Seroprevalence of Anti-SARS-CoV-2 Antibodies in Healthcare Workers

ABSTRACT

The state of Guanajuato in Mexico has a high frequency of confirmed COVID-19 cases, significantly affecting healthcare workers due to their contact with infected patients. It was made a review on seroprevalence of antibodies againsta SARS-CoV-2 in healthcare woit was found a significant association between seropositivity and the type of work unit, as well as community exposure, while training in the proper use of personal protective equipment demonstrated a protective effect. These findings highlight the importance of healthcare workers adequately protecting themselves both in their work environment and in the community, not only in Guanajuato state.

Keywords: Antibodies; COVID-19; Infection; population; SARS-CoV-2

1. INTRODUCTION

Seroprevalence refers to the presence of specific antibodies against a pathogen. In the context of SARS-CoV-2, it indicates how many individuals have been infected by the virus and have developed a detectable immune response. Understanding seroprevalence was crucial for assessing the spread of the virus within the community and among specific groups, such as healthcare workers, at the beginning of the pandemic. Comprehending the immunity behind this seroprevalence, as well as the context of healthcare workers, is fundamental for developing effective infection prevention and control strategies.

2. COVID-19 AND SARS-COV-2

COVID-19 is an acute respiratory illness caused by the SARS-CoV-2 virus; in 80% of cases, it tends to be mild, but the remaining cases can be severe. Cardinal symptoms include fever, cough, and general malaise, but it can also cause respiratory failure, multisystem inflammatory syndrome, thrombotic events, and death. The disease was initially identified in December 2019 following cases of atypical pneumonia in Wuhan, a city in Hubei Province, China. Due to its rapid transmission, the World Health Organization (WHO)

Comment [AA1]: among

Comment [AA2]: Prevalenceof

Comment [AA3]: Recastthisstatement

Comment [AA4]: Youneedtore-writeyourabstractproperly. Itispoorlywritten

Comment [AA5]: Thisisnotthe actual definition

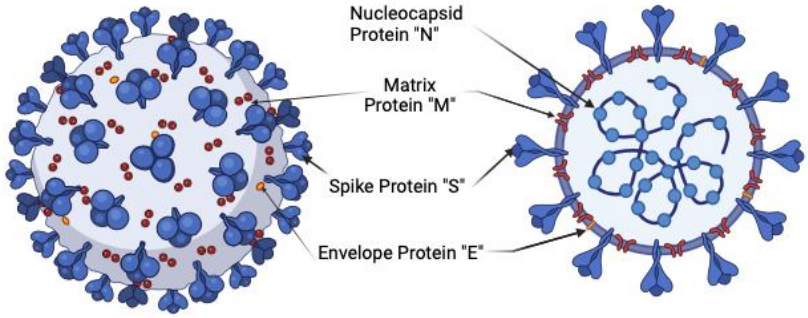
Comment [AA6]: reference

declared a public health emergency at the end of January 2020. In March of the same year, the WHO officially characterized the outbreak as a pandemic [1]. Currently, there have been 771,549,718 cases and 6,974,473 deaths globally due to COVID-19. In the latest epidemiological report from the WHO, it was detailed that, during the period from May 27 to June 23, 2024, the positivity rate of PCR tests for SARS-CoV-2 increased from 5.6% to 7.1%, particularly in the Americas and Europe. Over 135,000 new cases and more than 2,000 new deaths were recorded, representing a slight decrease of 3% compared to the previous period. The WHO emphasizes the importance of maintaining surveillance and monitoring infrastructures, including the provision of early clinical care, vaccination of high-risk groups, and improvements in ventilation [2].

The etiological agent of COVID-19 is SARS-CoV-2, a single-stranded RNA Betacoronavirus, similar to SARS-CoV and MERS-CoV, both of which have caused infectious outbreaks. Due to its genomic structure being very similar to coronaviruses isolated from bats, it is likely that these animals were the primary reservoirs before spreading to humans. Its RNA is encapsulated by a helical ribonucleocapsid formed by the nucleocapsid protein (N). The genome encodes four structural proteins: Spike (S), which facilitates entry into host cells by binding to the angiotensin-converting enzyme 2 (ACE2) receptor; Envelope (E); Membrane (M); and Nucleocapsid (N) [3]. With this structural arsenal, SARS-CoV-2 can enter cells that co-express the ACE2 receptor and the transmembrane serine protease 2 (TMPRSS2). These cells include pulmonary alveolar epithelial cells, upper respiratory tract epithelial cells, cholangiocytes, keratinocytes, gastrointestinal epithelial cells, pancreatic beta cells, renal proximal tubules, podocytes, among others [4].

