



Mini Review

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Observations on the Occurrence, Transmission and Management of the Covid-19 Pandemic Derived from Physics

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Abstract

Three important observations derived from the ongoing COVID-19 pandemic would hopefully allow the development of additional approaches to deal with it and avoid or at least minimize the occurrence and impact of future outbreaks. First, the dramatic increase in pandemics in the past decade alone suggests that the current relationship of humans with the environment is fast becoming unstable with potentially catastrophic consequences. In order to reduce the toll in life and treasure, we would need to shift our emphasis from control of, to "Symbiosis with Nature." This can then become the new framework for dealing effectively with environmental issues such as climate change, whereby "Medical Science" properly applied would provide the necessary impetus for action. Second, the existence of superspreaders of infection among us in this pandemic requires that we develop objective tests most likely of genetic nature to identify them rather than apply indiscriminate, draconian controls across the board. Not identifying superspreaders in a timely fashion could allow this pandemic to turn into a Black Swan event with a catastrophic impact on society. Third, we need to refocus our efforts in dealing with this pandemic from the virus itself to the human hosts. An objective morbidity risk index can be developed such that most of us can go about our daily business without the fear of becoming seriously ill, while measures can be implemented to protect those who are most vulnerable to this virus. These observations point clearly to the need for a paradigm shift.

Keywords: COVID-19, SARS-CoV-2, Nature, Symbiosis, Quantum World, Superspreader, Infection Pathway, ACE-2 Marker, Power Law, Morbidity Risk Index

Introduction

Infectious diseases have been around at least since the beginning of the Neolithic era some 12,000 years ago, when humans settled into communities, domesticated animals and grew crops [1]. The COVID-19 pandemic demonstrates the power of a tiny organism, the virus SARS-CoV-2, to disrupt the lives of billions of humans across the globe and create economic losses amounting to tens of trillions of dollars and still rising. The response across the board from scientists, to health professionals, to the general public has been almost unanimous and entirely predictable: find ways to control the virus, get rid of it altogether and return to a business as usual existence as soon as possible. It is not uncommon for elected

officials and ordinary citizens alike to speak of the war against the virus. And while the current war-like approach to dealing with this virus may or may not succeed, it reveals potentially a deep misunderstanding of the presence of the virus amongst us. As is often common in human reasoning cause and effect tend to be reversed. The virus has arrived amongst us because we humans have extended unwittingly an invitation to it. Enlightened members of the scientific community and undoubtedly a large number of the public recognize already that aspect of the appearance of this virus [2]. The sooner we recognize it across the board the better we will be able to deal with the pandemic situation most effectively at every



level, from the individual to the societal. This of course implies that we must refocus our efforts away from the virus and onto us.

Observations

According to the WHO, infectious diseases are responsible for 20% of deaths across the globe, amounting to over 11 million annually [3]. The COVID-19 pandemic will increase these figures [4], but it is still nowhere close to the 1918 influenza pandemic that killed an estimated 50 million [2] or to the earlier recorded pandemics of 541 AD (Justinian Plague) and of 1348 AD (Black Death), each of which killed an estimated 1/3 of the populations in Eurasia [5,6]. In the case of the Black Death between 75 to 150 million people may have perished. The SARS-CoV-2 virus has the potential to create another major pandemic, because it has not infected humans before in a sustained manner, it has an extremely high degree of transmission, and it has a relatively high rate of mortality [2]. Moreover, if it is found that either this virus never leaves an infected person, but hides in the body dormant, or immunity to infection is very short-lived, then the COVID-19 pandemic will be around for a long time.

The first observation is that all living organisms along with all inanimate objects, i.e., all of the natural world, exist in an interdependent and interconnected state or in a symbiotic manner to use a term from biology. Interconnectedness is the key tenet of our quantum world that has been gradually replacing over the past one hundred years the earlier concept of a mechanistic world [7,8]. We may also note that the notion held widely among biologists that quantum physics is not applicable in their field has been demonstrated to be incorrect [9]. The idea of interconnectedness in nature was observed, studied and published extensively by Alexander von Humboldt in the first half of the 19th century, although it was later put aside most likely for political reasons [10-12]. Humans can control at will a mechanistic world but they have to live in harmony within the quantum world, within the Cosmos of which they are an integral component. And while the mechanistic or reductionist approach has had a tremendous impact on the wellbeing of humans, particularly in regard to the advances in medicine, it may now be reaching its useful limit.

