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Research note

SARS-CoV-2 new infections among health-care workers after the first dose of the BNT162b2 mRNA COVID-19 vaccine. A hospital-wide cohort study

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ABSTRACT

Objectives: To evaluate the effect of mRNA severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) vaccination on the incidence of new SARS-CoV-2 infections in health-care workers (HCW).

Methods: The evolution of the incident rate of microbiologically confirmed SARS-CoV-2 infection in a cohort of 2590 HCW after BNT162b2 mRNA SARS-CoV-2 vaccination, compared with the rate in the community ($n = 170\ 513$) was evaluated by mixed Poisson regression models.

Results: A total of 1820 HCW (70.3% of total) received the first dose of the BNT162b2 mRNA vaccine between 10 January and 16 January 2021, and 296 (11.4%) received it the following week. All of them completed vaccination 3 weeks later. Incidence rates of SARS-CoV-2 infection after the first dose of mRNA SARS-CoV-2 vaccine declined by 71% (Incidence Rate Ratio (IRR) 0.286, 95% CI 0.174–0.468; $p < 0.001$) and by 97% (IRR 0.03, 95% CI 0.013–0.068; $p < 0.001$) after the second dose, compared with the perivaccine time. SARS-CoV-2 incidence rates in the community (with a negligible vaccination rate) had a much lower decline: 2% (IRR 0.984, 95% CI 0.943–1.028; $p 0.47$) and 61% (IRR 0.390, 95% CI 0.375–0.406; $p < 0.001$) for equivalent periods. Adjusting for the decline in the community, the reduction in the incident rates among HCW were 73% (IRR 0.272, 95% CI 0.164–0.451 $p < 0.001$) after the first dose of the vaccine and 92% (IRR 0.176, 95% CI 0.033–0.174; $p < 0.001$) after the second dose.

Conclusions: mRNA SARS-CoV-2 vaccination is associated with a dramatic decline in new SARS-CoV-2 infection among HCW, even before the administration of the second dose of the vaccine.

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Introduction

Besides the appropriate use of personal protection equipment, vaccination has become the main tool for the control of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in the clinical setting [1]. However, there is scant evidence regarding the effects of SARS-CoV-2 vaccination on the incidence of new SARS-CoV-2 infection among health-care workers (HCW) [2–5].

We sought to describe the effects of a hospital-wide vaccination programme with BNT162b2 mRNA coronavirus disease 2019 (COVID-19) vaccine (Pfizer/BioNtech) on the evolution of new SARS-CoV-2 infections among HCW, compared with the evolution in the general population in the same geographical area.

Materials and methods

The cohort of 2590 HCW attended at the Occupation Health Unit of the hospital. SARS-CoV-2 tests from nasopharyngeal swabs were performed for all HCW when they had a SARS-CoV-2 risk exposure (either at work or in the community) or developed any symptoms compatible with SARS-CoV-2 infection. The Abbott Panbio Rapid Antigenic Corona® antigen test (Abbott Laboratories, Chicago, IL, USA) was used for symptomatic HCW [6]. If negative, a SARS-CoV-2 PCR test was performed 48–72 hours later. Asymptomatic HCW were evaluated with a SARS-CoV-2 PCR test using nasopharyngeal swabs with the Bio-Rad CFX96™ Real-Time PCR Detection System (Bio-Rad, 1000 Alfred Nobel Drive, Hercules, California 94547, USA), as previously described [7,8]. New HCW infections were defined as a SARS-CoV-2 positive antigen or PCR test. Date of infection was defined as the date of the first positive test. Weekly incident rates and 95% exact Poisson confidence intervals were calculated. Weekly community incidence rates at Alcorcón ($n = 170\,513$ inhabitants) were obtained from the official data published by regional and national authorities [9]. For the purpose of this paper, three time periods were used: peri-vaccination (Period 0: 3 weeks before the beginning of vaccination, the first week of first dose massive vaccination, and the week thereafter), intermediate

(Period 1: weeks 2–4 after first dose vaccination) and post-vaccination (Period 2: weeks 5–14 after the first doses of the vaccine, i.e. 1 week after the full vaccination and thereafter; Figs. 1 and 2). These times were chosen as representative of baseline pre-vaccination, and expected immunological effects of the first dose of the vaccine and the full vaccination [10]. Relative changes in the incidence of new SARS-CoV-2 infection in HCW and in the geographical area of the hospital were evaluated by multivariate regression models. To estimate rate ratio between periods, a mixed Poisson regression model with group (HCW/community) and time periods as random effects and the group population as exposure variable was adjusted. Analysis was performed with STATA 14 (StataCorp., 4905 Lakeway Drive, College Station, TX 77845, USA). The study was approved by the Independent Review Board (CEIm) of Hospital Universitario Fundación Alcorcón. All HCW signed an informed content.

