Insights into SARS-CoV-2 evolution and predictors of transmissibility.

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Abstract

Outsmarting infectious disease-causing microbes means deepening our understanding on how they evolved to make us sick and how they adapted to evade our treatments. Urgent too, is the understanding of the predictors of viral transmissibility to enhance pandemic preparedness. In our persistent contact with microbes, the good news is that some established diseases are being defeated. Smallpox, a plague as ancient as human history was eradicated in the late 1970s, and similar campaigns are underway against influenza, malaria, measles, and polio. However, despite our advances in science and technology, some infectious diseases are still a pressing issue for our society. The bad news is that many microbes mutate extremely fast, making them highly versatile in the evolutionary arms race with each other and with us. Examples of such diseases are the killer flu (influenza), HIV/AIDS, Ebola, and now the coronavirus disease pandemic which continues to challenge our detection and response ability. Worldwide, viral diseases are making a resurgence as they evolve resistance to our immune defenses. A recent example is the coronavirus. From SARS-CoV to SARS-CoV-2, public health has confronted tough questions about the virus evolution. With the current public health concern focused on COVID-19, embracing evolutionary perspective could help us stop the pandemic and prevent future ones.

Evolution

Evolution is the most revolutionary concept in the history of science. It is the way living organisms change over time mainly driven by natural selection [1]. Viruses remain the unrecognized heroes of evolution while human beings and their ill health are the products of long evolutionary history. Nothing else has more radically changed our understanding of the natural world and ourselves like evolution [2], [3]. Evolutionary view point is a key variable which has been missing in understanding SARS-CoV-2 pandemic. It attempts to illuminate as well as pinpoint where new diseases come from and help predict where they are going. Unless we demystify the invisible realm and power of evolution we may not grasp how deadly these risks are and scheme for them. Mastery how coronavirus evolves is key to mitigating disease morbidity and mortality, raising the possibility of early detection, screening and maybe even preventive treatments [4].

In recent decade, our understanding of virus evolution has taken enormous progress. Advances in Artificial Intelligence (AI), machine learning (ML), genetics, epigenetics, and developmental biology challenge us to think afresh about the relationship between genes, organisms and the environment. These has implications for the origins of diversity, direction and speed of evolution [5], [6]. The risk ingrained to a novel virus are due to new features generally in the molecular structure of proteins, which enable the virus to infect the cells of the host organism more intensively, dramatically challenging host immunity, and thus be transmitted more readily in the host population [7].

There is evidence that the coronavirus is evolving but the extend has not been fully defined. Facts currently available about severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which has caused COVID-19 pandemic are; people who are genetically resistant to the virus will get sick, recover, and develop immunity, while those who are sensitive to the virus will need drugs and vaccines for recovery. If the pandemic persists, in a few decades it is predicted that SARS-CoV-2 will turn as safe as the four-non-severe acute respiratory syndrome coronaviruses (HCoV-NL63, HCoV-229E, HCoV-OC43, and HCoV-HKU1) currently circulating but causing low mortality in human population [7].

Predictors of Transmission

Infectious diseases affect the lives of each and every one on the planet. They are distinct in their potential for explosive global impact; threatening survival of all human race. They harm and also help us, we compete, coexist, and coevolve. On a worldwide scale, infectious diseases account for 26% of all deaths, second only to

cardiovascular diseases [8]. The emergence of SARS-CoV-2, since the severe acute respiratory syndrome coronavirus in 2002 and Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012, marked the third introduction of a highly pathogenic and large scale epidemic coronavirus into the human population in the twenty-first century. Bat is the possible primary source even though the intermediate source of origin and transfer to human is not fully documented. The novel coronavirus uses the same receptor, angiotensin-converting enzyme (ACE2) as that of SARS-CoV, and mainly spreads through the respiratory droplets [9]. The full range of transmission factors in humans are not yet known but systemic, specific, and individual health factors have been studied. The systemic factors include the biological characteristics of the virus and incubation period; specific factors for different regions or localities such as pollution and weather interactions may influence viral infectivity, and lastly the health level of individuals such as habits, immunity, age and sex. These can be summarized as natural and social factors which influence the general progression and trajectory of SARS epidemiology [10], [11]. Transmission through asymptomatic carriers is also a current challenge to contain COVID-19 [12].

A call to action: The talk of exposing people to the SARS-Cov-2 to build up herd immunity remains a dangerous idea. To understand why, it is crucial that public health practitioners, policy makers, virologists, and other stakeholders think about how the virus evolves as it jumps from one host to another and circulates in the human population. As Dobzhansky once said, "Nothing in Biology makes sense except in the light of evolution" [13].

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