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Short Communication

SARS-CoV-2 infection in fully vaccinated healthcare workers

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Introduction

The BNT162b2 mRNA COVID-19 vaccine has shown optimal protection in humans against severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) (Polack et al., 2020); this vaccine generates codification of the spike protein with high levels of immunity. In 2020, Yu et al. reported infections after exposure to SARS-CoV-2 in fully vaccinated monkeys; however, these animals showed much lower viral loads compared with the unvaccinated control group, suggesting correlation between neutralizing antibody levels of post-vaccine serum and protection against SARS-CoV-2.

Currently, following infection with SARS-CoV-2, the titres of neutralizing antibodies produced are considered to be correlated with protection against SARS-CoV-2 (Suthar et al., 2020; Manisty et al., 2021), although the production of these antibodies is not a prerequisite for the resolution of infection (Prévost et al., 2020; Reynolds et al., 2020).

On the other hand, assays that detect receptor-binding domain (RBD) immunoglobulin G (IgG) are highly specific and sensitive, and the information in their titres can be used as a substitute for neutralizing activity against SARS-CoV-2 (Suthar et al., 2020). It should be noted that the World Health Organization has not yet established the levels of antibodies needed to determine the efficacy or durability of a vaccine (World Health Organization, 2020).

Methods

Screening for SARS-CoV-2 infection was undertaken among healthcare workers vaccinated with BNT162b2 mRNA COVID-19 vaccine who had been in close contact with positive cases, who had just started work at the study hospital, or before travelling to another region in the country.

Reverse transcriptase polymerase chain reaction (PCR) (Allplex SARS-CoV-2/FluA/FluB/RSV Assay, Seegene, Seoul, South Korea) using nasopharyngeal swabs taken from both nostrils was performed. This assay is able to detect and differentiate between three different target genes of COVID-19 (S gene, RdRP gene and N gene).

Antibody titres were measured using three different Abbott ARCHITECT i System assays: SARS-CoV-2 spike-specific quantitative IgG (post-vaccine IgG detection), SARS-CoV-2 IgG (nucleocapsid IgG) and SARS-CoV-2 IgM (spike 1 RBD IgM) in serum.

Results and discussion

The total number of healthcare workers at the study hospital was 5773; of these, 5543 (96%) had received one dose of the vaccine and 5484 (95%) had received both doses.

This article reports five cases of SARS-CoV-2 infection in fully vaccinated healthcare workers that occurred >15 days after administration of the second dose of BNT162b2 mRNA Covid-19 vaccine. These cases represent 0.4% of all 1250 PCR assays performed on healthcare workers at the study centre after two doses of the vaccine. It was believed that sufficient time had passed since the second dose of vaccine for development of the humoral response, and yet these five healthcare workers became infected.

All cases had high cycle threshold (Ct) values (mean 35.84, range 38.01–33.51), and were asymptomatic at the time of PCR

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Table 1

Reverse transcriptase polymerase chain reaction (RT-PCR) amplification cycles and antibody titres against severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) in each case.

Case	Amplification cycle (RT-PCR)			Post-vaccine IgG		Nucleocapsid antibody (IgG qualitative)	Spike-RBD antibody (IgM qualitiative)
	Gene S	Gene RdRP	Gene N	Result	BAU/mL		
A	35.09	35.78	38.01	Positive	2861.7	Negative	Positive
B	35.86	36.74	–	Positive	4420.7	Negative	Negative
C	37.52	37.33	–	Positive	3392	Positive	Positive
D	36.79	37.27	–	Positive	778.9	Negative	Negative
E	34.06	37.95	33.51	Positive	1530	Negative	Positive

BAU, binding antibody units.

determination. None of them had developed symptoms by 10-day follow-up. The positive samples were sent for sequencing in order to determine whether the healthcare workers were infected with variants of concern, but it was not possible to obtain results as these types of test are not useful with such high Ct values.

