



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.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

protective effects of BCG vaccination on infections,<sup>10</sup> randomised trials are warranted to establish the validity and strength of such effects.

We declare no competing interests.

\*Mihai G Netea, Reinout van Crevel  
mihai.netea@radboudumc.nl

Department of Internal Medicine and Center for Infectious Diseases, Radboud University, Nijmegen, Netherlands (MGN, RvC); Department of Immunology and Metabolism, Life and Medical Sciences Institute, University of Bonn, Bonn, Germany (MGN)

- Doherty M, Buchy P, Standaert B, Giaquinto C, Prado-Cohrs D. Vaccine impact: benefits for human health. *Vaccine* 2016; **34**: 6707–14.
- Benn CS, Netea MG, Selin LK, Aaby P. A small jab—a big effect: nonspecific immunomodulation by vaccines. *Trends Immunol* 2013; **34**: 431–39.
- Glynn JR, Dube A, Fielding K, et al. The effect of BCG revaccination on all-cause mortality beyond infancy: 30-year follow-up of a population-based, double-blind, randomised placebo-controlled trial in Malawi. *Lancet Infect Dis* 2021; published online July 5. [https://doi.org/10.1016/S1473-3099\(20\)30994-4](https://doi.org/10.1016/S1473-3099(20)30994-4).
- Aaby P, Roth A, Ravn H, et al. Randomized trial of BCG vaccination at birth to low-birth-weight children: beneficial nonspecific effects in the neonatal period? *J Infect Dis* 2011; **204**: 245–52.
- Netea MG, Domínguez-Andrés J, Barreiro LB, et al. Defining trained immunity and its role in health and disease. *Nat Rev Immunol* 2020; **20**: 375–88.
- Rieckmann A, Villumsen M, Sørup S, et al. Vaccinations against smallpox and tuberculosis are associated with better long-term survival: a Danish case-cohort study 1971–2010. *Int J Epidemiol* 2017; **46**: 695–705.
- Usher NT, Chang S, Howard RS, et al. Association of BCG vaccination in childhood with subsequent cancer diagnoses: a 60-year follow-up of a clinical trial. *JAMA Netw Open* 2019; **2**: e1912014.
- Sfakianos JP, Salome B, Daza J, Farkas A, Bhardwaj N, Horowitz A. Bacillus Calmette-Guérin (BCG): its fight against pathogens and cancer. *Urol Oncol* 2021; **39**: 121–29.
- Arts RJW, Moorlag SJCFM, Novakovic B, et al. BCG vaccination protects against experimental viral infection in humans through the induction of cytokines associated with trained immunity. *Cell Host Microbe* 2018; **23**: 89–100.e5.
- Giamarellos-Bourboulis EJ, Tsilika M, Moorlag S, et al. Activate: randomized clinical trial of BCG vaccination against infection in the elderly. *Cell* 2020; **183**: 315–323.e9.

## India's COVID-19 vaccination drive: key challenges and resolutions



India has been gravely struck by the second wave of COVID-19<sup>1</sup> caused by SARS-CoV-2, and is predicted to be hit by the third wave in the next few months. It is challenging for the Government of India to implement a mass vaccination drive while mitigating the subsequent COVID-19 waves. Recommendations for the second wave of COVID-19 in India have been described elsewhere.<sup>2</sup> Here, we highlight challenges and resolution measures for mass vaccination of the second-most populous country in the world.

India sustains a staggering 17.7% (1.39 billion) of the world's population, and vaccine production has therefore been a challenge in the country. India has three vaccines (Covishield [ChAdOx1 nCoV-19; Oxford–AstraZeneca; manufactured by Serum Institute of India], Covaxin [BBV152; Bharat Biotech], and Sputnik V [Gam-COVID-Vac; Gamaleya Research Institute of Epidemiology and Microbiology]) approved for emergency use. Around 70 million Covishield doses and 10 million Covaxin doses per month have been manufactured in India up to May, 2021.<sup>3</sup> This production pace is insufficient to cover the enormous population of India; hence, manufacturers have committed 100 and 80 million doses per month, respectively, in the coming months. Indian Immunologicals will also provide 10–15 million doses of Covaxin per month by

August–September, 2021.<sup>3</sup> Besides national production, the country should also consider importation to achieve mass vaccination quickly.

Vaccination planning has also been a challenge in India. Earlier in the year, individual Indian citizens had to register on the CoWIN or Aarogya Setu portal in order to receive a COVID-19 vaccination. The limited number of vaccination slots resulted in fewer administrations during the initial 5 months of the vaccination programme (phase 1–4). The Government of India has now amended the vaccination policy by waiving the preregistration requirement and offering free vaccinations to accelerate the programme. However, mass gatherings at health-care settings might lead to a further surge in daily cases. Door-to-door vaccination might be a feasible and safe solution to avoid such assemblies.

The COVID-19 vaccine drive in India was launched on Jan 16, 2021. From May 1, 2021, all people older than 18 years are eligible in phase 4 of the vaccination drive. By July 20, 2021, 326.4 million people in India (23.4% of the population) had received the first dose of the vaccine, and 85.4 million people (6.1% of the population) had received the second dose.<sup>4</sup> At the current pace, it would not be possible to vaccinate the whole nation by the end of 2021. The Government of

Published Online  
September 13, 2021  
[https://doi.org/10.1016/S1473-3099\(21\)00567-3](https://doi.org/10.1016/S1473-3099(21)00567-3)

India therefore implemented a centralised vaccination policy and administered more than 8.6 million COVID-19 vaccine doses on day 1 (June 21, 2021).<sup>4</sup> Such a vaccination strategy might be helpful in achieving mass vaccination against COVID-19. However, ensuring a consistent vaccine supply is a substantial challenge to maintaining such a high pace and achieve nationwide coverage.

