Perspectives

Infodemiology: The Science Studying Infodemic and Inforus

George F. Gao[1,2,3,#]

After three years of great effort, we are now facing a new challenge from the coronavirus disease 2019 (COVID-19) pandemic in China. From strict lockdown in Wuhan City (*1*–*2*), Hubei Province, to dynamic zero-COVID and subsequent precision prevention and control, the control strategies have been a good example with great achievements for preparedness and emergency response in modern settings of public health. While there are always arguments, it is clear that life-saving and time-winning processes have made essential materials available for the new challenge, with more vaccines and inhibitors/drugs available for use by now. In the past, discussions about a strategy switch raised concerns about China's response capacity and even led to rumors or mis/disinformation, which challenged the resilience and tolerance of society. China was able to explore the zero-COVID strategy because it has a strong community-level public health service (*3*) and the capacity to ensure the execution of the strategy. We have been working hard to tackle both the COVID-19 pandemic and the mis/disinformation epidemic, which was referred to as an "infodemic" as early as in 2002 (*4*). The word "infodemic" was already widely used to refer to an information epidemic when the severe acute respiratory syndrome (SARS) outbreak occurred. This term was borrowed from the real disease epidemic, but was used to refer to a wider field, including the science of humanity. An infodemic can be more exaggerated than a respiratory pathogen-caused disease because it is mainly transmitted through the internet, which allows for faster spread.

Infodemics often start suddenly whenever something new and difficult to understand occurs for the public. Recently, when the new Omicron sub-variant XBB was found in Japan, the word "hellhound" was used for this virus to scare the public and it was very effective at disturbing society. Anxiety and fear are emerging in the society and information and mis/disinformation are mixed and disseminated. While the government and professionals are working hard to control the emergence of the COVID-19 cases, they also have to work hard to deal with the infodemic.

Infodemic can sometimes be even more harmful than the disease epidemic itself. When the COVID-19 outbreak occurred in late December 2019 and early January 2020, rumors and mis/disinformation filled social media, causing serious panic around the world. Dr. Anthony Fauci, a world-renowned infectious disease expert and long-term director of National Institute of Allergy and Infectious Diseases (NIAID), National Institutes of Health (NIH), USA, was attacked and someone on social media even threatened to kill his two daughters. Emails of my conversation with Dr. Fauci were revealed under the US law. Bill Gates was also blamed on social media for supporting grants for infectious diseases research, claiming he supported the creation of the SARS-CoV-2 virus, the causative agent of COVID-19. Our publications from China CDC, including the identification and isolation of the SARS-CoV-2 (then called hCoV-19) and the determination of the epidemiological parameters, were published in both *the Lancet* and *The New England Journal of Medicine*. It is hard to believe that scientific research could be a target of an infodemic, even though science has played a very important role in the fight against COVID-19. Many more examples can be listed here during the early stage of the COVID-19 pandemic. Therefore, the study of infodemics needs more attention from the academic research field in the future as we face more attacks of emerging and re-emerging pathogens in the foreseeable future and other public health issues that may suddenly emerge.

We always ask ourselves if we are ready for the next potential epidemic or even pandemic. As a member of Global Preparedness Monitoring Board (GPMB) under the World Health Organization (WHO), and we have meetings twice a year to evaluate preparedness for the control and prevention of emerging pathogens. I remembered in the 2019 Annual Report, it claimed that the next pandemic might be caused by an influenza virus or coronavirus, with coronavirus at the top of the list. I was also in present in New York at the tabletop exercise of preparedness and response, called Event 201, organized by Johns Hopkins University on October 18, 2019 with an "imaginary enemy" of disease, called coronavirus associated pneumonia syndrome (CAPS), which truly sounded like the real COVID-19. As professionals, we knew that a coronavirus pandemic was a possibility but we were not ready (*5*–*6*). And indeed, we now have COVID-19 in the real world. Because of this exercise, we were

attacked and accused of knowing about or even releasing SARS-CoV-2. Again, the infodemic damaged the reputation of scientists and professionals working closely on preparedness and response for a possible pandemic. It is clear that infodemic is a real disease, which must be well studied and given more attention.

Therefore, the science of the study of infodemics is called infodemiology. Infodemiology is a new branch of epidemiology, which studies the epidemiology of infodemics. Epidemiology is a word formed from three Greek words: "epi," "demos," and "logos," which mean "on the study of population." By definition, epidemiology is a discipline of science under medicine that studies events (including diseases) that occur in a population level. In more detail, it is the study, assessment, and analysis of public health concerns in a given population; tracking the patterns and effects of diseases, environmental toxins, violence, terrorist attacks, etc. For infodemiology, as a new sub-discipline of epidemiology that typically deals with population-level questions, it studies the source and risk assessment of the mis/disinformation, public concerns, and tracks of the patterns of effects of infodemics. An infodemic is the disease. What is the causative agent of the infodemic? When I tried to figure out a good name for this, I exchanged emails with Dr. Fauci, and we both agreed to name the causative agent of the infodemic as an inforus, which is a portmanteau of information and virus. Therefore, I propose the terminology as follows: an inforus causes an infodemic, or it is the causative agent of infodemic. The study of both infodemics and inforuses is infodemiology.

In essence, an inforus is the mixture of misinformation or disinformation, plus the correct information. Unlike rumors, it is often hard to distinguish and identify an inforus because it can be a "zipped" agent of misinformation, disinformation, and information. There is a distinction between these words. Disinformation is false information spread in order to deceive people; while misinformation is wrong information or the fact that people are misinformed. Ultimately, both of them are related to people, so they fall under the category of epidemiology. Under the COVID-19 pandemic, what the virus was man-made is a typical example of inforus. In this story, mass data were "zipped" together with so many looked reasonable without scrutiny as people reply more on information of social media in the current society.

Retrospectively, we can recall so many notorious infodemics, such as vaccine hesitancy being a good example when Andrew Wakefield published his paper in *The Lancet* (*7*), linking measles vaccine with autism. Though the publication was later withdrawn, it caused several outbreaks of measles in the UK and USA, causing an increase in the death toll for children. Even now we still have serious problems with vaccine hesitancy for COVID-19. In most countries, there is only 70%–80% vaccination coverage for COVID-19. In China, though we have over 90% coverage, the coverage of both elderly population and people with underlying diseases is much lower than the average, but this population is especially vulnerable.

Infodemic are not specific diseases in public health, they can also be seen in many other fields, including the humanities. We should always bear in mind that we have to work together to tackle the infodemic problem. This is truly a global issue. I want to restate my 4 C principles (*8*) for good practice in infodemiology: Cooperation, Competition, Communication, and Coordination.

Infodemiology should be considered in the curriculum of the university level or graduate course. It should be coordinated by a joint-force to link several ministry-level offices. Let's all take the cause of infodemiology to study inforus and infodemic, for a bright future in the world.

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[#] Corresponding author: George F. Gao, gaofu@chinacdc.cn.

[1] Chinese Center for Disease Control and Prevention, Beijing, China; [2] Institute of Microbiology, Chinese Academy of Sciences, Beijing, China; [3] Savaid Medical School, University of Chinese Academy of Sciences, Beijing, China.

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