COVID-19: An Emerging Zoonosis Pandemic

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Introduction

As severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was causing a worldwide spread of a new disease named the coronavirus disease 2019 (COVID-19), the World Health Organization (WHO) declared the outbreak to be a global pandemic on March 11, 2020 (Cucinotta & Vanelli, 2020).

Some common symptoms of the disease are respiratory (nasal congestion, runny nose, shortness of breath, cough, coughing blood, sputum production, chest pain, sore throat), digestive (loss of appetite, nausea or vomiting, diarrhea, abdominal pain), systematic (fever, muscle or joint pain, fatigue), neurological (loss of smell / taste, dizziness, headache), and others (rash) (Butcher & Fenton, 2020). However, it is the severe symptoms caused by SARS-CoV-2-altered immune responses that are most worrying for public health.

In a typical immune response to a virus, upon activation of pattern-recognition receptors (PRRs) by viral RNA, type I interferon (IFN-I) is secreted, which is proved to be effective in controlling coronavirus infections (Channappanavar et al., 2016). SARS-CoV-2 is likely to suppress the release of IFN-I, which allows sustained viral replication within the host (Blanco-Melo et al., 2020). The virus could at the same time promote secretion of proinflammatory cytokines (Li et al., 2020), where consequent hyperinflammation leads to the most severe symptoms of the disease such as respiratory failure, multi-organ failure, and death (Mehta et al., 2020).

Description of Topic Background

There were three steps for COVID-19, an emerging zoonotic disease to reach a global pandemic: direct or indirect transmission of the pathogen from wild reservoir to human, direct transmission of the pathogen between humans, and travelling of the pathogen on a global level (Wolfe, Daszak, Kilpatrick, & Burke, 2005).

The risk factors of a potential zoonotic pathogen to infect human are microbe diversity in a region, the density of pathogen-infected wildlife in the region, and the amount of human/domestic animal-wildlife contact (Wolfe, Daszak, Kilpatrick, & Burke, 2005). While diversity of viruses is difficult to determine, general biodiversity could be used as an indicator of viral diversity (Keesing et al., 2010). The risk of initial establishment of human-to-human transmission of a zoonotic viral pathogen increases with the frequency and diversity of its primary infections in human (Wolfe, Switzer, Folks, Burke, & Heneine, 2004). When the reproductive ratio of the disease (R_0) is > 1, a local outbreak occurs and sustains. Global travelling of the pathogen then drives a local-level epidemic into a pandemic.

After SARS-CoV-2 emerged and adapted through an unknown host (Andersen, Rambaut, Lipkin, Holmes, & Garry, 2020), human-to-human transmission of the virus was enabled and was then spread all around the globe upon international travelling. In controlling the pandemic, stay-at-home and business closure orders were issued by some governing bodies to slow down the disease reproduction, and travel restrictions were implemented to confine the disease within its current geographical regions of existence.

Challenges

Preventative measures against initial emergence and adaptation of potential zoonotic pathogens in humans are still underdeveloped, while the effectiveness and tradeoffs of some current policies around physical distancing are assessed to be objectionable.

The Chinese government's ban on wildlife trades and meat consumption is subjected to be a "blanket policy" which neither work to reduce human-wildlife interface nor promote development of new policies that do (Roe & Lee, 2021). The risk to public health could be even increased though reduced regulation and transparency in wildlife trading, increased human contact with domestic livestock on which existing zoonoses have established, and increased pathogen-infected wildlife due to derivation of habitat recruited for livestock production. The ban is also not applicable to all countries, due to cultural and financial constraints. There are no conveniently existing alternatives for wild meat because reasoning behind wild meat consumption is not simple or uniform (Booker, 2019). The financial loss due to terminated wild meat production would be massive and difficult to be compensated, especially under the impact of COVID-19.

It is evident that strict orders of stay-at-home and business closure do not have more beneficial effects on controlling disease transmission than a collection of approaches as nonaggressive as providing the public with social distancing guidelines to follow (Bendavid, Oh, Bhattacharya, & Ioannidis, 2021). Physical distancing measures in general, affect individual

rights to some extent on movement, religion, assembly freedoms and liberty (Gostin & Wiley, 2020).

Hopes

In the hope of reducing impact of zoonotic diseases on public health, it would be desirable to prevent future emergence and re-reemergence zoonoses, and to end and recover from the COVID-19 pandemic.

In order to prevent a zoonotic emergence, it is essential to track SARS-CoV-2 to its biological origin, assess risk factors for initial transmissions and adaptation of potential zoonotic pathogens, predict risky events and make policies in order to reduce the chance of them happening. To prevent reemergence of a zoonosis, a project like the Wild Bird Global Avian Influenza Network for Surveillance (GAINS) can be useful for tracking geographical locations of the animals capable of transmitting known zoonoses (Barclay, 2008).