The limit to the reductionist approach is becoming apparent from the explosive increase in potentially pandemic infectious diseases in the 21st century such as SARS (2002), H1N1 (2009), MERS (2012), Chikungunya (2014), Zika (2015), recurrence of Ebola (2014) and now COVID-19 [2]. All these diseases as well as the aforementioned earlier pandemics either have originated in animals or have employed animals for their transmission. Bats and pangolins are believed to be the animal culprits in COVID-19 [13]. The link of human infection to an animal pathogen was expounded scientifically in the middle of the 19th century by Rudolph Virchow, who coined the term Zoonosis to describe it [14]. Yet more than

150 years later we remain by-and-large oblivious to this link as manifested by our human-dominated interaction with the environment. It is reported that the Black Death in its initial phase lasted for about five years and then it kept coming back periodically, albeit not as virulent, for the next 400 years [6]. Depending on how long the COVID-19 pandemic persists and whether an effective vaccine against it can be developed, humans may have to rethink seriously their relationship with nature sooner rather than later.

The new relationship may entail among others the following: people moving away from dense metropolitan centres and back into the country; the reduction in commuting for work and for shopping if such activities can be carried out remotely from home; a revision of social interactions whereby families can cluster together; increased efficiency in the use of energy, water and food; more effective recycling and reuse of wastes; local production of food to the extent possible. The debate on "climate change" over the past several decades has had a limited degree of acceptance among the public, perhaps because it is framed in the wrong way [15]. The choice of framework is crucial not only for communicating the impact, but also for implementing a solution. The term "climate change" conveys little about the impact and even less about the solution: change is unavoidable and occurs naturally all around us. For example, the remedy brought up by the term carbon tax sounds ominous as indicative of the state raising taxes that are perceived as going to be wasted. As another example, the framing of the problem as Global Warming emphasizes only one aspect of the impact that is not readily witnessed from year to year due to the weather variability, and creates a negative, i.e., undesirable, feeling among the public.

In the middle of the 19th century, Rudolf Virchow, a physician, anthropologist, biologist, historian, writer and politician, who is known as the father of modern pathology and the founder of social medicine, coined the well-known aphorism: "Medicine is a social science, and politics is nothing else but medicine on a large scale" [16,17]. And even though in recent times the emphasis of medicine has been in treating disease, the revolutionary accomplishment of medicine since the mid-19th century has been the avoidance of disease. The current pandemic can reorient the emphasis of medicine to bring it back to prevention but at a grand scale encompassing the interconnectedness of humans with themselves and the rest of the "Cosmos." Thus, Social or Holistic or Quantum Medicine can become the effective, i.e., persuasive, means of action for the public at large to recognize, accept and live in the new framework of "Symbiosis with Nature."

The second observation from the COVID-19 pandemic is the realization of the existence of superspreaders of the infection among the population [18,19]. That is to say, while most infected people may infect only a small number, a few infected persons can

infect a very large number creating what is called a cluster event. Cluster events have occurred aboard ships, at nursing homes, meet packing plants, ski resorts, churches, restaurants, hospitals, prisons and are manifested by the nature of the occurrence of infection among the general population. An example is shown in Figure 1. Epidemiologists use the reproduction number R to describe the average number of new infections caused by each infected person. For most people R will be zero, but for the superspreaders it will be quite high. For SARS-CoV-2 the average value of R without social distancing is estimated to be between 2 and 3 at least in the early stages of the pandemic. In addition to R , a parameter called the dispersion factor k is used to describe how much a disease cluster.

The lower the k is the more transmission comes from a small number of people. For example, the estimated value of k was for SARS 0.16, for MERS 0.25 and for the 1918 influenza pandemic close to one. For SARS-CoV-2 the current estimates of k vary from a 0.10 to 0.44 [18,20]. This suggests that superspreaders are not important for influenza but they are very much so for SARS-CoV-2. Moreover, if it is conclusively established that most transmissions occur during the pre-symptomatic phase of infection, then SARS-CoV-2 becomes difficult to contain as computer simulations show [21]. In that instance the COVID-19 pandemic could evolve into the perfect storm [2]



Figure 1: Example of COVID-19 Cluster Outbreak in Lansing, Michigan at a Restaurant and Pub by a few Infected Superspreaders (Source: Ingham County Health Department).

