The modern technologies used in the COVID-19 have supported the advancement of public health

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Abstract: In the late 2019, a previously unknown pneumonia broke out in Wuhan, China and spread at an alarming rate. The highly contagious and virulent virus has pushed the world into deep water. There are no suitable treatments, insufficient medical resources, and no effective way to prevent widespread transmission. Scientists have come up with a number of ways to deal with these challenges posed by COVID-19, the most important of which is the application of technology. AI, drones, E-nose, stem cell therapy, monoclonal antibodies, pan-viral vaccines and telehealth help a lot, especially for the advancement of public health, giving people hope of getting through the difficult times. However, disadvantages of technologies remain because of technical bottlenecks and disclosure of personal privacy. Containing the COVID-19 pandemic requires trust, responsibility, cooperation and technology revolution. Only with these tools can we have the confidence to deal with the challenges of the future.

1. Introduction

In the late 2019, a previously unknown pneumonia broke out in Wuhan, China and spread at an alarming rate. This new type of corona virus proved to be astonishingly highly contagious and virulent, and there is no specific medicine to treat. People started to wear masks reluctantly because the virus later known as SARS-COV-2 rarely transmits by aerosols which caused widespread transmission. Human society, economics, culture and international order are all effortless to stabilize as usual in the face of the pandemic and will deeply impact over a prolonged period. With the growing crisis, almost all companies and researchers are looking for the ways to meet the challenges of this virus, to mitigate the spread and develop a cure for this disease. And public health stands at the forefront again after years of fighting plague, smallpox, and influenza.

Without doubt, science and technology have played an essential role in this smoke-free battle. For example, early in the outbreak when China initiated its response to virus it utilized infrared thermal imaging thermometer to measure human body temperature without contact which is based on artificial intelligence (AI), face recognition and infrared principle, and drones to disinfect a wide range of public areas in order to cut off the spread of the virus from the outside world and from person to person (Nguyen T et al, 2020). AI has been applied extensively in surveillance, diagnosis, treatment, prevention, prediction, etc., which immensely assisted governments and health departments in the selection and implementation of countermeasures (Kumar A et al, 2020). Besides, other technologies like big data, Internet of Things (IoT), nanomedicine, are involved in the fight against the COVID-19. Compared with the 1918 Spanish flu pandemic, the ways to address the challenges of COVID-19 are so much better. Thanks to these modern technologies, the big developing space for public health is expanding infinitely. Sincerely, the integration of various technologies has bought public health to a new level, and the advancement of AI has made it possible for human to reasonably predict the future rather than random thinking, which reshape public health in all aspects and prepare for the next "Disease X".

Hence, we discuss the challenges of the COVID-19 pandemic that need to deal with, various modern technologies used in the pandemic and how they benefit the research of experts, and their impact on public health.

2. Challenges faced during the COVID-19 pandemic

There are lots of challenges to the sudden attack on COVID-19. To begin with, let's focus on SARS-COV-2. As an unfamiliar RNA virus, it poses a great threat to humans having a cunning survival and escape mechanism that can infect people secretly and cause disease easily. In the year and a half of the global pandemic, this health crisis has had a catastrophic impact resulting in more than 3.8 million deaths worldwide (Vaishya Raju et al, 2021). Although clinical researchers worldwide have made extraordinary efforts to develop novel vaccines against SARS-COV-2 at an unprecedented speed, it still cannot prevent the mutation of virus variants or even catch up with the mutation of it.

What's more, at the beginning of the COVID-19 pandemic, health care workers and essential medical equipment had to be overloaded to cope with hundreds of new daily cases (Vaishya Raju et al, 2021), especially for the remote areas where patients hardly get quality treatment. Also, it is not a simple matter for doctors and nurses to prevent themselves and other patients in the hospital from being infected when treating infected cases because the virus is highly contagious. At the same time, researchers are struggling to formulate personalized treatment strategies for patients with different medical histories based on disease severity. All of them are pretty resource and money consuming.

