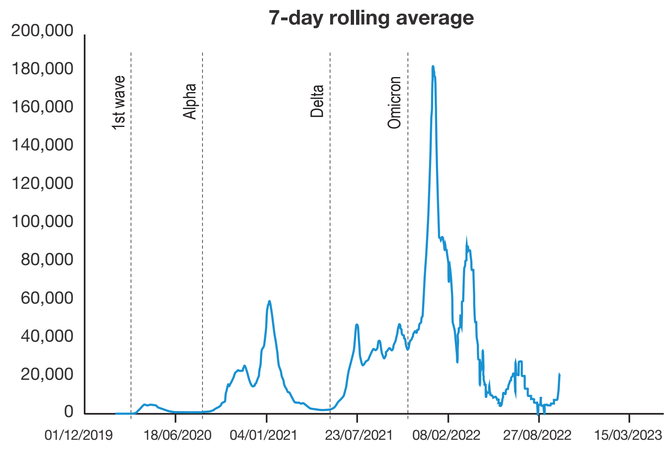
Introduction

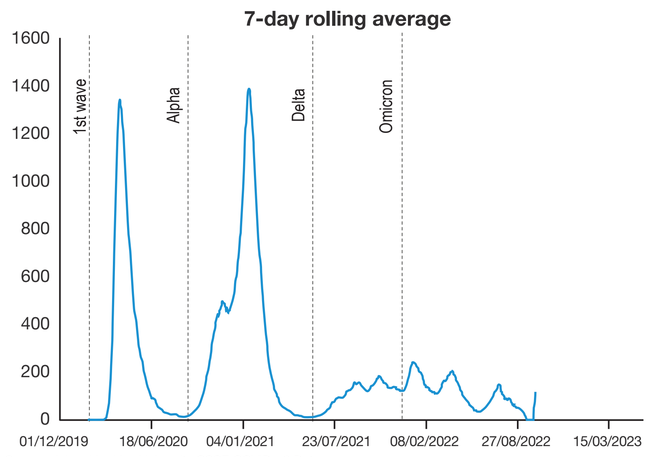
As of 10th October 2022, there have been more than 23,735,000 diagnosed cases of COVID-19 in the UK (**Figure 1**), resulting in 207,528 deaths (**Figure 2**)[1]. Despite a highly successful vaccination campaign (**Figure 3**), leading to a dramatic fall in the COVID-19 case fatality rate (**Figure 4**), there remains an immense and ongoing pressure on the National Health Service (NHS). We have looked at what this means in practice and consider the possible implications for the cost-effectiveness of COVID-19 vaccines, as well as vaccines targeting other infectious diseases.

Figure 1. Daily New Confirmed COVID-19 Cases in the UK, Calculated as a Seven Day Rolling Average, From 30-Jan-20 to 10-Oct-22



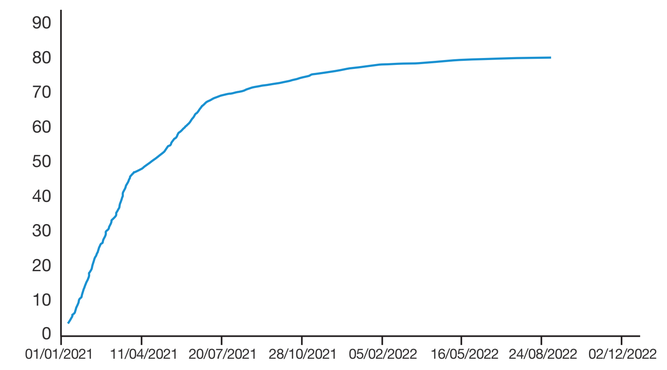
Source: Johns Hopkins University CSSE COVID-19 Data.

Figure 2. Daily New Confirmed COVID-19 Deaths in the UK, Calculated as a Seven Day Rolling Average, From 30-Jan-20 to 10-Oct-22



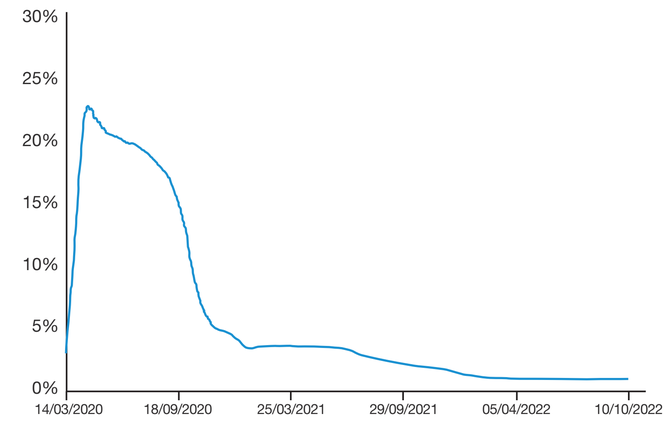
Source: Johns Hopkins University CSSE COVID-19 Data.

