Received: 13 March 2022 | Accepted: 22 June 2022

DOI: 10.1002/prp2.996

ORIGINAL ARTICLE

Toward a big picture of COVID-19

Felix Tretter[1] | Janet J. McIntyre-Mills[2,3] | Gary R. Smith[4]

[1]Bertalanffy Center for the Study of Systems Science, Vienna, Austria

[2]Adelaide University, Adelaide, Australia

[3]University of South Africa, Pretoria, South Africa

[4]Systemic Practice International Society for the Systems Sciences, UK

Correspondence
Janet J. McIntyre-Mills, Adelaide University, Adelaide, Australia.
Email: janet.mcintyre@adelaide.edu.au

Felix Tretter, Bertalanffy Center for the Study of Systems Science, Vienna, Austria.
Email: felix.tretter@bcsss.org

Gary R. Smith, Systemic Practice International Society for the Systems Sciences, UK.
Email: grs0036@gmail.com

Abstract

The paper aims to illustrate and explain the problems and opportunities for improvement in Covid management that become evident when taking a systems perspective. Critical time delays occurred in the regulation of the pandemic that the *management cycle of political cybernetics* makes explicit. In general, the executive management of the pandemic in global, regional, and national organizations was unprepared in detecting and responding to the onset of the waves and making appropriate decisions towards differential instead of general lockdowns based on available data. This was further complicated by the mutants of SARS-CoV2 that perpetuated the high dynamics of the pandemic. In addition, the diversity of medical specialisms, without appropriate big picture thinking, led to an imbalanced response that failed to appreciate the role of virology and epidemiology compared to clinical and public health-related issues. In consequence, laboratory experts suggested everyday regulations for the citizens without taking into account wider considerations for empirical research. There was an insufficient effort made for proposed treatment studies using existing agents based on the established understanding of essential physiology and the role of local and systemic chronic inflammation. In contrast, driven by media popularization, drugs that later proved beneficial were put in doubt and other drugs that lacked benefit and potentially caused harm were driven to clinical trials and utilization. Person-centered systems view backed by scientific knowledge and established data would have set better priorities. Finally, we need to take a step back and consider the Corona crisis pandemic in the context of the unidimensional utility-driven handling of natural ecosystems by the culture of industrialized countries. This ever-accelerating destruction of life spaces for species drives adaptations are the basis of zoonoses. There is strong evidence that future pandemics should be faced with a more systemic socio-ecological conceptual framework that also reflects the fatal impact of human civilization on natural ecosystems, no matter if SARS CoV2 is a zoonosis or a laboratory accident. It is critical for the future of our species that we collectively learn from this experience, address limitations in our perspectives, enhance our system-based science and bolster global, regional, and national crisis management. The impact of

Abbreviations: CFR, case fatality rate; IFR, infected fatality rate; MR, mortality rate; PCR tests, Polymerase Chain Reaction Tests.

climate change and biodiversity loss has crossed the horizon and is now clearly in full sight.

KEYWORDS
cybernetics, eco, governance, inflammation, pandemic, pathology, system, system, zoonosis

1 | THE CORONA WAVES—DRIVERS AND BRAKES

The Corona pandemic in most countries showed a complex pattern which is not well understood. Measured by the daily new infections related to 1 mio inhabitants (incidence), the intrinsic drivers by exposure behavior of the population and the extrinsic brakes by governmental intervention shaped the curves. What have we learned up to now on the rise and fall of infections and mortality?

To facilitate a more detailed examination we focus on the European situation and especially on Germany (GER and Austria (A)). The Coronavirus has spread all over the world, starting in China in December 2019, although even this has been debated. From there it spread to Southeast Asia and Australia in January 2020, during February/March it progressed to and across Europe, then quickly followed in the USA and a global presence shortly after.

The peak of the first wave in (A) was toward the end of March 2020 and in GER in late April. After about 2 weeks (A) and three (GER) weeks of hard lockdown (only facilities for vital necessary goods are open, obligation to stay at home, mask wearing in public space, etc.), at first glance the emergency measures for public health by public order measures were a success (Figure 1). But this was dearly bought by high numbers in unemployment, with an increase of about 1% of the total population within 1 month and insolvent companies (undetermined valid numbers yet). After consideration, a hard and short lockdown might have overall been better for the economy than a longer soft lockdown. Interdisciplinary working groups of medical and economic experts combining their specialist perspectives might improve decision making and achieve better results (Dorn et al. 2020[2]).

The next phase after the first wave in spring was the "silent" summer of 2020, with a low level of infection rates in both countries, although much transmission occurred because of summer tourism. In consequence, a second wave rose in September when the infection rate began to increase exponentially again. Obviously, there was a political resistance to react with a second hard lockdown and politicians took arguably a popular interpretation of the rise of the numbers as a result of increased testing. This resulted in several weeks delay until the governments started with a second lockdown in the fall of 2020. However, the lockdown in (A) was a soft one and the overall consequence was an extremely high incidence (around 800) and eventually during Christmas in (A) and (GER) hard lockdowns had to be realized due to similar levels of incidence. Vaccinations started to be applied at that time, but in spring 2021 the various mutants of the SARS CoV 2 were pushing a third wave that started in (A) at about the end of February 2021 which compared with a faster increase and higher peak than (GER). Hard lockdowns till April for some weeks continued in (A) until the decline of the incidence was identical with (GER) until the middle of July 2021.

At the time the paper was written, the weekly rate of new infections for both countries was about 50/100.00 inhabitants. Also, quite a good ratio of the population in both countries is already fully vaccinated (about 40%). In the near future, there could be a fourth wave by September/October: We might hypothesize that there will be an upper limit of vaccinable persons (~70% being a pragmatic estimate) because of psycho-socio-cultural reasons. Additionally, there