In disease modelling of COVID-19, voluntary behavioral response to the disease situation is found to be a significant component of individual behaviors but is often neglected, resulting in overestimation of policy effectiveness (Chernozhukov, Kasahara, & Schrimpf, 2021). At the current phase of the pandemic, the public has been informed on the existence of the disease-causing virus, how to protect oneself from it, and how to stop it from spreading. While the disease morbidity is eventually being diminished given that effective vaccines are available, it might be ethical and feasible to remove direct governmental control over individual behaviors and get an undisturbed observation of individual behavioral choices during a pandemic. The

effectiveness of former policies on this issue can be then be evaluated closer to the real number using models that adjust for individual behavioral responses.

Without the actively increasing adverse effects of government interventions imposed on education, economics, food security and other health-related elements of society, we are in the hope to see the society help itself out to go back to its original healthy functioning, and maintain its stability, until another emerging zoonosis pandemic begins.

Reference

Andersen, K. G., Rambaut, A., Lipkin, W. I., Holmes, E. C., & Garry, R. F. (2020). The proximal origin of SARS-CoV-2. *Nature Medicine, 26*(4), 450-452. doi:10.1038/s41591-020-0820-9

Barclay, E. (2008). Predicting the next pandemic. *The Lancet, 372*(9643), 1025-1026. doi:10.1016/s0140-6736(08)61425-7

Bendavid, E., Oh, C., Bhattacharya, J., & Ioannidis, J. P. (2021). Assessing mandatory stay-at-home and business closure effects on the spread of COVID-19. *European Journal of Clinical Investigation, 51*(4). doi:10.1111/eci.13484

Blanco-Melo, D., Nilsson-Payant, B. E., Liu, W., Uhl, S., Hoagland, D., Møller, R., . . . TenOever, B. R. (2020). Imbalanced host response to SARS-CoV-2 drives development of COVID-19. *Cell, 181*(5). doi:10.1016/j.cell.2020.04.026

Booker, F. (2019). Why eat wild meat?. *Convention on Biological Diversity*.

Butcher, R., & Fenton, N. (2020). Extending the range of symptoms in a Bayesian network for the predictive diagnosis of COVID-19. doi:10.1101/2020.10.22.20217554

Channappanavar, R., Fehr, A., Vijay, R., Mack, M., Zhao, J., Meyerholz, D. K., & Perlman, S. (2016). Dysregulated type I interferon and inflammatory monocyte-macrophage responses cause lethal pneumonia in SARS-CoV-infected mice. *Cell Host & Microbe, 19*(2), 181-193. doi:10.1016/j.chom.2016.01.007

Cucinotta, D., & Vanelli, M. (2020). WHO declares COVID-19 a pandemic. *Acta bio-medica : Atenei Parmensis*, *91*(1), 157–160. doi:10.23750/abm.v91i1.9397

Chernozhukov, V., Kasahara, H., & Schrimpf, P. (2021). Causal impact of masks, policies, behavior on early COVID-19 pandemic in the U.S. *Journal of Econometrics, 220*(1), 23-62. doi:10.1016/j.jeconom.2020.09.003

Gostin, L. O., & Wiley, L. F. (2020). Governmental public health powers during the COVID-19 pandemic. *JAMA, 323*(21), 2137. doi:10.1001/jama.2020.5460

Keesing, F., Belden, L. K., Daszak, P., Dobson, A., Harvell, C. D., Holt, R. D., . . . Ostfeld, R. S. (2010). Impacts of biodiversity on the emergence and transmission of infectious diseases. *Nature, 468*(7324), 647-652. doi:10.1038/nature09575

Li, J., Guo, M., Tian, X., Liu, C., Wang, X., Yang, X., . . . Liang, Q. (2020). Virus-host interactome and proteomic survey of PMBCs from COVID-19 patients reveal potential virulence factors Influencing SARS-CoV-2 pathogenesis. doi:10.1101/2020.03.31.019216

Mehta, P., McAuley, D. F., Brown, M., Sanchez, E., Tattersall, R. S., & Manson, J. J. (2020). COVID-19: Consider cytokine Storm syndromes and immunosuppression. *The Lancet, 395*(10229), 1033-1034. doi:10.1016/s0140-6736(20)30628-0

Roe, D., & Lee, T. M. (2021). Possible negative consequences of a wildlife trade ban. *Nature Sustainability, 4*(1), 5-6. doi:10.1038/s41893-020-00676-1

Wolfe, N. D., Daszak, P., Kilpatrick, A. M., & Burke, D. S. (2005). Bushmeat hunting, deforestation, and prediction of zoonotic disease. *Emerging Infectious Diseases, 11*(12), 1822-1827. doi:10.3201/eid1112.040789

Wolfe, N. D., Switzer, W. M., Folks, T. M., Burke, D. S., & Heneine, W. (2004). Simian retroviral infections in human beings - reply. *The Lancet, 364*(9429), 139-140. doi:10.1016/S0140-6736(04)16622-1