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Letter to the editor

Cumulative seroprevalence among healthcare workers after the first wave of the COVID-19 pandemic in El Salvador, Central America

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ARTICLE INFO

Article history:

Received 26 March 2022

Received in revised form

14 June 2022

Accepted 16 June 2022

Available online 28 June 2022

Editor: L. Leibovici

To the Editor,

The novel COVID-19 pandemic has threatened public health systems worldwide. Its impact, however, has been under-evaluated in most low- and middle-income countries, including regions in Central America [1]. We launched a seroepidemiological survey, extending from end-January to mid-February 2021, at a tertiary care referral hospital located in the capital city of El Salvador, where a large number of confirmed and far more suspected cases of SARS-CoV-2 affected healthcare workers (HCWs) had been documented during the first wave of the pandemic.

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A total 2322 HCWs from the National Clinical Laboratory and the National Rosales Hospital were recruited, of which 973 individuals (41.9% response rate, aged 43 ± 11 years, 71.7% female) having consented to participate were eligible for analysis. The sites served as the main referral facilities for COVID-19 during May through July 2020. The same level of protection (full length gown, face shield, N95 or higher-level filter mask, and gloves) was mandated for all of the COVID-19 contacts, and training for its use was provided uniformly. During the study period of end-January through mid-February 2021, the participants completed a questionnaire through the web-based REDCap electronic data capture tool [2] and provided sera for serological evaluation. The questionnaire queried about the participants' demographic data, anthropometric measurements, medical history, occupational role, prior COVID-19 diagnosis, and family member contracting COVID-19. The serological status was defined by the combination of two immunoassays: Roche Elecsys Anti-SARS-CoV-2 assay (Basel, Switzerland) and Abbott SARS-CoV-2 IgG II Quant (Chicago, IL, USA). The participants of 'indeterminate' serology with discordant results (1.7%, 17 of 973) were excluded from analyses. An χ^2 test was used upon comparison and the 'non-patient-related' occupations served as reference for risk ratio calculation. The p thresholds of Bonferroni-adjusted 0.017 defined the statistical significance. The research was approved by the Osaka City University Institutional Ethics Committee [#2020-003] and the National Research Ethics Committee of El Salvador [#CNEIS/2020/029].

The overall seropositivity rate in HCWs reached 52.6% (512 of 973). Among the seropositive individuals, 61.7% (316 of 512) had experienced documented COVID-19, of which 70.6% (223 of 316) were laboratory-confirmed by PCR (the rest were diagnosed clinically). Finally, those never having been suspected of the diagnosis nor underwent SARS-CoV-2 PCR testing, but still revealed positive for anti-SARS-CoV-2 antibodies, aggregated to the excessive 38.3% (196 of 512) of 'unrecognized seroconversions.' Nurses had the

highest seropositivity rate of 63.8%, followed by HCWs assigned to other patient-related work (55.9%), and medical doctors (46.7%). Auxiliary HCWs assigned to non-patient-related work, ranking bottom among occupations, still showed surprisingly high seroprevalence (44.2%). Additionally, 21.8% (97 of 444) of seronegative individuals reported of their family member contracting COVID-19.

The presented Salvadorian HCW cohort listed highest in seroprevalence (52.6%) among the pooled trend for HCWs globally (4.8% through 12.4%) [3,4], far exceeding that reported from Brazil (29.9%), another Latin American country [5]. The risk of infection per occupation generally reflected their variable degrees of proximity with COVID-19 patients; patient-related work associated with higher risk (see Table 1). Interestingly, however, respiratory care specialists who perform the highly aerosol-generating, endotracheal procedures on COVID-19 patients carried less risk in contracting the disease compared with cleaning staff entering the COVID-19 ward (45.5% vs. 71.9% in seroprevalence). Previous studies targeting HCWs have reported similar traits for cleaning personnel carrying high infection risk [6–8]. A high risk of infection among the cleaning staff has been attributed to their lower adherence to protective measures, due to less understanding about (1) the transmission mechanisms of viral respiratory infections, as well as (2) the proper use of countermeasures to mitigate them. Their circumstances outside the hospital (i.e. socioeconomic factors potentially linked to public transportation use or housing conditions prone to crowd exposure) have also been raised as contributing factors. The same logic may apply to our present cohort. Lastly, our data highlighted the possibility of the current epidemiological estimates having been under-representative of the true regional burden. Under-estimation of COVID-19 burden may be explained by the excessive number of pauci/asymptomatic, thus unrecognized, seroconversions [9]. Seroprevalence among non-patient-related Salvadorian HCWs (44.2%) was highly elevated to exceed twice the community seroprevalence in United States at the time (18.4%) [10]. Together with the high frequency (21.8%) of seronegative individuals in this study reporting of household COVID-19 cases, our findings in total were indicative of substantial transmission having occurred in the communities, potentially