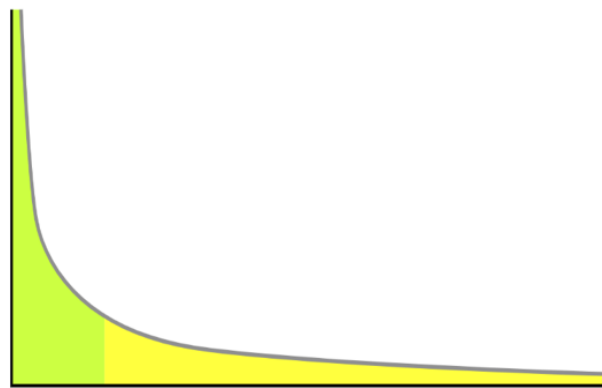


Figure 2: Power Law: Horizontal Axis-Persons; Vertical Axis-No of Infections per Person; Green Area-Infections by Superspreaders ~80% of total; Yellow Area-Infections by 80% of all Persons.

The occurrence of superspreaders in the COVID-19 pandemic is indicative of a power law statistical distribution for the occurrence of the disease. In a power law, shown schematically in Figure 2, the functional relationship between two quantities is such that a change in one quantity results in a proportional relative change to the other quantity, independent of the initial size of those quantities. Power laws are ubiquitous in nature (some examples are given in parenthesis) from physics (black body radiation, quantum

mechanics) to economics (income and wealth distribution, cost of health benefits per person) to finance (business income per client, contribution of taxes per person) to geography (size of cities) to geology (size of lakes and mountains, volcanic eruptions) to environmental quality (emission by cars and power plants) linguistics (occurrence of words and letters) to sociology (criminal charges per convict) to ecology (number of distinct species per ecosystem) and so on.

A power law is also known either as the Pareto law, because Vilfredo Pareto articulated it first at the turn of the 20th century as descriptive of wealth distribution or as the law of 80/20, because typically 20% of the input is responsible for 80% of the outcome. In the case of the COVID-19 pandemic indications are that between 10 and 20% of those infected generate 80% of subsequent infections [18,19]. A very important characteristic of a power law is that it is scale invariant. This means that depending on the parameters of the power law, it may or may not have a well-defined mean and a finite variance. As it turns out most power laws occurring in nature have a well-defined mean but not a finite variance. A lack of a finite variance can lead to a so-called Black Swan event, an event that is rare, is unexpected, has a huge impact and can be explained in hindsight [22,23]. The values of R and k for COVID-19 will determine whether the current pandemic can lead into a Black Swan event, but since we may not know that for some time, if ever, it behoves us to develop new measures to reduce the likelihood of such outcome. Clearly the present "3 C's" approach to suppress the impact of superspreaders by imposing on everybody the avoidance of (a) closed spaces with poor ventilation, (b) crowded settings, and (c) close contact with others is not a long-term solution [19].

Contact tracing, even though useful in curbing the spread of the virus, has its limitations in tracking asymptomatic superspreaders. This has been demonstrated clearly in Germany, where contact tracing is credited for the relatively lower infection and death rates, but still failed to identify in 65% of the cases how a person got infected [24]. The new measures to be developed would include the identification via objective means, i.e., testing of most likely genetic basis, of the superspreaders such that their contribution to additional infections can be effectively controlled [25]. It is already established that the gateway for invasion by SARS-CoV-2 into human host cells is via the Angiotensin-Converting Enzyme 2 (ACE2) receptor [26]. Consequently, SARS-CoV-2 has the unusual capacity to attack many different types of human host cells and tissues simultaneously in the respiratory, cardiovascular, gastro-intestinal, renal-excretory, reproductive and central nervous systems, thereby becoming injurious to diverse cells, tissues and organ systems and exploiting any immune weakness in the host.

The variability in the expression of the ACE-2 receptors among individuals and hence the potential for SARS-CoV-2 infection and severity as manifested by age, sex, ethnicity, medication and several co-morbidities, such as cardiovascular disease, cancer, metabolic syndrome and obesity, and cognitive decline may be also found to be critical in the genetic constitution and hence identification of the superspreaders. Thus, there are may be additional, e.g., GI-tract, and more effective, i.e., higher viral load, pathways for the transmission of infection than the presently emphasized respiratory path. The mapping of the expression of the ACE-2 receptors in superspreaders may form the basis of the genetic identification of these individuals

in the population. We may also note that the reason power laws are so prevalent is that nature confers equal chance of outcome to every actor, animate or inanimate, within a particular situation. In a pandemic everybody is given the same chance of infecting someone else and as a result we obtain the most probable distribution of the majority of people not contributing to the transmission and only a relatively small percentage affecting it. Even though this reason seems counterintuitive, it is borne out of experience in quantum physics whereby the derivation of Planck's Black Body Radiation Law is based on the assumption of the equal access to energy among all oscillators (actors) maximizing (most probable outcome) the system entropy (indicative of equilibrium) [8,27]. Thus, Symbiosis with Nature is here at work as well.

