

Controlling the COVID-19 Pandemic: The complex Epidemiological Triad of SARS-CoV-2

Opinion

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Opinion

Without doubt, the Covid-19 pandemic brought into existence by the worldwide outbreak of SARS-CoV-2 is currently the most notable event of this century. Taking into consideration that the first official report of this disease in Wuhan, China was documented back in December of 2019, to date (9/6/2021), SARS-CoV-2 has been in the spotlight for approximately 21 months. This situation has negatively impacted economies and health services internationally, changing the lives of millions of people, not only due to the number of deaths or illness, but also on account of the nature of the polices imposed to contain the pandemic. The tremendous impact produced by SARS-CoV-2 can be easily appreciated just by considering the 220,383, 954 cases and the 4, 561, 461 fatalities recorded so far around the world within these first 21 months of the pandemic (<https://covid19.who.int/>).

Currently, vaccines appear to offer the best chance to contain and control the pandemic, and a variety of different vaccine platforms are being used internationally to combat the spread of this novel virus. While other efforts, including the investigation of antivirals and use of differing treatment regimens are presently underway, at this point-in-time these vaccines offer proven protection against severe infection and death. In the United States, two vaccines are currently being used under emergency use authorization, with one additional vaccine given full approval at this time in persons aged sixteen or above. An initial evaluation conducted by the Centers for Disease Control and Prevention (CDC) showed the efficacy of the platforms authorized in the US to significantly reduce the risk of infection, hospitalization and death. At this point, the presence of breakthrough cases has been estimated to be as low as 0.007% (<https://www.cdc.gov/vaccines/covid-19/health-departments/breakthrough-cases.html>).

To date, a total of 5, 289, 724, 918 vaccine doses have been globally administered (<https://covid19.who.int/>), representing just 27 % of the world population being fully vaccinated (<https://www.nytimes.com/interactive/2021/world/covid-vaccinations-tracker.html>).

com/interactive/2021/world/covid-vaccinations-tracker.html). These numbers reflect the critical phase we are currently living under in regard to trying to control this current pandemic.

In this opinion note, we briefly summarize the main features involved with the epidemiologic triad of SARS-CoV-2. We present our point of view about how the complex interactions between the different components of the epidemiologic triad (agent, host, and environment) are affecting the control of this pandemic, demonstrating a perspective that could be considered in the implementation of measurements to contain this pandemic.

The Agent

SARS-CoV-2 emerged as the seventh human coronavirus ever recorded [1] Having a lower mortality (based on current numbers of cases and deaths of approximately 2%), yet higher transmissibility rates than SARS and MERS (highly virulent), SARS-CoV-2 possesses the perfect combination to circulate with extreme success within the human population. SARS-CoV-2 shows similarity to other human coronaviruses with low virulence including 229E, NL63, OC43, and HKU1, making its identification difficult, and thus increasing the chances of infection [1]. An additional feature of SARS-CoV-2 is its genome plasticity, a condition that has helped promote its evolution since the beginning of pandemic [2], leading to the emergence of multiple variants, such as the Delta variant that is currently dominating infections throughout the world. This capability for genome plasticity may increase both transmission rates as well as the potential ability to avoid the antibody response, compromising both vaccine efficacy and the overall control of this pandemic. Currently, beta and mu variants demonstrate an increased ability to resist the neutralization of antibodies from both convalescent and vaccinated individuals [3].

Host

Humans appear to be highly susceptible to the infection of SARS-CoV-2; however, a majority of reported cases are associated with



asymptomatic or mild clinical symptoms. Interestingly, infected individuals can spread the virus during the early stages of infection, even before the presentation of clinical signs. These conditions in the context of a delta variant infection that is two times more transmissible than the original variants, seem to be responsible for the increased number of cases experienced currently throughout the world. In fact, fully vaccinated individuals infected with the delta variant may spread the virus at a similar rate to that of those who are unvaccinated (<https://www.cdc.gov/coronavirus/2019-ncov/variants/delta-variant.html>), suggesting that vaccinated people may be playing a role in the transmission of the virus [4]. One major aspect to controlling this pandemic lies in the understanding of the duration of immunity in both previously infected and vaccinated individuals. In this context, preliminary studies suggest that the duration of humoral immunity may start declining within months after infection, and that cellular immunity may be more stable through the time. However, the role in the protection of cellular immunity is still not well understood [5].

Environment

From our perspective, the environmental component of the epidemiologic triad of SARS-CoV-2 has been the least considered when trying to fully understand the course of this pandemic. Interestingly, different studies have proposed how differences in economic, social, and political conditions worldwide may be playing a key role in the control of this pandemic [6-8]. These include the differences in implementation strategies (or not) of lockdown policies and subsequent effects as well as the ability of different countries to provide sufficient health services to help battle the effects of this pandemic. Also included is the worldwide availability, distribution, and acceptance of available vaccines for which socio-economic factors play a significant role.

At this point, we believe that is imperative to drastically reduce the number of infections worldwide to avoid the emergence of new viral variants that can make this situation worsen. In this sense, and in accordance with other authors [9], we also consider that one of the main challenges in the control of this pandemic, is to make sure that economic and political issues don't limit the access to COVID-19 vaccines internationally, especially in the poorest countries.

In conclusion, based on the complex epidemiologic triad of SARS-CoV-2, we consider that the control of this pandemic, in the short term, will not be a simple task. We are still at the early stages of understanding both the etiological agent itself as well as how we, as hosts, can most successfully combat this novel infection. We propose that strategies to control this pandemic can't be singularly focused and instead, they should be developed on not only the interaction between virus and host, but also include regionalization strategies that consider the economic, political, and social conditions of different societies.

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