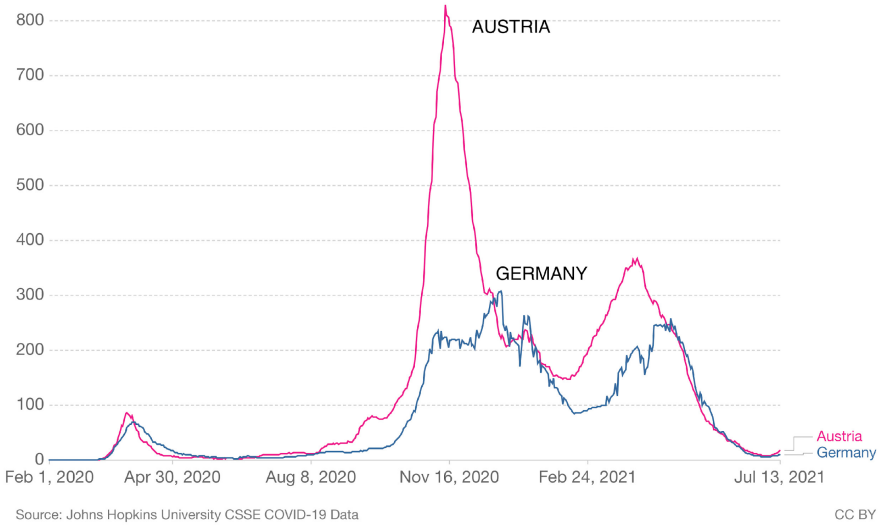

FIGURE 1 Daily new confirmed COVID-19 cases in Germany (GER) and Austria (A). Ordinate with a rolling 7 day average of daily incidence per 1 mio inhabitants (Source: Ourworldindata 2021[1]).

are signs that the delta variant of the virus continues to infect vaccinated persons, but with lower levels of severity.

Taking this into account, the logical conclusion is that these Corona viruses will continue to be a common global problem. Assuming that we lack sufficient treatments in the next months, one important point could be the improvement of Covid crisis management. This could provide an opportunity to strengthen our capabilities for the management of other crises in our preparations, situational awareness and response to climate change and loss of biodiversity.

2 | THE QUEST FOR SYSTEMIC COVID CRISIS MANAGEMENT

Shifting now the attention from the epidemiological point of view to the management side, we see a public health circle like this: The starting point was the infection of large parts of populations of different countries by the virus SARS-CoV2 whose origin is still questioned (WHO 2021[3]). It quickly became evident that the virus infects the population in an increasingly exponential way. This was detected by broad screening procedures by Polymerase Chain Reaction Tests (PCR tests) and by bringing together countrywide data sources at the health ministry level. In consequence, the governments evaluated the public health situation with regard to the expected number of deaths and the limits of carrying capacity of intensive care units, which are parameters for the value "save life". As a next step, in most countries, politics considered and decided lockdowns and other measures regarding the economic consequences. As a next step, the formulated regulations had to be implemented by organs of the state. As a consequence, the exposure situation of the population changed and the virus had lower chances to spread, etc. However, the virus exhibited mutations that induced a higher drive into the control loop that increasingly had to establish hard lockdowns to compensate.

2.1 | The cyber-systemic loop of public health management

With regard to Figure 2, as systems thinkers, we refer to a cyber-systemic model for understanding the national *control loop* of crisis management. This consists of components like the *population* that is affected by the *virus* (1) and the object of control, *science* that discovers the infection rate (2) and reports it to the *government* and *politics* (3) that makes decisions on how to respond with this situation referring to the set point of intensive care beds (4). Governance implements regulations by *public administration* as official authorities (5) that intervene with the population (6) with intended changes to bring about new behavior (7; Figure 2).

The crucial problem for decision makers was and still will be to evoke a reduction of health damage and the number of deaths on the one side but also to minimize economic damage on the other side, as well to protect rights for individual freedom. Lockdowns help to reduce the number of infected and consecutive COVID-19 diseases, but they also impact the economy, especially culture, tourism, gastronomy, and the hospitality industry.

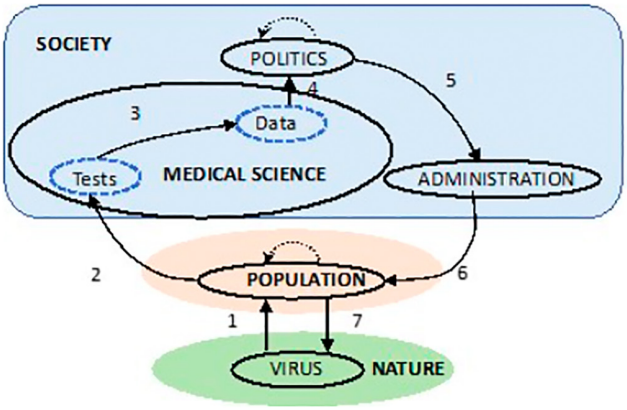

FIGURE 2 The cyber systemic national control loop for virus crisis management. (Figure adopted from Tretter 2020[4,5]; with permission from the publisher MWV and the Bertalanffy Center).

2.2 | Critical time delays

With this public health management model in mind, it can be seen easily that one of the most striking problems in this control loop were *time delays*: Time delays in the measurement of the populations state of probably 2 weeks and latencies of their adherence with consequences of intrinsic oscillations of the epidemic by critical under- and oversteering. For instance, in autumn in some countries not detecting exponential increases led to late and, therefore, hard decisions (hard lockdown) which worked like a hammer. After the reduction of the incidence numbers, there was a "dance" in finishing lockdown stepwise, observing the time course of the numbers, etc. This is also a well-known problem for epidemic management (Pueyo 2020[6]).

The systemic cue is that the time delays are critical—identification of diseased persons, reporting numbers to policy makers, and implementing public order measures: some are too late, some too hard.

2.3 | Organizational optimization of the control loop

These fuzzy moments of crisis management—late detection of exponential increase, disagreement about wearing masks, delayed lockdowns, the gaining of political will, etc.—is complex and problematic. In Germany for instance, experiences and warnings were available already in 2012 when zoonoses like SARS-Cov1, the first

variant of the coronavirus, had already shown the threat of potential pandemics and the need to better understand the pathological properties of these viruses and the specific vulnerability of host individuals (Deutscher Bundestag 2012[7]). Organizational action plans were provided by experts that would have served well in the upper levels of power in case of a pandemic emergency. But the appropriate mitigation plan was not established for Germany (and with few exceptions, most other countries suffered from the same lack of preparation).

As a consequence, the management of COVID-19 was suboptimal. There were several short-sighted and weakly thought through interventions and the predictive framework relating the conditions of population dynamics of the pandemic and the systemic pathology of infected people has seen room for improvement. Even economists understood that control of the dynamics of the pandemic was a necessary condition of a normalized economic life. There was also a top-down control lacking a structure as "systemic management" proposes that integrates hierarchically low-level autonomy with higher level planning and control by the transdisciplinary composition of the players in the control loop (Senge,[8] Ison,[9] Midgley,[10] Malik,[11]).

Regarding public opinion, increasingly a suppression of alternative scientific views on the pandemic could be observed, leading to the silent exclusion of critical scientists who estimated a lower danger of the pandemic: they disturbed the conformity of public opinions, and their opinions finally were abused by oppositional political parties (reference needed). As medicine has a leading role in the assessment of risks and management of the pandemic this diversity of opinions within medicine should not be suppressed but integrated by "consistency conferences" that cultivate differences in a dialectic way. In this way, in complex situations, better solutions are found through synergies that take into account multiple perspectives.