Figure 3. Percentage of the UK Population Receiving at Least One Dose of a COVID-19 Vaccine, From 10-Jan-21 to 04-Sep-22



Source: Official data collected by Our World in Data — Last updated 11 October 2022.

Figure 4. Case Fatality Rate for COVID-19 in the UK, From 14-Mar-20 to 10-Oct-22



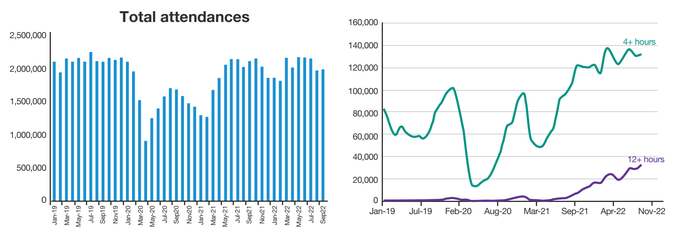
Source: Johns Hopkins University CSSE COVID-19 Data.

A National Health Service Under Pressure

In a report published in November 2021[2], the British Medical Association (BMA) warned of "record numbers of patients waiting for care and treatment" and "the influenza season and high burden of Covid cases across the UK causing strain on health services and leading to crippled emergency departments". The two lockdowns due to COVID-19 led to temporary reduction in accident & emergency (A&E) attendances, however, since these measures were eased, attendances have rebounded and the number of patients having to wait 12+ hours to be admitted has soared (**Figure 5**) due to the ongoing pressure on services, the backlog of care and chronic workforce shortages.

A National Health Service Under Pressure (cont'd)

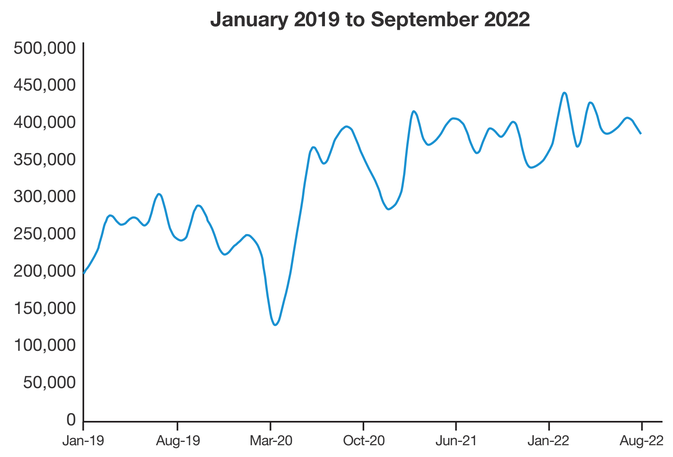
Figure 5: Total Emergency Department Attendances and Waits in England From Jan-19 to Aug-22



Source: NHS England A&E Attendances and Emergency Admissions statistics (https://www.england.nhs.uk/statistics/statistical-work-areas/ae-waiting-times-and-activity/)

- The COVID-19 pandemic and the resulting pressure on critical care services have exposed the fact that England does not have enough critical care beds.
- In response to the arrival of COVID-19, the NHS freed up critical care capacity to prepare for a surge in patients, by reorganising existing resources to:
  - reduce demand by postponing non-urgent planned operations
  - increase the number of beds and physical spaces dedicated to critical care by reducing capacity elsewhere, including repurposing recovery rooms
  - redeploy staff from elsewhere in the NHS
- Consequently the number of available critical care beds increased sharply between March and April 2020, but at a high cost to the NHS which now faces extensive backlogs in other parts of the system.
- Following the pandemic, there have been an increasing number of unsuccessful GP referrals into consultant-led outpatient services, using the electronic referral service (e-RS), due to no slots being available, which points to capacity issues within the service (**Figure 6**).