Results

The BNT162b2 COVID-19 mRNA vaccine was offered to all HCW as soon as it was available (11 January 2021). A total of 1820 HCW (70% of total) received the first dose in the first week (11–17 January 2021) and 296 (11%) the following week (Figs. 1 and 2). A total of 116 new SARS-CoV-2 infections were detected at the Occupational Health Unit among HCW during the study period (between 21 December 2020 and 24 April 2021). Seventy-one HCW (61%) had a positive PCR test, 18 (16%) had a positive antigen test and 27 (23%) had both. Globally, 84% of new infections were confirmed by at least one positive PCR test. Fifty-five new infections were symptomatic

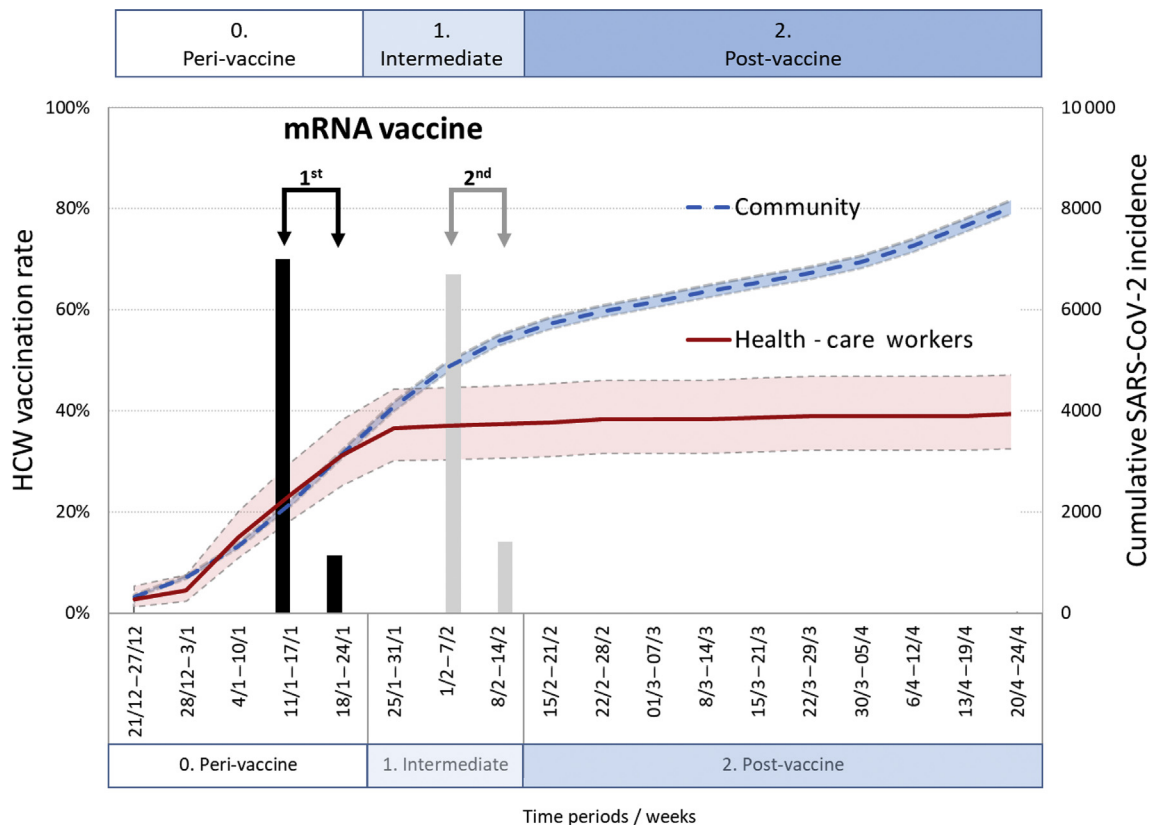


Fig. 1. Cumulative incident rate per 100 000 individuals of new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections among health-care workers (HCW) at Hospital Universitario Fundación Alcorcón ($n = 2590$) and the general population at Alcorcón (Madrid, Spain; $n = 170\,513$) from 21 December 2020. Shaded areas depict 95% CI. The proportions of HCW receiving the first and second doses of the BNT162b2 mRNA coronavirus disease 2019 vaccine are indicated at the appropriate times (bars). Vaccine-related periods are highlighted, indicating the expected immunological effects of the vaccine.