3 | BRIEF TIMELINE OF ENGAGEMENT OF MEDICAL DISCIPLINES AND THEIR EVALUATION BY SPECIFIC METHODS AND PERSPECTIVES

One essential flaw of medical expert opinion is still caused by the lack of cross-specialism learning and intradisciplinary integration of medicine. In the case of COVID-19, this has resulted in the over-representation of virology and epidemiology to handle the COVID-19 pandemic in public and private life. This has led to ignorance of other important potentialities for decision makers and lost opportunity. Here, by displaying the timeline of the pandemic, the separation of medical disciplines is shown and criticized as lacking "unity in diversity" and forgetting the utility of the bio-psycho-social model for understanding health and disease (Bertalanffy,[12] Engel,[13] Noble,[14] Tretter & Löffler-Stastka[15]). In the following narrative, the succession of advice for the policy makers draws attention to the heterogenous picture of fragmented views (see Figure 3). Here, we focus on China and Europe (e.g., Germany) and highlight schematically the first period of the pandemic, Dec 2019 till summer 2020 (WHO 2021[17]):

1. At the end of December 2019, *clinicians* in a hospital in the metropolis of Wuhan were the first who discovered the "unknown unknown" as severe interstitial pneumonia (WHO 2021[18]). First and foremost it is that pneumonia is a situation that has to be handled. This vital clinical perspective seems to have been lost throughout the pandemic.
2. It took a few weeks, then the viral trigger of this disease, SARS-CoV2, could be identified by another group of medical experts. It was *virologists* who identified the SARS Cov2 by sequencing in January in the laboratory and by electron microscopy of surface

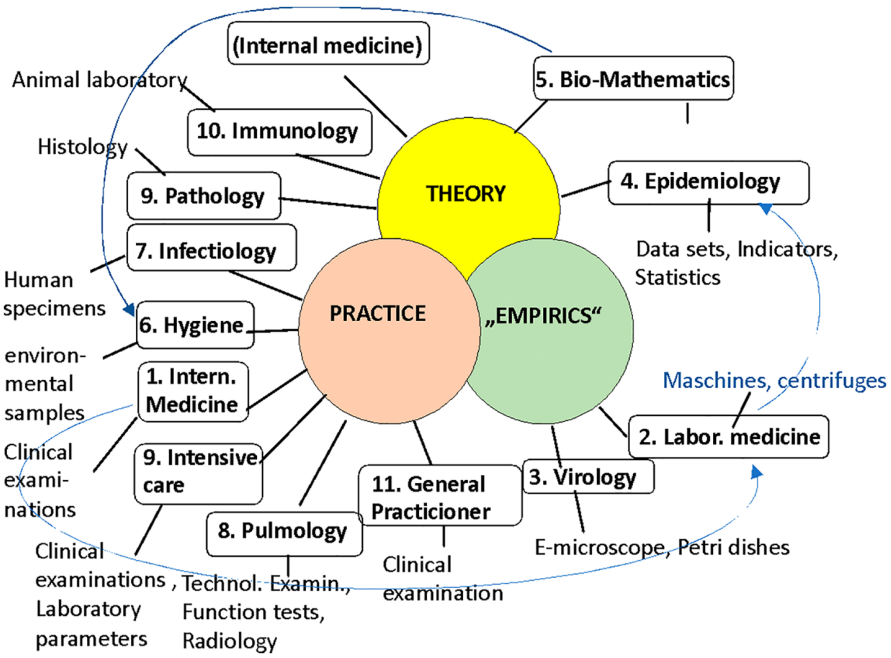

FIGURE 3 The spiral of knowledge production to COVID-19. Diverse sources, all informative and no doubt more. Did we take full advantage of the big picture for our understanding and timely response to the infection?[16] Copyright Felix Tretter, 2020 (unpublished)

structures (Wang et al. 2020[19]) based on earlier experience with SARS Cov1 (Drosten et al. 2006[20]).

3. In collaboration with *laboratory physicians*, molecular biologically based tests for epidemiological monitoring were developed, namely the now well-known PCR tests that allowed a population-wide application to explore the epidemic/pandemic potential of SARS Cov2 (Dinnes et al. 2019[21]).
4. Increasingly *epidemiologists* had enough data to describe the time course of dispersion of the infection within the population on the basis of the well-known Susceptible-Infected-Recovered (SIR) models. (Khailaie et al. 2021[22]).
5. *Bio-mathematicians* explored different methods of forecasting and they even made predictions like weather forecasts to identify the range of possible infected and deaths (Bertozzi et al. 2021,[23] van der Heiden & Hamouda 2020,[24] Cepelewicz et al. 2021[25]).
6. Insofar as *pharmacologists* did not know of a specific drug therapy option, many people died and so all efforts were put to prevention in the form of measures of *hygiene* ("distancing"). The effectiveness of such action could only be gradually demonstrated by environmental measurements. Distancing and mask wearing did become the most effective public health measure to protect against spreading the infection (CDC 2021[26]). Experts from hospital hygiene recommended antiviral procedures in case of infection of the upper airways (Kramer et al. 2021[27]).
7. Infectiologists, in cooperation with pharmaceutical companies, began to develop vaccination strategies in human samples in early summer 2020. An added concern remained the need for governments to address vaccination hesitancy as resistance. The diverse subjective viewpoints of the public as well as the objective viewpoints of science both need to be taken into account in order to obtain workable solutions for the common good. A careful consideration of the consequences of specific options for specific age groups and medical comorbidities also being required.
8. Specialists from internal medicine like *pulmonologists* (Kumar et al 2020[28]), together with *radiologists* (Huang et al. 2020[29]), showed very early the morphological features of lung affection by the virus. Pulmonology also showed long-term consequences of COVID-19 (LongCovid) by means of functional diagnostics and radiology imaging (Greenhalgh et al. 2020[30]).
9. *Intensive care medicine* desperately sought specific effective or at least symptomatic therapy strategies on the basis of laboratory parameters (NIH 2021[31]).
10. *Immunology* referred to the "cytokine storm" as a molecular sign of the derailment of the immune system with laboratory findings and animal experiments (Bergamaschi et al., 2021.[32]). *Inflammation in Covid patients has been linked with neurological symptoms that are similar to Alzheimer's or Parkinson's disease.*[33] *"Long Covid" is also linked with fatigue and depression and similarities with sepsis survivors.* https://www.sepsis.org/news/post-covid-syndrome-or-post-sepsis-syndrome/
11. *Pathology* discussed the causation of death: general organ failure or lung-specific failure (Wichmann et al. 2020[34]). Pathology investigated deaths and, with the multi-organ manifestation of inflammation, partly demonstrated the particular harmfulness of the virus.
12. *General practitioners*, on the contrary, have to distinguish colds from COVID-19 patients through clinical examination (AAFP 2021[35]).