The post-vaccine IgG level was between 778.9 and 4420 binding antibody units/mL (mean 2197, standard deviation 1455). The results are shown in Table 1. Case C was positive for nucleocapsid IgG, so could be related with a large evolution of the infection.

Two patient care technicians (Cases A and B) were detected after one of them returned to work following a holiday; following an epidemiological survey, PCR was performed on their co-worker, and this returned a positive result without other previous risk exposure. These two cases could be epidemiologically related if these healthcare workers did not protect themselves adequately in the rest area. It is believed that there was one secondary case from one of these diagnosed healthcare workers. No further secondary cases appear to have derived from these workers.

As soon as the diagnosis was made, cases who had been close contacts were identified and quarantined; no more cases were diagnosed. Two other cases (C and D) were a nurse and a patient care technician who were close contacts of a positive patient in the emergency department; they did not have close contact with each other.

The last case (E) was a casual finding in a travel screening PCR test who had not been in contact with a previously identified positive case.

This study reflects how vaccination protected healthcare workers from disease, but the transmissibility of the virus following vaccination remains to be determined (Hodgson et al., 2021). The European Centre for Disease Control and Prevention has recently conducted a review of published literature on the duration and characteristics of immunity following natural SARS-CoV-2 infection and following vaccination (European Centre for Disease Prevention and Control, 2021); this concluded that follow-up of cohorts with previous SARS-CoV-2 infection and vaccination is needed to better assess the effect of protection against virus transmission.

Conclusions

For all these reasons, it is important to preserve prevention measures against SARS-CoV-2 in the hospital environment at the present time, particularly as vaccinated healthcare staff may develop the false belief that they cannot be infected by the virus after vaccination.

Conflict of interest statement

None declared.

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Ethical approval

Not required.

References

European Centre for Disease Prevention and Control. Risk of SARS-CoV-2 transmission from newly-infected individuals with documented previous infection or vaccination. 29 March 2021. Stockholm: ECDC; 2021.

Hodgson SH, Mansatta K, Mallett G, Harris V, Emary KRW, Pollard AJ. What defines an efficacious COVID-19 vaccine? A review of the challenges assessing the clinical efficacy of vaccines against SARS-CoV-2. Lancet Infect Dis 2021;21:e26–35.

Manisty C, Treibel TA, Jensen M, Semper A, Joy G, Gupta RK, et al. Time series analysis and mechanistic modelling of heterogeneity and sero-reversion in antibody responses to mild SARSCoV-2 infection. EBioMedicine 2021;65:103259.

Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. N Engl J Med 2020;383:2603–15.

Prévost J, Gasser R, Beaudoin-Bussières G, Richard J, Duerr R, Laumaea A, et al. Cross-sectional evaluation of humoral responses against SARS-CoV-2 spike. Cell Rep Med 2020;1:100126.

Reynolds CJ, Swadling L, Gibbons JM, Pade C, Jensen MP, Diniz MO, et al. Discordant neutralizing antibody and T cell responses in asymptomatic and mild SARS-CoV-2 infection. Sci Immunol 2020;5(54)eabf3698, doi:http://dx.doi.org/10.1126/sciimmunol.abf3698.

Suthar MS, Zimmerman MG, Kauffman RC, Mantus G, Linderman SL, Hudson WH, et al. Rapid generation of neutralizing antibody responses in COVID-19 patients. Cell Rep Med 2020;1:100040.

World Health Organization. Establishment of the WHO International Standard and Reference Panel for anti-SARS-CoV-2 antibody. Geneva: WHO; 2020 Available at: https://www.who.int/publications/m/item/WHO-BS-2020.2403. [Accessed 15 June 2021].

Yu J, Tostanoski LH, Peter L, Mercado NB, McMahan K, Mahrokhian SH, et al. DNA vaccine protection against SARS-CoV-2 in rhesus macaques. Science 2020;369(6505):806–11, doi:http://dx.doi.org/10.1126/science.abc6284.