Quantifying the effect of vaccination on transmission in modelling studies

Daniel Pan,[a,b,c,d,e,f] Ji Soo Choi,[a,b,c,d] Christopher A. Martin,[a,b,c,d] Joshua Nazareth,[a,b,c,d] Laura B. Nellums,[g] and Manish Pareek[a,b,c,d,*]

[a]Development Centre for Population Health, University of Leicester, United Kingdom
[b]Department of Respiratory Sciences, University of Leicester, United Kingdom
[c]Department of Infectious Diseases and HIV Medicine, University Hospitals of Leicester NHS Trust, United Kingdom
[d]NIHR Leicester Biomedical Research Centre, United Kingdom
[e]Li Ka Shing Centre for Health Information and Discovery, Oxford Big Data Institute, University of Oxford, United Kingdom
[f]WHO Collaborating Centre for Infectious Disease Epidemiology and Control, School of Public Health, Li Ka Shing Faculty of Medicine, The University of Hong Kong, Hong Kong, China
[g]College of Population Health, University of New Mexico, Albuquerque, USA

eClinicalMedicine
2024;73: 102669
Published Online xxx
https://doi.org/10.1016/j.eclinm.2024.102669

We read with great interest work by Bartsch and colleagues, who used a computational model of the United States population to explore the impact of a universal pan-coronavirus vaccine. This work is highly impactful because the authors demonstrated that such a vaccine could offer significant reductions in infection, hospitalisation and death, as well as economic costs.[1]

We note that whilst this study does consider the effect of vaccines on protection against infection, the model used did not consider the effect of vaccines on reducing transmission, because this occurs *once they are infected* and may be independent of exposure, infection or severe disease as shown in Fig. 1. Transmission is also directly related to the quantity of virus someone emits, a variable that is rarely studied in the SARS-CoV-2 literature compared to other variables such as age, gender and comorbidities, which are related to exposure, infection and disease severity.

Current SARS-CoV-2 vaccines have little effect on transmission compared to severe disease.[2] However, there are many reasons why the risk of transmission from an infected individual should be considered within vaccine modelling studies. First, it should be a key outcome for vaccine effectiveness. A stockpiled vaccine that directly cuts the chain of transmission would be more effective at preventing an emerging coronavirus

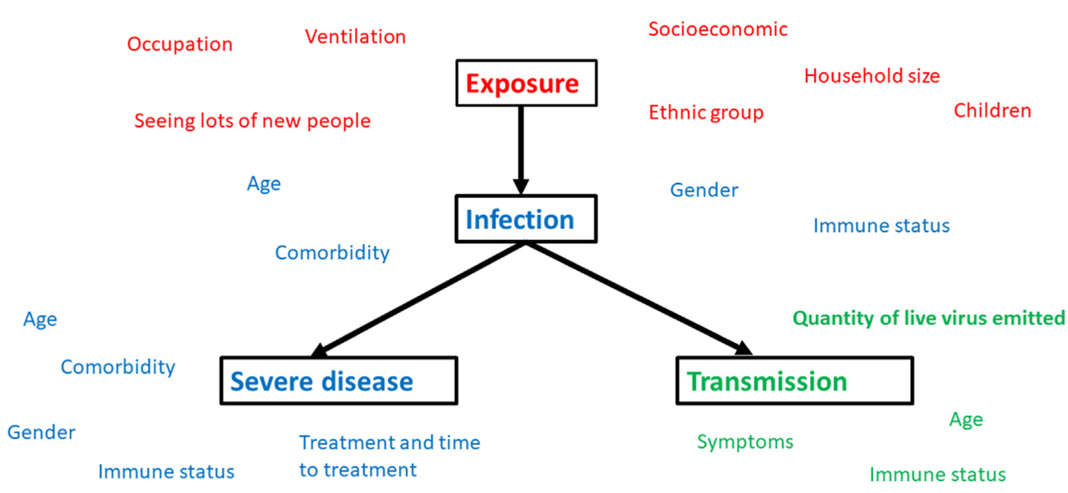

Fig. 1: **A compartmental diagram indicating key outcomes for COVID-19**. Factors relating to each outcome are outlined outside the dark boxes, in the same colour as the outcome. Vaccination primarily has an effect on infection and severe disease (outlined in blue), but not on exposure (outlined in red) or transmission (outlined in green, with quantity of live virus emitted in bold because it is the most important variable in relation to transmission).

DOI of original article: https://doi.org/10.1016/j.eclinm.2024.102670
*Corresponding author. Development Centre for Population Health, University of Leicester, United Kingdom.
E-mail address: manish.pareek@leicester.ac.uk (M. Pareek).
© 2024 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

from becoming a pandemic compared to one that is focused on mitigating severe disease. Second, the likelihood of transmission is not necessarily proportional to disease severity; those who are most infectious could be asymptomatic or pauci-symptomatic at the time of a transmission event, when they are unaware that they are infected and thus most likely to infect others.[3] Third, the COVID-19 pandemic has shown us that highly infectious individuals can cause disproportionate morbidity and mortality in environments with vulnerable people, such as nursing homes and hospitals.[4]

Demonstrating the benefits of a pan-coronavirus vaccine that can reduce transmission by reducing the infectiousness of the host is of considerable public health importance. Making a vaccine that can reduce viral emissions would require significant time, resources and perhaps administration directly into the upper respiratory tract, rather than the intramuscular route.[5] However, successful development and stockpiling of such a vaccine could be major breakthrough for not only SARS-CoV-2, but also for future coronavirus pandemics. We would be greatly interested to see the effects of a vaccine that could reduce transmission within the model of this paper by decreasing viral emissions from an infected host; such a model would justify even more the development of a pan-coronavirus vaccine as well as the specific investigation of transmission as a clinical outcome in future vaccine development.

Contributors

DP and JSC wrote the first version of the manuscript. CAM, JN, LBN and MP reviewed and approved the final version of the manuscript.

Declaration of interests

All authors declare no competing interests. DP is funded by a NIHR Doctoral Research Fellowship (NIHR302338).

References

1 Bartsch SM, O'Shea KJ, John DC, et al. The potential epidemiologic, clinical and economic value of a universal coronavirus vaccine: a modelling study. *eClinicalMedicine*. 2024;68:102369.
2 Singanayaman A, Hakki S, Dunning J, et al. Community transmission and viral load kinetics of SARS-CoV-2 delta (B.1.617.2) variant in vaccinated and unvaccinated individuals in the UK: a prospective, longitudinal, cohort study. *Lancet Infect Dis*. 2021;22(2):183–195.
3 Johansson MA, Quandelacy TM, Kada S, et al. SARS-CoV-2 transmission from people without COVID-19 symptoms. *JAMA Netw Open*. 2021;4(1):e2035057.
4 Bjoerkheim BM, Tabarrok A. Covid in the nursing homes: the US experience. *Oxf Rev Econ Pol*. 2022;38(4):887–911.
5 Adler JM, Martin VR, Langner C, et al. An intranasal live-attenuated SARS-CoV-2 vaccine limits transmission. *Nat Commun*. 2024;15:995.