the disaster management and health adaptation plans, accordingly.

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Coronavirus: a novel threat and ICT-based mitigation

Coronavirus, the deadly RNA virus causes severe respiratory illness in humans and sometimes results in death. In December 2019, an outbreak of this virus was reported from Wuhan, China, which has been named the novel coronavirus (2019-nCoV)[1]. During the time of writing this letter, it has become an epidemic in China with more than 1000 lives lost and 40,000 cases detected. The rapid spread of this virus is not only a threat to China, but to the whole world. Recently, some cases have been reported from Singapore, Thailand, Japan, Germany, the United States and India[2]. The World Health Organization (WHO) has declared the 2019-nCoV outbreak as a Public Health Emergency of International Concern[3].

The symptoms of coronavirus infection are similar to influenza, including runny nose, sore throat, cough, dizziness, fever and quick spread from human to human[4]. Researchers are playing a vital role along with the medical professionals to combat this virus. Bats are considered as the host of this airborne virus, as the whole genome sequence is about 96% similar to the bat coronavirus[5]. Phylogenetically, 79.5% nucleotides of 2019-nCoV are similar to the SARS-CoV (severe acute respiratory syndrome related coronavirus)[5]. Several research articles, research bulletins, etc. are now continuously being published with updates about the status of the 2019-nCoV outbreak along with rapid detection and possible treatment methods. CDC has provided a flowchart to identify the virus infection and RT-PCR based assay for its detection.

A recently published report by WHO indicates that a number of countries and geographical regions have been affected by nCoV during December 2019 to the first week of February 2020 (Figure 1)[6]. Figure 2 presents the epidemic curve in China based on the onset of symptoms and reported travel history. The Worldmeter reports that 40,614 such cases have been registered till 10 February 2020 worldwide, and 910 deaths have been recorded[7]. It shows that nCoV cases till 9 February 2020 has $R^2 = 0.6922$ and $R^2 = 0.7052$ for nCoV cases and death polls respectively, in (a) and (b); the difference is 0.0137. It shows how closely the two plots are related. The similarity between the two graphs is 99.9863%. We found the infection rate to be $nCoV_{rate} = 12.977 * \ln(days) - 11.959$ and death rate to be $nCoV_{death} = 295.36 * \ln(days) - 246.32$. From here, we can expect that nCoV infection shall come under control between the second week of March and the first week of April 2020, if appropriate measures are introduced.

We all need to be aware of this epidemic and also be conscious about the challenges brought by the 2019-nCoV infection. We should be updated about the genetic and epidemiological information related to this virus, and also be in contact with the international community support that can control its rapid outbreak and can potentially save lives. We prescribe a list of measures that should be followed by fellow citizens to protect themselves from the nCov infection: (i) avoid close contact with such infected persons, (ii) wash hands frequently, (iii) avoid unprotected contact with animals, (iv) maintain cough etiquette, and (v) contact the respective emergency health department in case of suspected nCoV infection.

We have devised a novel scheme to mitigate such viral infections using the Internet of Things (IoT). The IoT provides a platform to connect heterogeneous things with the internet to disseminate smart services like e-healthcare. In this context, we can foresee IoT as a key enabler to counter nCoV infections by predicting such occurrences far ahead of time. This can be achieved by installing