Comment [AA7]: pleasethisshould be theopeningparagraphofthissub-topic

Figure 1. Structural Proteins of SARS-CoV-2.



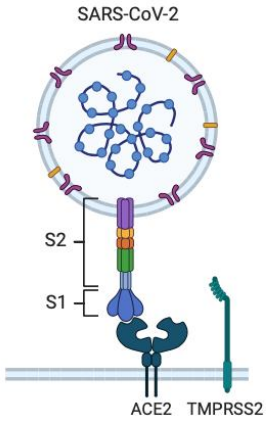
Sourcve: Adapted from [3,4] Created with BioRender.com.

The transmission of COVID-19 occurs primarily through respiratory fluids carrying infectious viruses, mainly via droplets. It is also evidenced that a person's secretions are infectious 2-3 days before they develop symptoms [4].

3. PATHOGENESIS AND IMMUNE RESPONSE

SARS-CoV-2 binds to the angiotensin-converting enzyme 2 (ACE2) receptor through the "S" protein. However, to enter the cell, the presence of transmembrane serine protease 2 (TMPRSS2) is necessary to first cleave the ACE2 receptor and activate the "S" protein [4].

Figure 2. Binding of SARS-CoV-2 to Host Cell



Source: Adaptedfrom [4] Created with BioRender.com.

The immune response to SARS-CoV-2 begins with the innate response of Toll-like receptors (TLR) 3, 4, and 7 present in infected cells, triggering an inflammatory response characterized by the recruitment of polymorphonuclear leukocytes, which release tumor necrosis factor-alpha (TNF-alpha) and interleukins (IL-1 and IL-6). This, in turn, causes

cytotoxicity and a "dysregulated" immune response. As viral replication progresses, it begins to compromise the integrity of the epithelial-endothelial barrier, causing prothrombotic effects. In some cases, it can lead to a cytokine storm. The dysregulated inflammatory response becomes so severe that it causes infiltration of neutrophils and monocytes, endothelial thickening, increased vascular permeability, and finally pulmonary edema, further activating the kinin-kallikrein system, an inflammatory system that perpetuates even more vascular permeability [4,5].

The inflammatory response, in turn, triggers the activity of the humoral system, which ultimately generates antibodies primarily against the "spike-S" and "nucleocapsid-N" glycoproteins. IgM becomes detectable from the seventh day of infection, reaches its highest titers around days 10-12, and decreases approximately 18 days after symptom onset. On the other hand, IgG becomes detectable on day 14 and begins to decrease from the 8th week after symptom onset, although it can remain detectable for 8-12 months. It is likely that in less severe infections, humoral immunity is less durable [4, 5].

4. SEROPREVALENCE OF ANTI-SARS-COV-2 ANTIBODIES IN HEALTHCARE WORKERS

Serological tests are useful in detecting previous infections and the level of acquired immunity, provided they are performed 14 days after symptom onset [5, *6*]. Among the serological tests, the IgG antibody test is preferred over other tests such as IgM, IgA, or IgG/IgM due to its higher accuracy [*6*].

Among population groups, healthcare workers are at high risk of SARS-CoV-2 infection due to direct contact with potentially infected patients, significantly increasing their risk of virus exposure. Additionally, procedures such as intubation, mechanical ventilation, and cardiopulmonary resuscitation generate aerosols, a highly effective means of virus transmission [4, *6*]. Another important aspect is the association between poor ventilation and increased SARS-CoV-2 transmission, as demonstrated by the study by Dai H. et al [8]. The CDC defines a place as "ventilated" when it has less than 800 ppm of CO2 and recommends that concentrations between 800-1000 ppm are acceptable in crowded

Comment [AA8]: reportingtheepidemiologyofthedisease Will makeitricher

spaces [*9*]. Implementing CO2 monitors in high-occupancy areas, including healthcare facilities, could be an effective monitoring measure to assess space ventilation.