It is obvious that many medical subdisciplines did not achieve a complementary view and that there was a lack of integration. Maybe only *Public health* could integrate some of these diverse medical specialties (APHA 2021[36]), but in public discussions and political decisions, only the specialists that were considered more interesting were given attention. Another potential, however, *health economics* is a field in medicine (and in macroeconomics) that could highlight the other side of COVID-19, namely the economic costs of health benefits of lockdowns (AEA 2021[37]). This link between medicine and economics obviously needs further support but the monetization of human health has led to methodological (commercial drivers favoring new drugs rather than the utilization of already available generics in new circumstances) and ethical problems (drugs only for those that can afford them).

4 | THE DARK SIDE OF THE NECESSARY DIVERSITY OF MEDICINE

Several misunderstandings occurred within medicine. For instance, the assessment of the *dangerousness* of SARS-Cov2 differed between medical experts when referring to the quantification of the risk to die which can also be communicated effectively to the public (1 in x, 1:x as follows): till summer 2020 some experts used the number of persons who died among the number of infected defined by positive PCR tests and resulting in a rate of about 3% (1:30). Technically speaking this is the case fatality rate (CFR). Others used the ratio of infected persons that were identified by local samples with blood analyses that showed that only 50% of the seropositive persons were positively tested by PCR tests and extrapolated this number to the whole population—they calculated maybe 1% (1:100). This indicator is called the infected fatality rate (IFR), and some experts compared the mortality rate (MR) of influenza which is about 0,1% (1:1000) with the mortality of COVID-19, resulting in a ratio of 0.3% (1:300), saying that this indicates that COVID-19 is only some kind of heavy influenza, but ignoring the fact, that counter-actions like lockdowns were never made in the last decades because of influenza.

Regardless of the various methodological problems of sensitivity and specificity of tests and time delays of reports of test results to the health authorities the highest risk number was the CFR that was 30 times higher than MR as the usual death risk indicator.

This difference was present within the medical scientific community and it was amplified by mass media with the result that

polarization of opinions within the German and Austrian populations occurred. The followers of the repressive style of lockdowns accepted the CFR, whereas the "conspiracy theoreticians" and "Alu-hats" even classified Corona as fiction or invention of the ruling class. Still, this difference is strong and has become a special topic of political science and politics in practice. In the fall of 2020, this controversy contributed to the enforcement of the anti-corona movement which in a governmental counter-movement led to the marginalization of persons who criticize governmental measures for public health and public order.

Concluding this issue, the question arises as to why medical science could not develop an integrated view. In complex matters, the overall situation can only truly be appreciated when taking a step back and bringing together all of the perspectives. This is nicely illustrated with the metaphor of the elephant (Figure 4, adapted from Himmelfarb J, Stenvinkel P, Ikizler TA, Hakim RM. The elephant in uremia: oxidant stress as a unifying concept of cardiovascular disease in uremia. Kidney Int. 2002 Nov;62(5):1524–38):

Interestingly, the diversity in opinions was not only among different medical specialties but also within the community of virologists, who are not leading experts in epidemiology. This controversy over mortality is still open in the public discussion and there is also no common statement published by different associations of medical specialists that makes clear that the different assessments are mainly based on different choices of indicators.

In consequence, the politicians and the public who use these scientific assessments for their political and everyday risk assessment do not understand the reasons behind the numerical differences in medical risk assessment and they probably use the numbers that best fit their implicit opinions regarding COVID-19. This basic problem of (selective) use of science can also be seen regarding other topics like climate change, etc. This can, however, be addressed if more effort is made within science (universities, research institutions, ministries of science, and education) to connect the different disciplines and to better communicate an overall general understanding to the public.

5 | GOVERNANCE AND UNDERSTANDING RISK

According[38] to Flyvberg (2020:614)[39] It is just a matter of time before we experience another pandemic or extreme climate event, and the lessons that climate change and COVID-19 teach us are that policy makers need to take the convergent challenges to humanity very seriously by acting fast and at scale. The problem is that current forms of governance do not act effectively across local, regional, national, and post-national regional levels (Stafford Beer, 1994,[40] Florini,[41] 2003, Archibugi,[42,43] McIntyre-Mills, 2017,[44] McIntyre-Mills and Christakis, 2021[45]).

5.1 | The importance of relationality

The relationship between the observer and the observed can change interactions. Carlo Rovelli (2021) a physicist and scholar as part of the annual Mike Jackson lecture[46] hosted by the Systems Institute at the University of Hull discussed the philosophical principle that when we try to understand reality we need to look at the relationships across variables. The observer and the object of the research are just two variables within a systemic relational context. Thus, we need to consider the many biological, socio-political, cultural, economic, and environmental relationships that come into play when doing research. Ecologists, zoologists, climatologists, physicists, economists, and philosophers have joined up the dots and made the