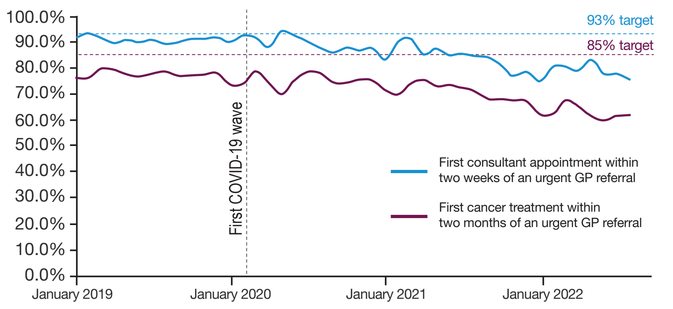
Figure 6. Number of GP Referrals Into Consultant-led Outpatient Services Using e-RS That are Unsuccessful Due to no Slots Being Available. No Slots Points to Capacity Issues Within the Service



Source: NHS Digital e-RS Appointment Slots Issues (ASI) reports (https://digital.nhs.uk/services/e-referral-service/reports-and-statistics/appointment-slot-issue-report).

- The percentage of patients seen within two weeks of an urgent GP referral for cancer care has followed a downward trend since the start of the pandemic and has been below the 93% target in all but one month (**Figure 7**). Similarly, the percentage of patients receiving their first cancer treatment within two months of an urgent GP referral has also followed a downward trend and has been below the 85% target for the entire period.

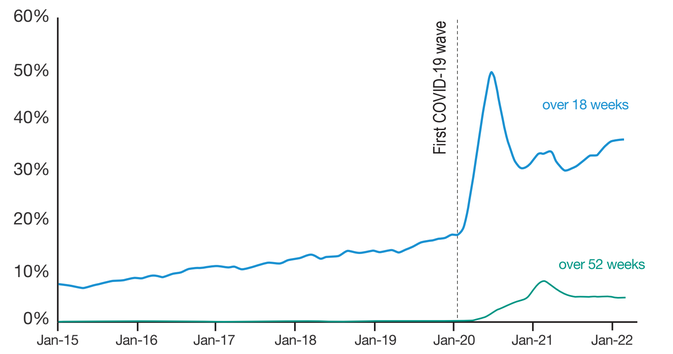
Figure 7. Percentage of Patients seen Within Target Timescales Following GP Referral for Cancer Care From Jan-19 to Aug-22



Source: NHS England Cancer Waiting Times Statistics (https://england.nhs.uk/statistics/statistical-work-areas/cancer-waiting-times/).

- Waiting times for consultant-led elective care have increased dramatically following the pandemic. The percentage of patients waiting more than 18 weeks increased sharply at the start of the pandemic, to nearly 49%. This figure fell back to 30% before resuming an upward trend (**Figure 8**). The percentage waiting over 52 weeks rose to 8% before falling back to stabilise at 5%, well above the prepandemic level of <0.1%.

Figure 8. Percentage of Patiemts Waiting Over 18 and 52 Weeks for Consultant Led Elective Care From Jan-15 to Mar-22

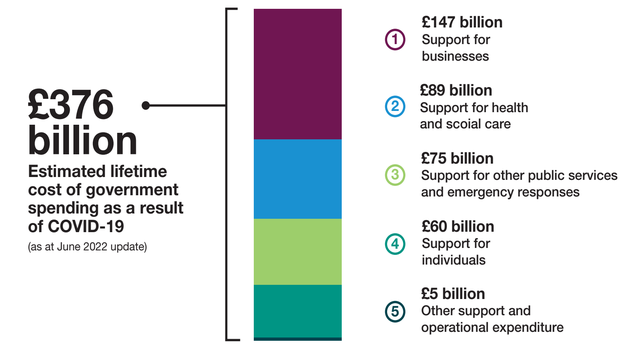


Source: NHS England Consultant-led Referral to Treatment Waiting Times Statistics (https://england.nhs.uk/statistics/statistical-work-areas/rtt-waiting-times/rtt-data-2021-22/).

Government spending due to COVID-19

- The UK National Audit Office has estimated the lifetime cost of government spending resulting from the COVID-19 pandemic, as of June 2022, to be £376 billion (**Figure 9**). Support for health and social care accounts for £89 billion.