The third observation from the COVID-19 pandemic is that we focus so far too much on the virus and not enough on the person getting infected: the "host." It has already been established that certain characteristics as well as pre-existing conditions of the human hosts make them more susceptible to severe illness and increased risk of death: age (85 or older), because of the normally occurring immune system senescence; obesity (body mass index above 30); blood type (type O offers increased protection); cardio-vascular disease (heart failure, coronary artery disease, cardiomyopathies, pulmonary hypertension); cancer; diabetes (type 2); chronic kidney disease; chronic obstructive pulmonary disease; immune compromised state; sickle cell disease; gender (male or female); race; and perhaps other conditions to be determined as we acquire a better understanding of the virus [2,28,29].

Thus, the SARS-CoV-2 virus can cause severe disease and even death to those who happen to be afflicted by any of the aforementioned conditions or co-morbidities at any age. As it is to be expected the occurrence of such co-morbidities increases naturally with age while the immune system is losing some of its potency. It is interesting to note that the COVID-19 pandemic reconfirms clearly both aspects of the 19th century debate on the causality of disease: Louis Pasteur and Robert Koch demonstrating that a microbe was the necessary agent, while Rudolf Virchow insisting that only those with compromised cells would become ill [14]. Of course, both sides were correct in understanding the causality of an infectious disease. No one would disagree that each host is unique in so far as his or her immune system and body would respond to the virus, a clear indication of a quantum effect. But the complexity of the immune system, which may never be fully understood at the microscopic level, should not stop us from taking action as there are still general macroscopic markers that can be employed to assign a degree of morbidity with respect to the virus to each individual. These markers comprise the aforementioned macroscopic conditions that SARS-CoV-2 exploits.

Based on statistical analysis of the data on the millions of infected people and the hundreds of thousands of them who

became severely ill and even succumbed to the disease, even if the data are not perfect, one can develop a quasi-quantitative numerical risk index, say, a number between 0 to 100, of a person's degree of morbidity. Those with a higher risk index would need to be shielded against exposure, while those with a lower risk index could resume normal activities without the fear of getting seriously ill. Such a system could be readily implemented via the internet and through social media at a much faster pace, a much lower cost and most likely higher efficacy than, for example, a vaccine. The proposed re-focusing on the human host will serve well to complement the administration of even a highly efficacious vaccine. We may also note that even in the deadliest pandemics members of the population manage not to be infected even though they are in the midst of infected people. This would seem to defy the traditional cause and effect mechanistic view of infection. The question then is whether there is another, as yet unknown but profound, quantum in nature, psychosomatic connection between the human host and the infectious agent that can be ascertained through Symbiosis with Nature [8,30,31].

Conclusions

In this study, we have briefly addressed three observations derived from the current pandemic and have presented an alternative course of action. First, we would need to reconsider our relationship with nature from that of control to one of symbiosis. Depending on how the current pandemic evolves we may be forced into symbiosis sooner rather than later. After all the popular adage "our actions will destroy nature" is false. Rather, we should realize that "if we do not heed the warnings of nature, we will end up being destroyed." Second, regarding the existence of superspreaders in the current pandemic, we would need to expand our understanding of transmission pathways and develop suitable objective genetic tests, based perhaps on the variability of ACE-2 receptors, to identify those among the human hosts that are the superspreaders. Third, we should focus our efforts much more on the human hosts, i.e., us, instead of the agent, i.e., the virus, in order to develop a prescriptive morbidity risk index for every human host. Discriminating policies would then be implemented to protect those at higher risk, while those at lower risk can go about their lives without fear and anti-social restrictions. These three seemingly unrelated, but in fact highly inter-related observations from a physics perspective, point to the need for a paradigm shift from the current command and control approach into a new one, which can be framed as "Symbiosis with Nature" having at its core Medical Science properly implemented as its realization.

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