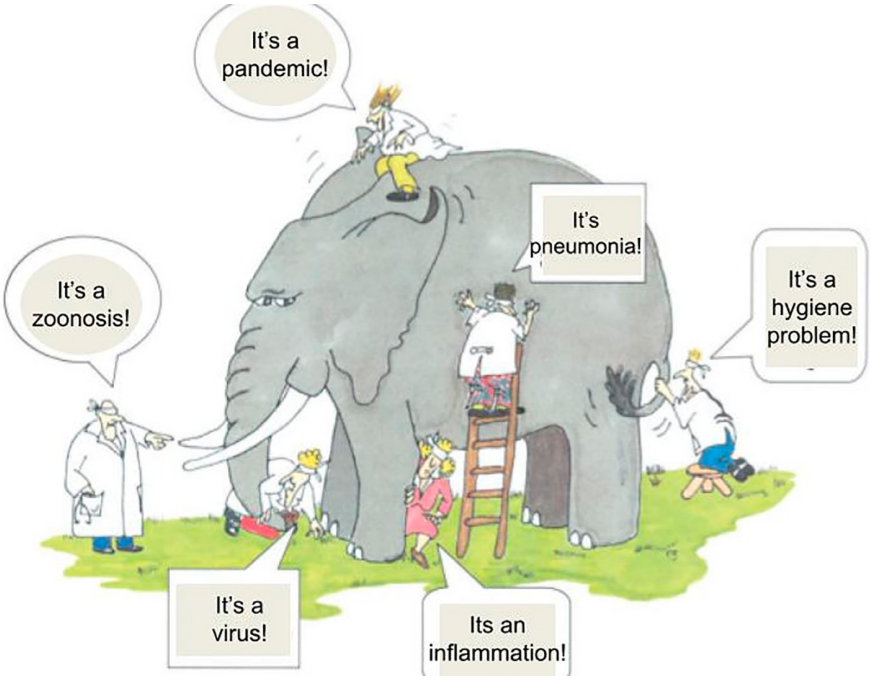

FIGURE 4 Diversity in medical perspectives but with little integrated unity. Complexity manifests in the diversity of perspectives necessary to appreciate a situation. The value of solutions increases with diverse stakeholder engagement. Adapted from the following source and bases on conversations with members of a discussion group led by Gary Smith as part of a special working group within the International Society for the Systems Sciences: Himmelfarb J, Stenvinkel P, Ikizler TA, Hakim RM. The elephant in uremia: oxidant stress as a unifying concept of cardiovascular disease in uremia. Kidney Int. 2002 Nov;62(5):1524-38. doi: http://doi.org.10.1046/j.1523-1755.2002.00600.x. PMID: 12371953.

case that the problems underpinning pandemics are relational. The political context of the origins and spread of the virus has led to a cooling of international relations and escalating tensions expressed in terms of trade.

Underpinning the problem of the COVID-19 epidemic is a lack of recognition of our hybridity and interconnectedness[47] as stressed in the previous sections in relation to addressing risks. This has implications for governance, ethics, and democracy[48] as stressed by several contributors to the volume "From Polarization to Multispecies Relationships (2021)".[49] The ethics of consumption needs to be revisited as we reflect on the virus. David Attenborough[50] reminds us that human beings are superfluous on the planet but insects are not! We are consuming the planet[51] by living beyond the limits,[52] which poses an existential risk.[53]

It has been suggested that the disease was incubating in a range of contexts as a result of trafficked creatures (that would never usually come into contact in the wild) being brought together in wet markets in a number of places in Africa and Asia. Pangolins from Africa meet bats from Asia in stacked cages where they sicken as they wait to be slaughtered. It is also discussed that the research in Wuhan (apparently partly funded by the USA[54] as a collaborative gesture) could also have contributed to the spread to or from the nearby market. Jane Goodall,[55] Attenborough,[50,56] and Vandana Shiva[57–60] make connections across loss of habitat, confinement, approaches to the production, marketing of food and the implications for ethics, farming, and trafficking of animals. COVID-19 can be linked with a range of other epidemics including SARS (from poultry that ought to be a free range) and swine flu. The roots of the problems lie in anthropocentrism and approaches to economics that work *against*, rather than *with* nature. Donaldson and Kymlica stress the need for safe habitats for animals,[61] this is an ethical issue that has implications for human security. This is the low road to morality. The high road is to recognize that all species form part of the web of life[62] and have *a right to a life that is worth living*.[63]

Current economic systems are off track because well-being stocks[64,65] are not adequately valued and protected. Paradoxically, the virus lockdowns have resulted in a lowering of carbon emissions.[66] Another paradox is that: "human beings strive to be individuals and part of a group (Berger, 1977)[67] but COVID-19 is teaching us that 'A is better off when B is better off', to cite the cybernetics axiom popularized by Von Foerster (1995).[68] The caveat is 'as long as B is not undermining the rights of current and future generations of living systems' could be added." This axiom is inherently cosmopolitan as stressed in "Systemic Ethics" (McIntyre-Mills, 2014: 48)[69] and it requires laws (such as the bill for an Ecocide Law[70]) to make a practical difference. From this basic precept, many ethical principles follow. For example, if viable vaccines are not widely shared we will all suffer. If aid is not shared, we will face the potential of more conflict. If we continue to ignore the implications of a carbon economy, we face "existential risk" (Bostrom, 2011[53]). Tragically, by striving to understand the place of human beings in relation to others and nature, Western science and philosophy emphasized categorical thinking, drawing on dualism as a rationalization, people, animals, plants, and the environment are commodified as the first step (see McIntyre-Mills and Corcoran Nantes 2021 and 2022 forthcoming)[71] in a global food production system that is not only "misdirected"[72] but is responsible—aided and abetted by industrialized production—for harming biodiversity and small local producers.

The social, economic, environmental, and of course political contexts all play a role in the creation of the perfect storm as governments hastened to point the finger of blame. Instead, we need to look at the way current systems impact biodiversity which impacts on what Stiglitz et al (2010:15)[64] call "well-being stocks" comprising a multidimensional measure of well-being spanning: (1) Material living standards (income, consumption and wealth), (2) Health,

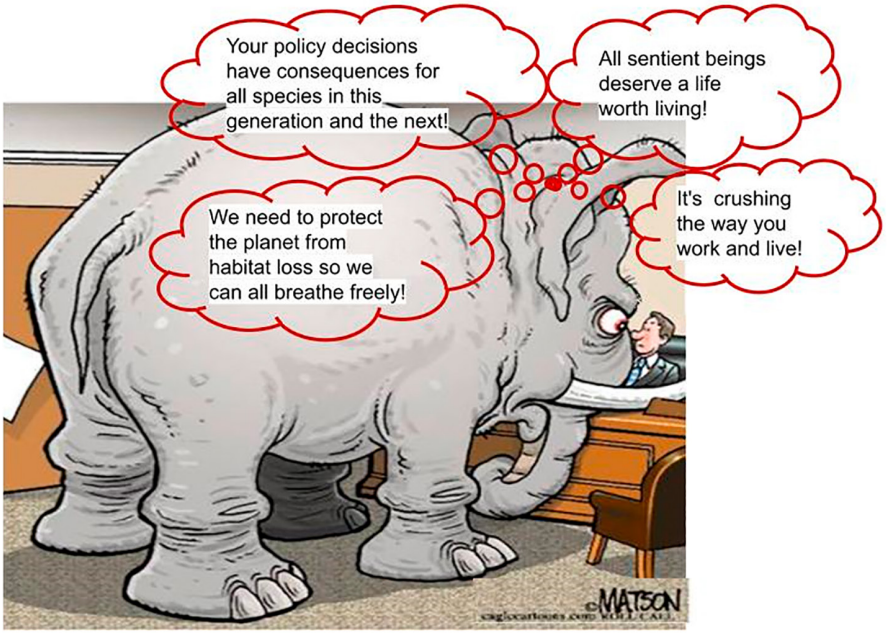

FIGURE 5 An elephant that can no longer be ignored (adapted from RJ Matson) https://www.cagle.com/r-j-matson/2012/01/the-elephant-in-the-room.