Figure 9. Lifetime Cost of UK Government Spending as a Result of the COVID-19 Pandemic as of June 2022

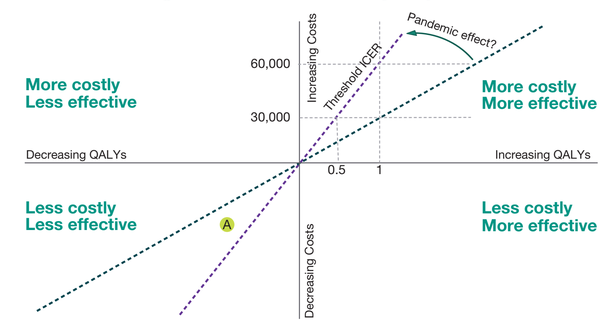


Source: National Audit Office COVID-19 cost-tracker (www.nao.org.uk/overviews/covid-19-cost-tracker/).

Health Economic Consequences for Vaccines

- The immense cost imposed by the pandemic meant that there was little need to subject early COVID-19 vaccines to formal cost-effectiveness evaluations. Provided they were safe and moderately effective, the comparison with no vaccination would certainly result in them being deemed cost-effective, provided prices were not extortionately high.
- Now that there are established vaccines that have reduced the severity of COVID-19 disease in immunized individuals, new or updated vaccines are coming under renewed health economic scrutiny.
- Given the immense strain placed on the NHS as a result of the pandemic and the resulting increases in health care costs we would postulate that the average cost of gaining a quality adjusted life year (QALY) has increased within the NHS. If this is so, then the *de facto* cost-effectiveness threshold has also increased, raising the economically justifiable price of a vaccine, while at the same time budgetary constraints have become more restrictive. This sets up a heightened tension between budget impact and cost-effectiveness considerations.
- The increase in the *de facto* cost-effectiveness threshold also makes if more difficult for less effective vaccines to boost their cost-effectiveness by reducing their price below comparator vaccines and using the cost savings to buy QALYs through a reduction in opportunity cost. The increased cost of a QALY means that these cost savings buy fewer QALYs (**Figure 10**).

Figure 10. Cost-effectiveness Plane of Interventions With a Shifting Incremental Cost-effectiveness Ratio (ICER) Threshold, Cost in Pounds Against Effect in Quality-adjusted Life Years



- We postulate that the immense strain placed on health services by the pandemic has increased the cost of health care, pushing up the cost of gaining a quality-adjusted life year (QALY), thereby reducing the opportunity cost of funding a new vaccine and so raising the cost-effectiveness threshold.
- If the threshold ICER is £30,000/QALY, spending £30,000 means the NHS forgoes 1 QALY elsewhere (the opportunity cost). If the threshold ICER has increased to £60,000/QALY, spending £30,000 now incurs an opportunity cost of only 0.5 QALYs.
- It is therefore apparent that a higher threshold ICER would decrease the cost-effectiveness of interventions that are less effective but less costly (**Intervention A, Figure 10**). The increased cost of a QALY resulting in a smaller reduction in the opportunity cost.
- COVID-19 is now transitioning to an endemic state. New strains will continue to emerge and may escape vaccine control to varying degrees. It is therefore likely that an increased pressure on the NHS will be maintained for the foreseeable future. The non-linear nature of infectious disease transmission dynamics and quantitative uncertainty around aspects of the epidemiology and natural history of COVID-19 make it difficult to forecast the likely medium to long term trends in disease prevalence. This adds a further challenge to the health economic evaluation of COVID-19 vaccines.

Conclusions

- The COVID-19 pandemic has had a profound impact on the NHS
- This impact is ongoing
- There is reasonable cause to believe that the cost of supplying health services has increased
- If this is the case, then the mean level of expenditure per QALY gained has increased
- This has implications for both budget impact and cost-effectiveness evaluations of COVID-19 vaccines, as well as for vaccines targeting other infectious diseases
- A formal re-evaluation of the cost per QALY gained across the NHS and the resulting cost-effectiveness threshold used in health economic analyses in the UK is long overdue

References

1. COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. https://ourworldindata.org/coronavirus/country/united-kingdom. Accessed 14-Oct-22
2. Weathering the storm: vital actions to minimise pressure on UK health services this winter. https://www.bma.org.uk/media/4834/bma-weathering-the-storm-report-nov21.pdf Accessed 14-Oct-22

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