

**DEVELOPMENT OF ENVIRONMENTAL HEALTH ENGINEERING FACILITIES, EQUIPMENT, SENSORS AND PUBLIC HEALTH SYSTEMS FOR TACKLING COVID-19 PANDEMIC**

**BY**

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**CHAPTER ONE**

**INTRODUCTION**

# Background and Motivation

Environmental health has been defined in a 1999 document by the [World Health Organization] (WHO) as: Those aspects of the human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that can potentially affect health.

Environmental health as used by the WHO Regional Office for Europe, includes both the direct pathological effects of chemicals, radiation and some biological agents, and the effects (often indirect) on health and well being of the broad physical, psychological, social and cultural environment, which includes housing, urban development, land use and transport. As of 2016 the WHO website on environmental health states "Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, as well as genetics.

The WHO has also defined environmental health services as "those services which implement environmental health policies through monitoring and control activities. They also carry out that role by promoting the improvement of environmental parameters and by encouraging the use of environmentally friendly and healthy technologies and behaviors. They also have a leading role in developing and suggesting new policy areas.

The term [environmental medicine](https://en.wikipedia.org/wiki/Environmental_medicine) may be seen as a medical specialty, or branch of the broader field of environmental health. Terminology is not fully established, and in many European countries they are used interchangeably.

**DISCIPLINES**

**Five basic disciplines** generally contribute to the field of environmental health: **environmental epidemiology, toxicology, exposure science, environmental engineering, and environmental law**. Each of these disciplines contributes different information to describe problems and solutions in environmental health, but there is some overlap among them.

* [Environmental epidemiology](https://en.wikipedia.org/wiki/Environmental_epidemiology) studies the relationship between environmental exposures (including exposure to chemicals, radiation, microbiological agents, etc.) and human health. Observational studies, which simply observe exposures that people have already experienced, are common in environmental epidemiology because humans cannot ethically be exposed to agents that are known or suspected to cause disease. While the inability to use experimental study designs is a limitation of environmental epidemiology, this discipline directly observes effects on human health rather than estimating effects from animal studies.
* [Toxicology](https://en.wikipedia.org/wiki/Toxicology) studies how environmental exposures lead to specific health outcomes, generally in animals, as a means to understand possible health outcomes in humans. Toxicology has the advantage of being able to conduct randomized controlled trials and other experimental studies because they can use animal subjects. However there are many differences in animal and human biology, and there can be a lot of uncertainty when interpreting the results of [animal studies](https://en.wikipedia.org/wiki/Animal_studies) for their implications for human health.
* [Exposure science](https://en.wikipedia.org/wiki/Exposure_science) studies human exposure to environmental contaminants by both identifying and quantifying exposures. Exposure science can be used to support environmental epidemiology by better describing environmental exposures that may lead to a particular health outcome, identify common exposures whose health outcomes may be better understood through a toxicology study, or can be used in a risk assessment to determine whether current levels of exposure might exceed recommended levels. Exposure science has the advantage of being able to very accurately quantify exposures to specific chemicals, but it does not generate any information about health outcomes like environmental epidemiology or toxicology.
* [Environmental engineering](https://en.wikipedia.org/wiki/Environmental_engineering) applies scientific and engineering principles for protection of human populations from the effects of adverse environmental factors; protection of environments from potentially deleterious effects of natural and human activities; and general improvement of environmental quality.
* [Environmental law](https://en.wikipedia.org/wiki/Environmental_law) includes the network of treaties, statutes, regulations, common and customary laws addressing the effects of human activity on the natural environment.

Information from epidemiology, toxicology, and exposure science can be combined to conduct a [risk assessment](https://en.wikipedia.org/wiki/Risk_assessment) for specific chemicals, mixtures of chemicals or other risk factors to determine whether an exposure poses significant risk to human health (exposure would likely result in the development of [pollution-related diseases](https://en.wikipedia.org/wiki/List_of_pollution-related_diseases)). This can in turn be used to develop and implement environmental health policy that, for example, regulates chemical emissions, or imposes standards for proper [sanitation](https://en.wikipedia.org/wiki/Sanitation). Actions of engineering and law can be combined to provide [risk management](https://en.wikipedia.org/wiki/Risk_management) to minimize, monitor, and otherwise manage the impact of exposure to protect human health to achieve the objectives of environmental health policy.