(3) Education, (4) Personal activities including work, (5) Political voice and governance, (6) Social connections and relationships, (7) Environment (present and future conditions), (8) Insecurity, of an economy as well as a physical nature.

Without protecting the fabric of life the well-being of all animals, including humans will be increasingly at risk.[39] This requires new forms of systemic governance to protect living systems and to mitigate "existential risk[53]". It is time to face up to that elephant in the room (Figure 5), it has been standing there staring at us for quite some time.

6 | CONCLUSIONS

The paper aims to show that the diversity of medical views on COVID-19 and public health and public order strategies caused a suboptimal management of the COVID-19 crisis and finally was the source of polarized public opinions. In contrast, systems thinking, meaning thinking in connectivities, could frame the often contraproductive aspect-centered viewpoints in research and politics. Systems thinking in medicine between different specialized disciplines that by integration via a systemic bio-psycho-social model could lead to a view of a "Systems pathology" could bridge several conceptual and theoretical gaps and it even could serve as an integrative framework that allows to focus on details and special views without forgetting the other aspects. Also, the Eigen-dynamics of the virus (mutations) should be considered more in advance.

Basically and in accordance with systems methodology, the affected persons (recovered patients, relatives, clinicians) should be integrated from the very beginning at the problem definition in order to obtain a more adherent problem solving (ratio of followers of public health measures).

Finally, the method of systemic management could improve the speed of and the adherence to non-pharmaceutical interventions as public health measures and more interventions to address the different life chances of those who are required to isolate without access to income supports, food, or protection from violence or neglect. Furthermore, access to scarce vaccines needs to be addressed through more equitable distribution. Medical (and other services) in many countries are under-resourced and under-staffed resulting in under-reporting of the systemic impacts of social, psychological, and economic impacts of life and death decisions.

We suggest that training in systems thinking in different disciplines and fields of governance should be enforced through laws to protect the environment, laws to prevent the inhumane treatment of sentient beings including animals[61] by containing or trafficking.[55] these could be buttressed by means of a suite of existing laws but specific laws to protect the well-being of farmed[73] and wild animals is overdue as the need for an Ecocide Law[70] which stresses the need to protect *all the inhabitants within a region*. It is not species specific and it could be a way forward to implement the notion that A is better off when B is better off. With the Sendai Risk Platform,[74] the approach of the UN could be better addressed by means of early warning risk management using multiple indicators of well-being.

Finally, with regard to the origin of zoonoses like Covid 19 very basically the effects of the interpenetration of natural and social ecosystems by deforestation and urbanization should be considered with regard to the prevention of cross-species infections. The notion of protecting habitats for diverse species has been stressed by Donaldson and Kymlicka[61] and by Jane Goodall.[55] We need an "ecology of mind"[75,76] to understand that we are participants in the organization of life and our choices matter ontologically and epistemologically. Nora Bateson[77] makes the point that research needs to be relational and that by dissecting life in the process of intervening or doing research—we are misrepresenting it.

We are no longer top predators[78] and we need to understand that our decisions have consequences for all living systems. Living systems are relational and participatory as underlined by physicists such as David Bohm and the Dalai Lama[79,80] All effects have causes resulting in multiple ongoing relationships:

> Systems thinking without ecology is empty and ecology without systems thinking is blind.

AUTHOR CONTRIBUTIONS

Conceptualization: All the authors. Methodology: All authors. Validation: All authors. Analysis of secondary data: All authors. Writing and checking: All authors.

ACKNOWLEDGMENTS

None.

CONFLICT OF INTEREST

None of the authors received a grant for this paper and we have no financial interests related to this paper.

DATA AVAILABILITY STATEMENT

The research uses only secondary data which has been cited appropriately.

ETHICS STATEMENT

This research uses only secondary data which has been cited appropriately.

ORCID

Felix Tretter https://orcid.org/0000-0002-1076-1220
Janet J. McIntyre-Mills https://orcid.org/0000-0001-7733-1228
Gary R. Smith https://orcid.org/0000-0001-6654-0921

REFERENCES

1. Ourworldindata. 2021. Accessed July 15 2021. https://ourworldindata.org/covid-vaccinations
2. Dorn F, Khailaie S, Stöckli M, et al. "Das gemeinsame Interesse von Gesundheit und Wirtschaft: Eine Szenarienrechnung zur Eindämmung der Corona- Pandemie," ifo Schnelldienst Digital, ifo Institute - Leibniz

