Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Developing COVID-19 vaccine policy in increments

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Over the past several months, there has been fierce debate in the public domain as to whether booster vaccinations are needed to sustain vaccine-induced immunological protection against SARS-CoV-2 infection.[1] Discussions in medical journals, news outlets, social media, and among the wider public have been robust but limited owing to the paucity of data for the breadth and durability of existing vaccines.

In *The Lancet*, Sara Tartof and colleagues from Kaiser Permanente Southern California (KPSC) and Pfizer provide evidence that supports the use of a third vaccination for those who completed an initial series, administered at least 7 days apart, with the BNT162b2 (tozinameran, Pfizer–BioNTech) mRNA COVID-19 vaccine.[2] With the spike in cases across the globe owing to the delta (B.1.617.2) variant of SARS-CoV-2, increasing numbers of so-called breakthrough infections have occurred among vaccinated individuals.[3,4] The question emerging is whether the breakthrough cases are due to waning immunity, in which case a booster is required, or simply incomplete coverage of the delta variant by vaccine-induced immunity.

Tartof and colleagues reviewed medical records in the KPSC health-care system, and found that among 3 436 957 individuals included, 1 146 768 received at least one dose of the vaccine, 91·0% of whom were fully vaccinated.[2] The remaining unvaccinated individuals served as control participants. Vaccine effectiveness was estimated at monthly intervals after achieving fully vaccinated status. The distribution of participants was balanced between groups, with a median age of 45 years (IQR 29–61); 1 799 395 (52·4%) participants were female and 1 637 394 (47·6%) were male; 40·5% were Hispanic, 32·3% were white, 11·6% were Asian or a Pacific Islander, and 8·0% were Black. In the year before the study start date, 74 284 (2·2%) had a positive SARS-CoV-2 PCR test.[2]

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Over the entire study period, the vaccine was 73% (95% CI 72–74) effective against infection among fully vaccinated people. However, the effectiveness against infections was highest during the first month after full vaccination (88% [86–89]), falling to 47% (43–51) after 5 months. Effectiveness against delta variant infections was similarly high during the first month after full vaccination (93% [85–97]), declining to 53% (39–65) effectiveness at 4 months after completion of the initial vaccine series. Similar declines in vaccine effectiveness were observed with non-delta variants. Fortunately, the protection against hospital admissions remained high at 93% (84–96) for delta and 95% (90–98) for non-delta variants throughout the 6-month observation period. Taken together, these data support the narrative of waning vaccine-related immune protection over time against SARS-CoV-2 infection, regardless of variant, thereby supporting the potential benefit of a booster injection 6–8 months after completion of the initial BNT162b2 vaccine series.

The strengths of this study include its large sample size, ability to evaluate a subset of individuals who were infected with delta and other variants, and continuous assessment of vaccine status, incident SARS-CoV-2 infection, and hospital admissions. The limitations include inability to establish a causal relationship between vaccinations and outcomes owing to the retrospective nature of the study, absence of randomisation, channelling bias (ie, tendency for clinicians to prescribe treatment based on a patient's prognosis), and the likelihood that some individuals were diagnosed with COVID-19 or received vaccination outside of the KPSC system. A key missed opportunity is the absence of assessment of those who had previous COVID-19 and the effect of

vaccination, or no vaccination, on a recurrent episode of infection.

Despite the contributions of this Article, many questions remain unanswered. Is immunity more robust for those who had a longer (eg, 3 month) gap between vaccinations? What about the need for a third vaccination among those who received the mRNA-1273 (Moderna) vaccine series or a second vaccination for those who received the Ad26.COV2.S (Janssen) vaccine? Is mixing and matching vaccine products (eg, BNT162b2 followed by mRNA-1273) beneficial and safe? Does this immunity wane in a similar manner as the vaccine for those who have had COVID-19 previously? Does vaccination after SARS-CoV-2 infection generate broader and more durable immunity? Or do these individuals, too, need a booster? With preservation of protection against severe disease and hospital admissions, should vaccine distribution be prioritised to resource-constrained regions before commitment to a third vaccination for people who are immunocompetent?

The reason so many questions exist is simple: the rapid release of the vaccines, which is estimated to have saved more than 100 000 lives in the USA during the first 5 months,[5] did not allow collection of durability data. We are learning as we go. Studies like Tartof and colleagues' study provide essential insights into the nature of immune protection induced by COVID-19 vaccines that can inform public policy. Yet, data from one study are not sufficient to answer the remaining questions.

I declare no competing interests.

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Childhood lower respiratory tract infections: more evidence to do less

Paediatric overtesting and overtreatment are well known issues in the field of quality of care. Children are vulnerable, with a potentially fast-changing clinical course, meaning they might have more investigations than an adult, and inappropriate prescription of medications is more common.[1] Overtesting and over-treatment of children are especially prominent in infectious diseases, when fever or other symptoms such as cough can be unspecific and can be of viral or bacterial origin. Through the implementation of public health measures, such as vaccination, the spectrum of infectious pathogens has changed. Most common infections, including lower respiratory tract infections (LRTIs), are viral induced, and have a high prevalence of misuse of some medications, such as antibiotics. Different methods and clinical prediction models have been proposed to simplify stratification of children at high risk for bacterial disease[2] and support reduction of unnecessary diagnostics and treatment.[3-5] However, most prediction models do not provide accurate diagnostics to all subgroups of patients. Furthermore, biomarkers (eg, procalcitonin) to discriminate bacterial versus viral infection have been suggested[6] but are rarely used in primary care. Moreover, other factors, such as cognitive biases or fears of medical error can result in overtreatment.[7,8] The proportion of paediatric recommendations that are evidence based is increasing. Organisations, such as the American Academy of Pediatrics or the Choosing Wisely initiative assess the quality of different scientific studies, summarise them, and provide evidence-based recommendations for clinicians. These guidelines are regularly updated with new evidence, which can help guide the process of reducing inappropriate prescriptions of medications and overtesting.

A clinical trial by Paul Little and colleagues[9] published in *The Lancet* compared antibiotic treatment with


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