At the beginning of the pandemic, monitoring immunity against COVID-19 was crucial for surveilling the degree of exposure to the virus and thus the effectiveness of the implemented preventive measures [*7*]. Several studies on the seroprevalence of SARS-CoV-2 among healthcare workers, such as the work by Padilla et al, demonstrated a seroprevalence of 9.29%, which is considered high [*10*]. The monitoring of seroprevalence was conducted through adapted surveys to understand the context of healthcare workers, including whether they were exposed in hospital or community settings, and whether they had been trained in the use of personal protective equipment (PPE). Most samples were analyzed specifically for IgG detection using immunoassays [*7, 10*]. Relevant associations for higher seroprevalence incidence were identified, such as the type of unit (whether they were COVID-19 hospitals or not), community exposure as a significant factor, and finally, training, and proper use of PPE as protective factors [*10*].Finally, it is important to emphasize that the behavior of seroprevalence in healthcare workers is slightly different in the context of vaccination. While the generation of antibodies through vaccination is similar to that obtained with infection in the work of Navarro-Olivos et al. [11], the duration of antibodies was moderately increased in individuals who had previously contracted the disease and were subsequently immunized, compared to those who were only immunized.

Comment [AA9]: trend

Comment [AA10]: comparisonofseroprevalence in thissubtopicisscanty. Researchfromotherpartsoftheworldshould be reportedtoo

5. CONCLUSION

The seroprevalence of anti-SARS-CoV-2 antibodies in healthcare workers highlights their high exposure to the virus and underscores the crucial importance of continuous surveillance and preventive strategies. Proper training and correct use of personal protective equipment (PPE) have proven to be essential protective factors, while community exposure and the type of medical unit significantly influence infection incidence. Serological tests have been fundamental in assessing acquired immunity and adjusting public health policies. Maintaining surveillance infrastructures, providing early

clinical care, administering vaccines to high-risk groups, and ensuring adequate ventilation in workspaces are priority measures to mitigate the impact of future COVID-19 waves.

REFERENCES:

1.- World Health Organization. Coronavirus disease (COVID-19) pandemic. 2020. Available in: https://www.who.int/emergencies/diseases/novel-coronavirus-2019

2.- World Health Organization. COVID-19 epidemiological update - Edition 169. World Health Organization.2024. Available in: https://www.who.int/publications/m/item/covid-19-epidemiological-update-edition-169

3.- Coronaviridae Study Group of the International Committee on Taxonomy of Viruses. The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. Nature microbiology. 2020; *5*(4): 536–544. Doi: https://doi.org/10.1038/s41564-020-0695-z

4.- WiersingaWJ, RhodesA, ChengAC, PeacockSJ,PrescottHC.Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19): A Review. JAMA. 2020; *324*(8): 782–793. Doi: https://doi.org/10.1001/jama.2020.12839

5.- PolandGA, OvsyannikovaIG,KennedyRB. SARS-CoV-2 immunity: review and applications to phase 3 vaccine candidates. Lancet. 2020; 396(10262): 1595–1606. Doi: https://doi.org/10.1016/S0140-6736(20)32137-1

6.- Hayden MK, Hanson KE, Englund JA, Lee F, Lee MJ, Loeb M, et al. Infectious Diseases Society of America Guidelines on the Diagnosis of COVID-19. Infectious Diseases Society of America **2022**; Version 2.0.0. Available in: https://www.idsociety.org/practice-guideline/covid-19-guideline-diagnostics/

7.- GalanisP, VrakaI, FragkouD, BilaliA,KaitelidouD.Seroprevalence of SARS-CoV-2 antibodies and associated factors in healthcare workers: a systematic review and meta-analysis. The Journal of hospital infection. 2021; 108: 120–134. Doi: https://doi.org/10.1016/j.jhin.2020.11.008

8.- DaiH, ZhaoB. Association between the infection probability of COVID-19 and ventilation rates: An update for SARS-CoV-2 variants. Building Simulation. 2023; 16(1): 3-12. Doi: https://doi.org/10.1007/s12273-022-0952-6

9.- Centers for Disease Control and Prevention.. Ventilation in buildings. Centers for Disease Control and Prevention.2024.Available in: https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html

10.- Padilla-Raygoza N, Navarro-Olivos E, Gallardo-Luna M. de J, Flores-Vargas G, Sanchez-Navarro M, Lara-Lona E, et al. Seroprevalence of SARS-CoV-2 in health-care personnel from the State of

Guanajuato, Mexico: A cross-sectional study. Biomedical&PharmacologyJournal. 2022; 15(3): 1427-1436. Doi: https://dx.doi.org/10.13005/bpj/2480

11.- Navarro-Olivos E, Magos-Vázquez FJ, Sánchez-Navarro MR, Díaz-Martínez DA, Lara-Lona E, Gallardo-Luna MJ, et al. Reactivity and safety of BioNTech/Pfizer® vaccine anti-SARS-CoV-2, in health personnel from the Mexican State of Guanajuato. Biomedical&PharmacologyJournal. 2022; 15(2): 993-1003. Doi:https://doi.org/10.13005/bpj/2435