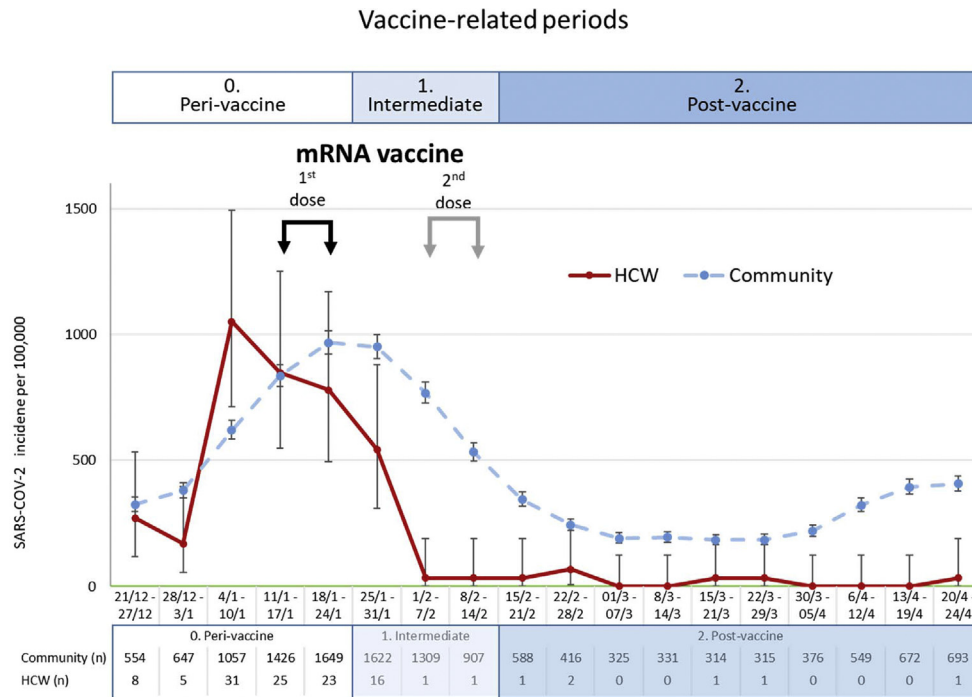


Fig. 2. Weekly incident rate of new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections among health-care workers (HCW) at Hospital Universitario Fundación Alcorcón and the general population of Alcorcón. Weekly incident rate per 100 000 individuals of new SARS-CoV-2 infections among health-care workers (HCW) at Hospital Universitario Fundación Alcorcón ($n = 2590$) and 95% exact Poisson confidence intervals. As a reference, the incident rate and the general population at Alcorcón (Madrid, Spain; $n = 170\,513$) depicts the evolution of the 'third' wave of the disease. Bottom table describes the weekly individual new diagnosis (n) of SARS-CoV-2 infections both among HCW and the general population of Alcorcón. Timing of the first and second doses of the BNT162b2 mRNA coronavirus disease 2019 vaccine are indicated (arrows). Vaccine-related periods are highlighted, indicating the expected immunological effects of the vaccine.

(47%), while the remaining 60 (53%) were detected as part of a screening protocol after close contact with individuals with COVID-19 ($n = 29$; 25%), nosocomial outbreak evaluation ($n = 29$; 25%) or travel requirements ($n = 2$; 2%).