## COVID-19

**Coronavirus disease 2019** (**COVID-19**) is an [infectious disease](https://en.wikipedia.org/wiki/Infectious_disease) caused by [severe acute respiratory syndrome coronavirus 2](https://en.wikipedia.org/wiki/Severe_acute_respiratory_syndrome_coronavirus_2) (SARS-CoV-2). The disease was first identified in December 2019 in [Wuhan](https://en.wikipedia.org/wiki/Wuhan), the capital of China's [Hubei](https://en.wikipedia.org/wiki/Hubei) province, and has since spread globally, resulting in the ongoing [2019–20 coronavirus pandemic](https://en.wikipedia.org/wiki/2019%E2%80%9320_coronavirus_pandemic). Common [symptoms](https://en.wikipedia.org/wiki/Symptom) include [fever](https://en.wikipedia.org/wiki/Fever), [cough](https://en.wikipedia.org/wiki/Cough), and [shortness of breath](https://en.wikipedia.org/wiki/Shortness_of_breath). Other symptoms may include [muscle pain](https://en.wikipedia.org/wiki/Myalgia), [diarrhea](https://en.wikipedia.org/wiki/Diarrhea%22%20%5Co%20%22Diarrhea), [sore throat](https://en.wikipedia.org/wiki/Sore_throat), [loss of smell](https://en.wikipedia.org/wiki/Loss_of_smell), and abdominal pain. While the majority of cases result in mild symptoms, some progress to viral [pneumonia](https://en.wikipedia.org/wiki/Pneumonia) and [multi-organ failure](https://en.wikipedia.org/wiki/Multi-organ_failure). As of 5 April 2020, more than 1.23 million cases of have been reported in more than two hundred countries and territories, resulting in more than 67,200 deaths. More than 252,000 people have recovered.

The virus is mainly [spread](https://en.wikipedia.org/wiki/Transmission_%28medicine%29) during close contact, and by [small droplets](https://en.wikipedia.org/wiki/Respiratory_droplets) produced when people cough, sneeze, or talk. These small droplets may be produced during breathing but the virus is not generally [airborne](https://en.wikipedia.org/wiki/Airborne_disease). People may also catch COVID-19 by touching a contaminated surface and then their face. The virus can survive on surfaces up to 72 hours. It is most contagious during the first three days after symptom onset, although spread may be possible before symptoms appear and in later stages of the disease. Time from exposure to onset of symptoms is generally between two and fourteen days, with an average of five days. The standard method of [diagnosis](https://en.wikipedia.org/wiki/Diagnosis) is by [reverse transcription polymerase chain reaction](https://en.wikipedia.org/wiki/Reverse_transcription_polymerase_chain_reaction) (rRT-PCR) from a [nasopharyngeal swab](https://en.wikipedia.org/wiki/Nasopharyngeal_swab). The infection can also be diagnosed from a combination of symptoms, [risk factors](https://en.wikipedia.org/wiki/Risk_factor) and a chest [CT scan](https://en.wikipedia.org/wiki/CT_scan) showing features of pneumonia.

Recommended measures to prevent infection include frequent [hand washing](https://en.wikipedia.org/wiki/Hand_washing), [social distancing](https://en.wikipedia.org/wiki/Social_distancing) (maintaining physical distance from others, especially from those with symptoms), covering coughs and sneezes with a tissue or inner elbow, and keeping unwashed hands away from the face. The use of [masks](https://en.wikipedia.org/wiki/Masks) is recommended for those who suspect they have the virus and their caregivers. Recommendations for mask use by the general public vary, with some authorities recommending against their use, some recommending their use, and others requiring their use. Currently, there is no [vaccine](https://en.wikipedia.org/wiki/Vaccine) or specific [antiviral treatment](https://en.wikipedia.org/wiki/Antiviral_treatment) for COVID-19. Management involves [treatment of symptoms](https://en.wikipedia.org/wiki/Palliative_care), [supportive care](https://en.wikipedia.org/wiki/Supportive_care), [isolation](https://en.wikipedia.org/wiki/Isolation_%28health_care%29), and [experimental measures](https://en.wikipedia.org/wiki/Medical_research).

The [World Health Organization](https://en.wikipedia.org/wiki/World_Health_Organization) (WHO) declared the 2019–20 coronavirus [outbreak](https://en.wikipedia.org/wiki/Outbreak) a [Public Health Emergency of International Concern](https://en.wikipedia.org/wiki/Public_Health_Emergency_of_International_Concern) (PHEIC) on 30 January 2020, and a [pandemic](https://en.wikipedia.org/wiki/Pandemic) on 11 March 2020. [Local transmission](https://en.wikipedia.org/wiki/Local_transmission) of the disease has been recorded in many countries across all six [WHO regions](https://en.wikipedia.org/wiki/WHO_regions).

COVID-19 is a major global public health challenge. Its outbreak in China presented the fastest spread, the widest scope of infections and the greatest degree of difficulty in controlling infections of any public health emergency since the founding of the People’s Republic of China in 1949.

In the battle against the outbreak, China actively leveraged digital technologies such as artificial intelligence (AI), big data, cloud computing, blockchain, and 5G, which have effectively improved the efficiency of the country’s efforts in epidemic monitoring, virus tracking, prevention, control and treatment, and resource allocation.

Here are a few of the ways information technologies were effectively leveraged:

**Artificial Intelligence**

In a crisis, collaboration is key. During the outbreak, a range of companies made their algorithms publicly available to improve efficiency and to support coronavirus testing and research.