Vaccine hesitancy is a widespread challenge in India, fuelled by misinformation and mistrust, particularly in rural areas where 65.5% of the population resides. For example, in Jamsoti village (Uttar Pradesh), there is a prevalent myth that SARS-CoV-2 does not exist in villages.<sup>5</sup> In another instance, a team for COVID-19 awareness and vaccination drive was attacked by the local residents of Malkhedi village (Madhya Pradesh). Rumours about vaccines disrupting the menstruation cycle and reducing fertility have also contributed to fear and skewed the data in favour of men.<sup>5</sup> To overcome these rumours at the village level, the Government of India needs to take stringent actions to achieve mass awareness and vaccination. Village heads and community health workers could have a proactive role in organising culturally relatable campaigns in local languages.

Various SARS-CoV-2 variants have emerged worldwide and been classified as variants of interest, variants of concern, and variants of high consequence on the basis of their impact on transmission, disease severity, diagnostics, vaccines, and therapeutics.<sup>6</sup> In India, variants of interest such as B.1.617 (sub lineages B.1.617.1 [kappa] and B.1.617.3) and B.1.618 have emerged. Currently, the variants of concern B.1.617.2 (delta) and B.1.617.2.1 (delta plus) are spreading quickly across the world, including in India.<sup>7</sup> Vaccine efficacy against these variants is a big concern. In a recent study, the effectiveness of Covishield against the SARS-CoV-2 delta variant was found to be only 60%.<sup>8</sup> The experience of Seychelles with the potency of the vaccines should concern everyone, especially those in India. Despite fully vaccinating 63% of its population, as of May 15, 2021, Seychelles reported more COVID-19 cases per 1 million people than India.<sup>9</sup> This surge in infections has put the vaccines' effectiveness against novel variants under scrutiny, as well as casting doubt

on the lifting of economic and festive restrictions. However, optimism about the vaccines remains as more than 80% of hospital admissions, almost all the severe cases requiring intensive care unit admission, and COVID-19 related deaths have been observed only in the unvaccinated population of Seychelles.<sup>10</sup>

In conclusion, the Government of India needs to devise effective public health strategies regarding mass vaccination and avoid assembling people at health-care units for vaccination. Many states have adopted door-to-door vaccination to avoid superspreading and to assist in the nation's mass vaccination efforts. Vaccine hesitancy should be tackled by awareness campaigns at the village level. Looking at the emerging SARS-CoV-2 variants, the government should focus on maintaining a high vaccination pace and coverage with a double-dose of COVID-19 vaccine and a shorter time between doses so that high efficacy rates can be achieved in the whole population of India.

We declare no competing interests.

\*Om Prakash Choudhary, Priyanka Choudhary, Indraj Singh dr.om.choudhary@gmail.com

Department of Veterinary Anatomy and Histology (OPC) and Type IV Quarter (PC), College of Veterinary Sciences and Animal Husbandry, Central Agricultural University Imphal, Selesih, Aizawl-796015, Mizoram, India; Community Health Centre, Deoband, Saharanpur-247554, Uttar Pradesh, India (IS)

- 1 The Lancet. India's COVID-19 emergency. *Lancet* 2021; **397**: 1683.
- 2 Balsari S, Udhwadia Z, Shaikh A, Ghafur A, Kataria S. Contextualising evidence-based recommendations for the second wave of the COVID-19 pandemic in India. *Lancet Infect Dis* 2021; **21**: 905-07.
- 3 Cohen J. The pandemic surge at home is threatening an Indian vaccine maker's bid to protect the world. *Science* 2021; published online May 14. <https://doi.org/10.1126/science.abj4746>.
- 4 Ministry of Health and Family Welfare. Cumulative coverage report of COVID-19 vaccination. Government of India. 2021. <https://www.mohfw.gov.in/pdf/CumulativeCovidVaccinationReport19thJuly2021.pdf> (accessed July 20, 2021).
- 5 Singh RK. Vaccine hesitancy puts India's gain against coronavirus at risk. June 21, 2021. <https://apnews.com/article/india-science-coronavirus-pandemic-health-8dd07a1f6bb56f4352130307f843458f> (accessed July 20, 2021).
- 6 Centers for Disease Control and Prevention. SARS-CoV-2 variant classifications and definitions. 2021 <https://www.cdc.gov/coronavirus/2019-ncov/variants/variant-info.html> (accessed July 1, 2021).
- 7 WHO. Tracking SARS-CoV-2 variants of concern. 2021. <https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/> (accessed July 1, 2021).
- 8 Bernal JL, Andrews N, Gower C, et al. Effectiveness of COVID-19 vaccines against the B.1.617.2 (delta) variant. *N Engl J Med* 2021; **385**: 585-94.
- 9 Subramanian SV. India faces a challenge with its mass vaccination efforts. *Lancet Glob Health* 2021; **9**: e1201-02.
- 10 Ministry of Health Republic of Seychelles. COVID-19 update: running average, 24 May 2021. <http://www.health.gov.sc/index.php/2021/05/26/covid-19-update-running-average-24-may-2021/> (accessed July 20, 2021).