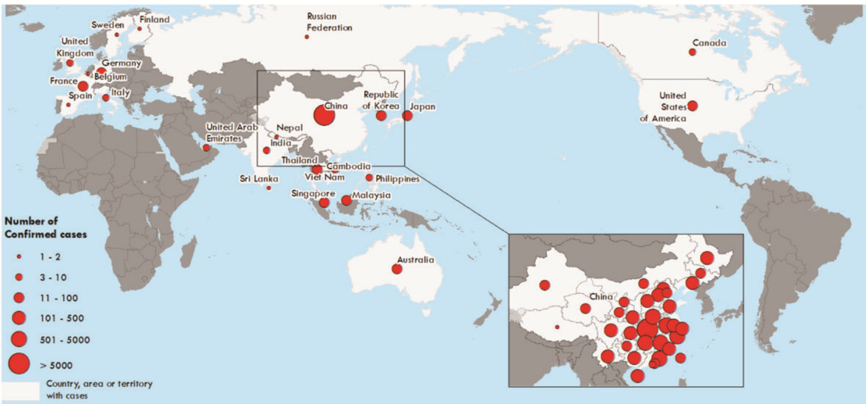

Figure 1. Global areas with reported cases of 2019-nCoV. Image Courtesy: Situation Report 20, WHO[6].

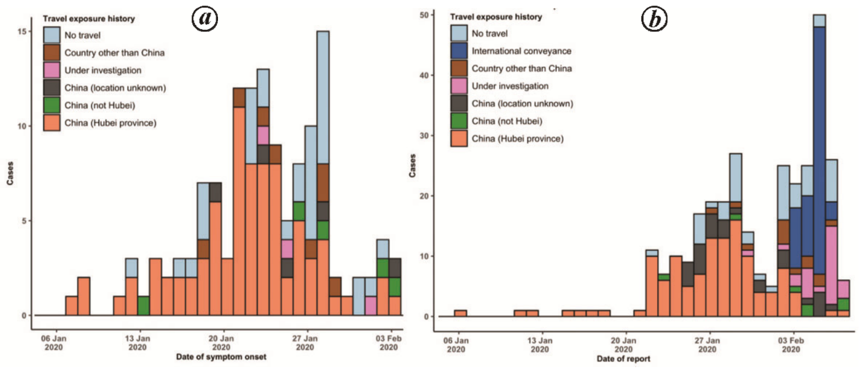

Figure 2. Epidemic curve in China on reported cases of 2019-nCoV by WHO. ***a***, Onset of symptoms. ***b***, Reported travel history.

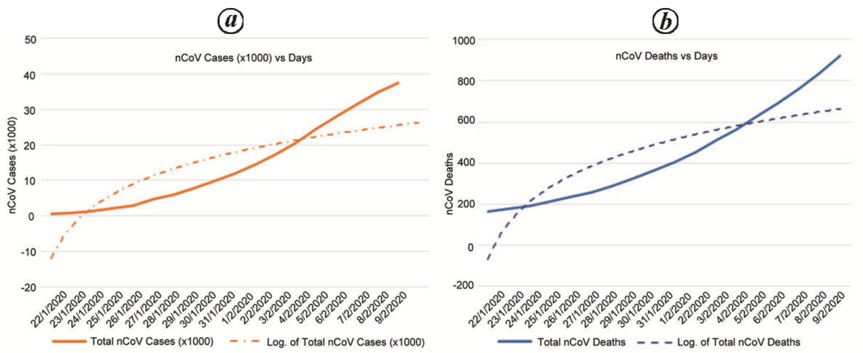

Figure 3. Epidemic cases and growth curve in China. ***a***, nCoV cases × 1000 versus days; ***b***, nCoV deaths versus days.

IoT-based smart temperature-monitoring systems in and around crowded locations such as train stations, bus stops, shopping markets, schools and offices. It will periodically track the body temperature of people and send as well as analyse the data in remote cloud centres to predict possible viral infections. Similarly, smart masks could be used by citizens that will continuously detect the user's inhale–exhale rate and heart rate. Such data could later be processed for taking appropriate decisions about the possible nCoV infection. We can also have IoT-based smart hand sanitizers that would readily remind the users or doctors at homes or hospitals to wash their hands after they visit an infected patient. On the other hand, IoT can be used to measure the virus-zapping technology installed in groundwater or overhead reservoirs to check whether the water is safe for drinking. IoT-enabled digital pathology microscope is another vital facility that could be utilized to detect nCoV infection. Thus, we urge the scientific community to work collaboratively so that a smart solution to nCoV infection could be found soon.

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