The number of HCW diagnosed with acute SARS-CoV-2 infection dropped by 71% in weeks 2–4 after the first dose vaccination compared with the previous 5 weeks (Period 0: peri-vaccine—Incidence Rate Ratio (IRR) 0.286, 95% CI 0.174–0.468; $p < 0.001$; Figs. 1 and 2, and see Supplementary material, Table S1 and Fig. S1). New SARS-CoV-2 infections among HCW virtually disappeared after the second dose of the vaccine (97% reduction, IRR 0.030, 95% CI 0.013–0.068; $p < 0.001$) compared with Period 0 (peri-vaccine; Figs. 1 and 2; and see Supplementary material, Table S1). There was also a reduction in the number of new SARS-CoV-2 infections in the general population at Alcorcón (Figs. 1 and 2), depicting the evolution of the 'third' wave of the disease, 2% (IRR 0.984, 95% CI 0.943–1.028; $p < 0.47$) and 61% (IRR 0.390, 95% CI 0.375–0.406; $p < 0.001$) for the same time periods, respectively. During the time of the study the vaccination rate in the community was negligible (4.8% on 29 March 2021 [11]). By Poisson model regression analysis, the reduced incidence among HCW adjusting for the background changes in the general population remained statistically and clinically significant: 3% reduction (IRR 0.272, 95% CI 0.164–0.451; $p < 0.001$) after the first dose of the vaccine and 92% (IRR 0.176, 95% CI 0.033–0.174; $p < 0.001$) after the second dose (see Supplementary material, Tables S1 and S2 and Fig. S1). It is conceivable that the response to the vaccine among HCW may have been boosted by a previous exposure to the virus [12,13]. As a sensitivity analysis we restricted the evaluation of new SARS-CoV-2 infections to HCW who had never tested positive in any of our wide seroprevalence surveys ($n = 1582$) [7]. As shown in the Supplementary material (Table S2), the decline in new SARS-CoV-2

infections was essentially identical to that in the total HCW population.

Discussion

Our results show a dramatic reduction in new SARS-CoV-2 infections in HCW after a hospital-wide vaccination programme with the BNT162b2 mRNA COVID-19 vaccine. Interestingly, the decline was important even before the administration of the second dose of the vaccine, suggesting that a single dose may confer substantial protection, in agreement with the original mRNA vaccination trials as well as recent observational studies [2–5]. However, our results should be interpreted with caution. First, we report a limited follow up in a medium-size hospital. Second, there was also a significant decline in the SARS-CoV-2 incidence in the general population within this time frame. The important reduction in the community rate most probably reflects the general public health measures made by regional and national governments, as the rate of vaccination in the general population in (Madrid) was lower than 5% [11]. Therefore, its potential effect on the declining infection rates in the community should be marginal. The powerful reduction among HCW strongly suggests a major role for the vaccine.

Our results after a single dose of the vaccine might not be extrapolated to other settings: our vaccination programme was extended to all HCW, including HCW with a previous documented SARS-CoV-2 infection [7]. We and others have recently shown that HCW with a previous SARS-CoV-2 infection exhibit a strong serological response to the first dose of the vaccine, reaching higher IgG anti-spike protein titres than those obtained after full vaccination in SARS-CoV-2 naive individuals [12,13]. Other vaccination programmes (excluding previously infected HCW) may exhibit a lower protection [2]. The protective effect of the first dose of the vaccine

in settings with a lower seroprevalence, such as the general population in Madrid, may be less evident [14]. However, in a sensitivity analysis excluding SARS-CoV-2-seropositive HCW before vaccination, the estimated decline in SARS-CoV-2 infection remained similar to that in the total HCW population. Recent reports have described a high degree of protection in HCW receiving the first dose of an RNA vaccine, in agreement with our results [5]. Our results are restricted to the BNT162b2 mRNA vaccine. Whether similar outcomes may be obtained with other vaccines cannot be ascertained from our data. However, recent data from the UK suggest that the protection provided by the first dose of mRNA or other vaccines may be substantial [15]. The optimal vaccination programme for HCW with previous SARS-CoV-2 infection remains to be defined.

In conclusion, a wide vaccination programme for HCW in the real world seems to offer powerful protection from new SARS-CoV-2 infection and provides a much safer clinical environment. Significant declines in SARS-CoV-2 infection rates may be achieved even before the full vaccination programme is completed. These data may encourage hesitant HCW to join vaccination efforts [4].

Author contribution

CG and MV wrote the original draft; CG, IG, DMP, EPF, JG, ZC and MVA performed the review and editing. Conceptualization was by CG, IG, VC and MV; data acquisition was by IG, DMP and MJG; methodology was by CG, EPF, MJG and MV; and formal analysis was by CG, EPF and MV.

Transparency declaration

The authors declare no conflict of interest for this paper. CG declares fees for advisory committees and lectures unrelated to the present work from Amgen, Daichi-Sankyo, MSD, Rubió and Sanofi. MV reports grants and personal fees from Gilead, grants for teaching courses from CINFA, MSD, ViiV and CINFA outside the submitted work.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cmi.2021.06.026>.

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