Baidu Research, a world leader in AI R&D, open-sourced LinearFold (its linear-time AI algorithm), to epidemic prevention centers, gene testing institutions, and global scientific research institutions. The algorithm is an important tool for gene testing institutions, and R&D institutions during the epidemic, reducing the time taken to predict and study coronavirus’s RNA secondary structure from 55 minutes to just 27 seconds. The algorithm also improves the speed of predicting and studying coronavirus‘s RNA secondary structure by 120 times and saves the waiting time for virus detectors and researchers by two orders of magnitude With the improved algorithm comes much-improved efficiency in virus detection and diagnosis than traditional algorithm.

Additionally, Zhejiang Provincial Center for Disease Control and Prevention (Zhejiang CDC) launched an automated genome-wide testing and analysis platform. Based on the AI ​​algorithm developed by the Alibaba DAMO Academy (a platform funded by Jack Ma for science research), the group has shortened the genetic analysis of suspected cases from several hours to half an hour and can accurately detect virus mutations.

Artificial intelligence was also leveraged in subway stations, train stations and other public places where there is a high concentration of people and a high degree of mobility. While using the traditional method of temperature measurement is time-consuming, and would increase the risk of cross-infection due to the clustering of the people, companies such as Wuhan Guide Infrared Co. Ltd put forth new temperature measurement technology based on computer vision and infrared technology. This technology made it possible to take body temperature in a contactless, reliable, and efficient manner, with the people even unaware of it. With this technology in place, those whose body temperatures exceeded the threshold could quickly and accurately be located.

**Big Data**

After the outbreak, big data played an important role in prediction and early warnings, analyzing the flow of people and the distribution of materials. Qihoo 360, a leading Internet company in China, released “Big Data Migration Map” this past February which users can access through mobile phones or computers to view the migration trend of the Chinese mainland from January 1, 2020 up to date. The tool became an important means of understanding and predicting changes in the epidemic situation nationwide.

**Cloud Computing**

In the epidemic response, relatively mature cloud computing technologies became as essential as water or electricity. Alibaba Cloud made its AI computing power available to public research institutions around the world for free to accelerate the development of new pneumonia drugs and vaccines. Meanwhile, Didi offered GPU cloud computing resources and technical support for combating the novel coronavirus to domestic scientific research institutions, medical and rescue platforms, for free.

As the virus spread, the demand for cloud-based video conferencing and online teaching has skyrocketed. Various cloud service vendors have actively upgraded their functions and provided resources. For example, Youku and Ding Talk (an all-in-one platform under Alibaba Group) launched the "Attending Class at Home" program to provide students with a secure learning environment and convenient learning tools. The “Online Classroom” function, which is made available for students of universities, primary and middle schools across China without charges during the epidemic, can support millions of students to take online classes simultaneously and has also covered schools in vast rural areas.

Furthermore, other enterprise companies increased access to their tools. Tencent Meeting made unlimited-time meetings for up to 300 participants free until the end of the epidemic. WeChat Work can support the audio and video conference up to 300 participants during the epidemic. During the epidemic, the tool provided free access to stable HD video conferences are accessible from phones allowing sharing documents and screens among up to 300 participants.

**Blockchain**

Blockchain technology eliminates intermediary, prevents data loss and tampering and provides traceability. It can play an important role in ensuring the openness and transparency of the epidemic information and the traceability of the epidemic materials. For example, blockchain technology can be used to record epidemic information and ensure that information sources are open, transparent, and traceable, thus effectively reducing rumors.

Lianfei Technology launched the nation's first blockchain epidemic monitoring platform, which can track the progress of COVID-19 in all provinces in real time, and register the relevant epidemic data on the chain so that the data can be traced and cannot be tampered with. The data links based on transparent monitoring and accountability are initially established to ensure that epidemic information is open and transparent.

**5G + Smart Applications**

5G, which has just been commercialized, has also played an important role in the epidemic prevention and control. It is mainly used in the fields of live-streaming video and telemedicine. China Mobile opened 5G base stations at Huoshenshan and Leishenshan hospitals, and realized 5G high-definition live broadcasting of the construction of these two hospitals, providing real-time views of the construction sites on a 24-hour basis for more than 20 mainstream media platforms such as People's Daily and Xinhua News Agency. The content was also distributed by China Daily overseas simultaneously, and the number of online viewers exceeded 490 million.

In addition, the epidemic also witnessed the transition of “5G + health” from "experimental phase" to "clinical phase". In order to make full use of the resources of experts in large cities and hospitals, the 5G + remote consultation system has been quickly implemented in many hospitals across the country. The first “remote consultation platform” of Huoshenshan Hospital allows medical experts far away in Beijing to work with front-line medical staff of Huoshenshan Hospital through remote video connections and conduct remote consultations with patients, thus further improving the efficiency and effectiveness of diagnosis and treatment. China's practice has proven that the new-generation information technologies have unique advantages and can play an important role in responding to major public health challenges.

The COVID-19 outbreak is a common challenge faced by mankind with all countries' interests closely intertwined. Countries continue to develop new solutions as the epidemic spreads. As it does, countries must share their learnings and work together. By doing so, they can collectively find the solutions needed to fight the virus and save lives.

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