Institute for Economic Research at the University of Munich, vol. 1(06), May 2020. https://ideas.repec.org/s/ces/ifosdd.html
3. WHO. *WHO-Convened Global Study of Origins of SARS-CoV-2: China Part*. WHO; 2021. https://www.who.int/health-topics/coronavirus/origins-of-the-virus?
4. Tretter F. *COVID-19 als Stresstest für die Wissensgesellschaft*. MWV; 2020. https://www.mwv-berlin.de/meldung/!/id/310
5. Tretter F. A systemic view on Corona crisis—revisited. 2020. https://www.bcsss.org/2020/a-systemic-view-on-the-corona-crisis-revisited-by-bcsss-vicepresident-felix-tretter/
6. Pueyo Pueyo T. Corona virus: the hammer and the dance. 2020. https://medium.com/@tomaspueyo/coronavirus-the-hammer-and-the-dance-be9337092b56
7. Deutscher Bundestag. Bericht zur Risikoanalyse im Bevölkerungsschutz 2012. 2012. https://dipbt.bundestag.de/dip21/btd/17/120/1712051.pdf
8. Senge P. The fifth discipline. Doubleday/Currency. 1990.
9. Ison R. *Systems Practice: How to act*. Springer; 2017.
10. Midgley G. *Systemic Intervention: Philosophy, Methodology, and Practice*. Springer; 2000.
11. Malik F. *Strategie des Managements komplexer Systeme: Ein Beitrag zur Management-Kybernetik evolutionärer Systeme*. Haupt; 2008.
12. Bertalanffy LV. *General Systems Theory*. Braziller; 1968.
13. Engel GL. The need for a new medical model: a challenge for biomedicine. *Science*. 1977;196(4286):129-136.
14. Noble D. *Music of Life*. Oxford University Press; 2006.
15. Tretter F, Löffler-Stastka H. Medical knowledge integration and "systems medicine": needs, ambitions, limitations and options. *Med Hypotheses*. 2019;133:109386. doi:10.1016/j.mehy.2019.109386
16. The spiral of knowledge production to COVID-19. Diverse sources Copyright Felix Tretter, 2020 (unpublished).
17. WHO. 2021. https://www.who.int/news/item/29-06-2020-covidtimeline
18. WHO. *COVID-19 Operational Update - A year in review: 2020*. WHO Regional Office for Europe; 2021.
19. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China. *JAMA*. 2020;7. doi:10.1001/jama.2020.1585
20. D Drosten C, Gunther S, Preiser W, et al. 2003. Identification of a novel coronavirus in patients with severe acute respiratory syndrome. *N Engl J Med* 348:1967–1976.
21. Dinnes J, Deeks JJ, Berhane S, et al. Rapid, point-of-care antigen and molecular-based tests for diagnosis of SARS-CoV-2 infection. *Cochrane Database Syst Rev*. 2021(3):CD013705. Accessed April 27, 2021. doi:10.1002/14651858.CD013705.pub2
22. Khailaie S, Mitra T, Bandyopadhyay A, et al. Development of the reproduction number from coronavirus SARS-CoV-2 case data in Germany and implications for political measures. *BMC Med*. 2021;19:32. doi:10.1186/s12916-020-01884-4
23. Bertozzi AL, Franco E, Mohler G, Short MB, Sledge D. The challenges of modeling and forecasting the spread of COVID-19. *Proc Natl Acad Sci USA*. 2020;117(29):16732-16738. doi:10.1073/pnas.2006520117
24. van der Heiden M, Hamouda O. Schätzung der aktuellen Entwicklung der SARS-CoV-2-Epidemie in Deutschland – Nowcasting. *Epid Bull*. 2020;17:10-16. doi:10.25646/6692.4
25. Cepelewicz J. The hard lessons of modeling the coronavirus pandemic. Quanta Magazine. 2021. https://www.quantamagazine.org/the-hard-lessons-of-modeling-the-coronavirus-pandemic-20210128/
26. CDC. Guidance for wearing masks—help slow the spread of COVID-19. 2021. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover-guidance.html
27. Kramer A, Eggers M, Hübner NO, Walger P, Steinmann E, Exner M. Virucidal gargling and virucidal nasal spray. *GMS Hyg Infect Control*. 2021;16:Doc02. doi:10.3205/dgkh000373. URN: urn:nbn:de:0183-dgkh0003736
28. Kumar S, Mehta S, Sarangdhar N, Ray A, Sinha S, Wig N. Management of COVID-19 from the pulmonologist's perspective: a narrative review. *Expert Rev Respir Med*. 2021;15(4):519-535. doi:10.1080/17476348.2021.1853529
29. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020;395(10223):497–506 [Published correction appears in Lancet 2020;395(10223):496.]
30. Greenhalgh T, Knight MA, Court C, Buxton M, Husain L. Management of post-acute covid-19 in primary care. *BMJ*. 2020;370:m3026. doi:10.1136/bmj.m3026
31. NIH. Care of critically ill adult patients with covid. 2021. https://www.covid19treatmentguidelines.nih.gov/management/critical-care/summary-recommendations/
32. Bergamaschi L, Mescia F, Turner L, et al. Longitudinal analysis reveals that delayed bystander CD8+ T cell activation and early immune pathology distinguish severe COVID-19 from mild disease. *Immunity*. 2021;54(6):1257-1275. doi:10.1016/j.immuni.2021.05.010
33. Cassella C. 2021. https://www.sciencealert.com/brain-changes-from-covid-19-look-eerily-similar-to-alzheimers-and-parkinsons-disease.
34. Wichmann D, Sperhake J-P, Lütgehetmann M, Stuerer S. Autopsy findings and venous thromboembolism in patients with COVID-19: a prospective cohort study. *Ann Intern Med*. 2020;173(4):268-277. doi:10.7326/M20-2003
35. AAFP. Respond to Coronavirus (COVID-19). Support your practice and patients with the latest information. 2021. https://www.aafp.org/family-physician/patient-care/current-hot-topics/recent-outbreaks/covid-19.html
36. APHA. CVOIDguidance.org. 2021. https://www.apha.org/topics-and-issues/communicable-disease/coronavirus/guidance
37. AEA. Health economics insights on covid-19 response. 2021. https://www.aeaweb.org/conference/2021/preliminary/2053?q=enqrvipols7ozm8lqsxivbkqhngvrjqmlwp1lbkli_otgrwlhaws1kjcxcarl7wkpl8ouxgokpjyczxkze2fsmoyu8tbxhqvffwwbuwnqgyujkadzifsxdc0ecgq
38. This section is elaborated in a draft paper McIntyre-Mills (to be submitted to SRBS): The importance of relationality: a note on co-determinism, multispecies relationships and implications for governance and risk: lessons from Covid-19.
39. Flyvbjerg B. The law of regression to the tail: how to survive covid-19, the climate crisis, and other disasters. *Environ Sci Policy*. 2020;114:614-618.
40. Beer S. Governance or government. In: Beer S, ed. *Beyond Dispute: The Invention of Team Syntegrity*. Wiley; 1994.
41. Florini A. *The Coming Democracy*. Island Press; 2003.
42. Archibugi D. *The Architecture of Cosmopolitan Democracy. The global Commonwealth of Citizens: Towards Cosmopolitan Democracy*. Princeton University Press; 2008.
43. Archibugi D. Architecture of cosmopolitan democracy. In: Brown GW, Held D, eds. *Cosmopolitan Reader*. Polity Press; 2010.
44. McIntyre-Mills, J. *Planetary Passport: Re-presentation, Accountability and Re-Generation*. Springer International Publishing AG. eBook ISBN, 978-3-319-58011-1. 10.1007/978-3-319-58011-1
45. McIntyre-Mills JJ, Christakis A. Social and environmental justice: the legacy of structured democratic dialogue and the potential of pathways to wellbeing. Chapter 14. In *From Polarization to Multispecies Relationships*. Springer; 2021.
46. Relational Interpretation of Quantum Mechanics and Alexander Bogdanov's Worldview by Carlo Rovelli. In this series Rovelli pays tribute to Werner Heisenberg, who discovered the fundamental equations of quantum mechanics. The other is Alexander Bogdanov. https://stream.syscoi.com/2021/05/05/the-centre-for-systems-studies-two-even-celebrating-the-life-and-contributi