outside the healthcare setting. Among the limitations of our study was the voluntary nature of participation. Accordingly, the response rate remained rather low, leaving room for bias if HCWs more health conscious and eager to be tested were more/less likely to be seropositive. The study targeted a single-centred cohort and thus may not have represented the general HCW population of the country. Also, the community seroprevalence in El Salvador remains to be elucidated before being conclusive on the major site of SARS-CoV-2 transmission among HCWs, whether within or outside the workplace.

Large healthcare-associated outbreaks not only endanger the assurance of quality care in the midst of a pandemic but also may impact the extent and kinetics of spread within the whole society. Alongside occupational exposures, protective measures are ought to target exposures outside the working environment with potential of subsequent introduction into the healthcare setting.

Author's contributions

YNa and MVRF conceptualized the study and performed the formal analyses. RD and YK provided supervision. YNa, MVRF, RD, and KSCM led the investigation. KSCM curated the data and ETK, YNi, and NK validated the outputs of the study. YNa visualised the data and wrote the original draft of the manuscript. MVRF, RD, ETK, NU, AK, and YK reviewed and edited the manuscript. YNa, NU, AK, and YK took parts in funding acquisition.

Transparency declaration

Yu Nakagama and Yasutoshi Kido report ownership of equity of Quantum Molecular Diagnostics, an Osaka City University spinout providing innovative diagnostics for infectious diseases. Yu Nakagama and Yasutoshi Kido also receive financial support outside the work from Abbott Japan, LLC.

Funding

This work was supported by Japan Agency for Medical Research and Development [grant numbers JP20jk0110021 and JP20he1122001]; the Osaka City University Strategic Research Grant 2021 for Young Researchers [grant number OCU-SRG2021_YR09]; Japan Society for the Promotion of Science KAKENHI [grant number 21K09078]; and the Osaka City University Special Reserves Fund for COVID-19.

Acknowledgements

The authors thank all healthcare workers who participated in the study as well as the co-investigators that facilitated data collection and material transfer.

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Table 1
Seropositivity rate in healthcare workers of different occupational categories

| Occupational category | Seropositive % (n = 512) | Seronegative % (n = 444) | Risk ratio | p ^a | |
|-----------------------------|-----------------------------|-----------------------------|------------|----------------|-------------------------------|
| Nurse | 222 | 63.8 | 120 | 34.5 | 1.44 <0.0001 ^b |
| Medical doctor | 50 | 46.7 | 56 | 52.3 | 1.05 0.69 |
| Other patient-related | 52 | 55.9 | 38 | 40.9 | 1.28 0.027 |
| Respiratory care specialist | 5 | 45.5 | 5 | 45.5 | |
| Radiology personnel | 12 | 52.2 | 9 | 39.1 | |
| Cleaning staff | 23 | 71.9 | 9 | 28.1 | |
| Other | 12 | 44.4 | 15 | 55.6 | |
| Non-patient related | 188 | 44.2 | 230 | 54.1 | — ^c — ^c |
| Blood bank personnel | 3 | 21.4 | 11 | 78.6 | |
| Laboratory professional | 26 | 28.0 | 65 | 69.9 | |
| Administrative officer | 98 | 51.3 | 90 | 47.1 | |
| Nutritionist | 6 | 60.0 | 3 | 30.0 | |
| Pharmacist | 17 | 68.0 | 8 | 32.0 | |
| Other | 38 | 41.3 | 53 | 57.6 | |

^a χ^2 test.

^b Statistically significant.

^c Reference group.

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