on-of-alexander-bogdanov-the-annual-mike-jackson-lecture-2-june-with-carlo-rovelli-and-seminar-on-3-june-both-online/
47. McIntyre-Mills J. Recognizing our hybridity and interconnectedness. *Curr Sociol*. 2017;1-24. doi:10.1177/0011392117715898
48. McIntyre-Mills J. The Covid-19 era: no longer business as usual. *Syst Res Behav Sci*. 2020;37:827-838. doi:10.1002/sres.2745
49. McIntyre-Mills JJ, Corcoran Nantes Y. *From Polarization to Multispecies Relationships in the Age of Mass Extinctions*. Springer; 2021.
50. https://www.abc.net.au/classic/the-margaret-throsby-interviews/sir-david-attenborough-interviewed-by-margaret-throsby/11757192
51. Urry J. Consuming the planet to excess. *Theory Cult Soc*. 2010;27(2-3):191-212. doi:10.1177/0263276409355999
52. Meadows D, Randers J. *Beyond the Limits: Global Collapse of a Sustainable Future*. Earthscan Publications; 1992.
53. Bostrom, N. *Existential Risk Prevention as the Most Important Task for Humanity*. Faculty of Philosophy & Oxford Martin School University of Oxford. 2011. http://www.existential-risk.org/
54. SciCheck Archives - FactCheck.org. The Wuhan Lab and the Gain-of-Function Disagreement By Lori Robertson Posted on May 21, 2021
55. https://www.cnn.com/videos/us/2020/03/19/coronavirus-jane-goodall-acfc-full-episode-vpx.cnn
56. Life on our planet documentary. David Attenborough. 2020. https://www.youtube.com/watch?v=mU4wZhFCsGs
57. Shiva V. *Monocultures of the Mind*. Third World Network; 2012.
58. Shiva V. *Making Peace with the Earth*. Fernwood Publishing; 2012.
59. Shiva V. Ecofeminism and the decolonization of women, nature and the future. 2020. Accessed March 25, 2020. https://www.youtube.com/watch?v=hVbbov9Rfjg - Uploaded by San Telmo Museoa
60. Shiva V. Two paths to the future of food and farming—ecofarm keynote. 2020. https://www.youtube.com/watch?v=9vNPGwqR4TQ
61. Donaldson S, Kymlicka W. *Zoopolis: A Political Theory of Animal Rights*. Oxford University Press; 2011.
62. Capra F. *The Web of Life: A New Synthesis of Mind and Matter*. Harper Collins; 1996.
63. Nussbaum M. *Frontiers of Justice: Disability, Nationality, Species Membership*. Belknap Press; 2006.
64. Stiglitz J, Sen A, Fitoussi JP. *Mis-Measuring Our Lives: Why the GDP Does Not Add Up*. The New Press; 2010.
65. Stiglitz JJ. Of the 1%, by the 1%, for the 1%. 2011. https://www.vanityfair.com/news/2011/05/top-one-percent-201105#
66. Abram S. Coronavirus: world's response has slashed CO_2 emissions—here's how to keep them down. 2020. https://theconversation.com/coronavirus-worlds-response-has-slashed-co-emissions-heres-how-to-keep-them-down-134094
67. Berger PL. *Facing Up to Modernity*. Penguin; 1977.
68. Von Foerster H. *Cybernetics of Cybernetics*. 2nd ed. Future Systems, Inc.; 1995.
69. McIntyre-Mills J. *Systemic Ethics and Non-anthropocentric Stewardship: Implications for Transdisciplinarity and Cosmopolitan Politics. Contemporary Systems Series*. Springer; 2014.
70. Higgins P, Short D, South N. Protecting the planet: a proposal for a law of ecocide. *Crime Law Soc Change*. 2013;59:251-266. doi:10.1007/s10611-013-9413-6
71. McIntyre-Mills J, Corcoran Nantes Y. *Transformative Education for Re-Generation and Wellbeing*. Springer; Forthcoming 2022.
72. Ackoff RL, Pourdehnand J. On misdirected systems. *Syst Res Behav Sci*. 2001;18(3):199-205.
73. Ivens, S. *New Zealand Legally Recognizes Animals as 'Sentient' Beings*. 2015. https://animalequality.org.uk/blog/2015/05/12/new-zealand-legally-recognises-animals-as-sentient-beings/#:~:text=New%20Zealand%20takes%20a%20monumental,%2C%20are%20%E2%80%9Csentient%E2%80%9D%20beings
74. United Nations Office for Disaster Risk Reduction. Sendai Framework. 2015–2030. http://www.preventionweb.net/drr-framework/sendai-framework/
75. Bateson G. *Steps to an Ecology of Mind*. Ballantine; 1972.
76. Bateson N. 2021. Plenary International Systems Sciences. https://norabateson.wordpress.com/2017/05/28/warm-data/Nora Bateson Plenary, July 12th International Systems Sciences. https://zoom.us/rec/play/_oe07ngyK1jHXqZxIaT5nBr_c95ReZ2KWOwXCrYw7u1K6rKfJRUPtUH_urEVNtII9m1WDZbqZFxJ8k7i.po_IqnXsYX9swRJr?continueMode=true&_x_zm_rtaid=u3XXrLmPQCaoiZM3sR9LHA.1626085969999.920d3aa8d2c700ad3a46aaaca293852c&_x_zm_rhtaid=301
77. Nora Bateson Plenary. July 12th International Systems Sciences. https://zoom.us/rec/play/_oe07ngyK1jHXqZxIaT5nBr_c95ReZ2KWOwXCrYw7u1K6rKfJRUPtUH_urEVNtII9m1WDZbqZFxJ8k7i.po_IqnXsYX9swRJr?continueMode=true&_x_zm_rtaid=u3XXrLmPQCaoiZM3sR9LHA.1626085969999.920d3aa8d2c700ad3a46aaaca293852c&_x_zm_rhtaid=301
78. McIntyre-Mills J. Prologue 'No longer top predator'. In: McIntyre-Mills JJ, Corcoran Nantes Y, eds. *From Polarization to Multispecies Relationships in the Age of Mass Extinctions*. Springer Nature; 2021. doi:10.1007/978-981-33-6884-2
79. Bohm D and Dalai Lama HH. From Fragmentation to Wholeness: David Bohm & Dalai Lama Life and mind enfolded in everything. 2018. https://www.youtube.com/watch?v=V2He4oU32sg
80. Dalai Lama HH, XIV(Bstan-'dzin-rgya-mtsho). *The Universe in a Single Atom. The Convergence of Science and Spirituality*. Harmony; 2005.

How to cite this article: Tretter F, McIntyre-Mills JJ, Smith GR. Toward a big picture of COVID-19. *Pharmacol Res Perspect*. 2022;10:e00996. doi: 10.1002/prp2.996