As for challenges for public health, they are more awkward and complex. One of the biggest problems is the public acceptance of appropriate information. The distance of the television media made people feel less threatened by the pandemic. Numerous people were skeptical of science and experts' advice before witnessing the serious consequences of the pandemic. In some western countries, people's protests have become more intense. According to analysis as part of the Global Peace Index, as of July 2021, there had been around 50,000 protests linked to the pandemic worldwide, 5,000 of which were violent. (Newey et al, 2021). Besides, the uncertainties around the transmission pattern and incubation period of COVID-19 and its potentially serious complications—along with the social confinement measures imposed by governments, the disruption of world economies, and the overabundance of information (including false rumors) in the media—raised concerns about an emerging public mental health crisis (Dong L, Bouey J, 2020). We all will agree that the pandemic is going to affect everyone, sooner or later (Sandeep Grover et al, 2020). The numbers of people affected by the fear of COVID easily surpass those infected with it. And people utterly had no idea that the earth-shaking changes are moving towards them. Moreover, public health requires real-time monitoring of the whereabouts of the public, screening of the epidemiological history of close contacts of infected cases, which may be regarded as personal privacy. The coordination and cooperation between various departments needs to be better and better, and the same is true for all countries (Chester County Hospital, 2020).

3. Various modern technologies used in the pandemic

New technologies that are beneficial for better delivery of medical services have made a huge contribution to containing the pandemic. They will not be infected by the virus, will not cause riots, and can also help researchers study including collecting and analyzing relevant data, early surveillance, testing, contact tracing, and strict quarantine (Whitelaw Sera et al, 2020). These technologies are excellent solutions to the challenges of the current COVID-19 pandemic. The following are some of the most prominent modern technologies:

3.1 Artificial Intelligence and Big data

The development of AI and big data has made great progress in all aspects over the years. It is almost impossible for ordinary people to notice that AI is actually around. Machine learning, especially deep learning, has made great advances and substantial progress in long-standing fields such as computer vision and natural language processing (NLP). Based on the big data, AI can be used in early detection and diagnosis of the infection, monitoring the treatment, contact tracing of the individuals, projection of cases and mortality, development of drugs and vaccines, reducing the workload of healthcare workers and prevention of the disease (Raju Vaishya et al, 2020). Firstly, AI is helpful in the diagnosis of the infected cases with the help of medical imaging technologies like Computed

tomography (CT), Magnetic resonance imaging (MRI) scan of human body parts. Secondly, AI can help analyze the level of infection by this virus identifying the clusters and 'hot spots' and can successfully do the contact tracing of the individuals and also to monitor them, predicting the future course of this disease and likely reappearance (Raju Vaishya et al, 2020). Thirdly, the learning ability of AI reduces the workload of health workers, who no longer have to worry about tedious basic work. However, personal privacy limits the advancement of AI. It's a grey area, and there are concerns that privacy exposure could cause problems for the public. How much information does AI get and what information is it? The answers may be for the specialized departments to manage and set up a monitoring system and enact supporting policies.

As for big data, it is an innovative technology which can digitally store a large amount of data of these patients. It helps to computationally analyze to reveal patterns, trends, associations and differences, minimizing the risks of transmission of the virus (Abid Haleem et al, 2020). Big data provides AI with good learning materials, and all kinds of information can be stored with data, which can be easily calculated.

3.2 Drones

Drones can offer many advantages during the COVID-19 pandemic. Transportation, aerial spraying, public space monitoring and guidance are the most sophisticated places for drones to be used. Three countries in Sub-Saharan Africa, namely Rwanda, Ghana and Malawi reported the use of drones to deliver regular medical commodities, COVID-19 supplies and medical samples (UNICEF, 2020). And the use of drones for aerial spraying of disinfectants in public outdoor spaces to contain the spread of the virus can be seen in cities in the early days of the pandemic. The media also reported that some agencies have deployed drones to surveil the public spaces and enforce quarantine by sending messages over a loudspeaker and tracking non-compliant citizens (UNICEF, 2020). Drones do represent contactless application examples, but they are still weak in some ways. For example, the lack of clear government regulatory policies, GPS-jamming and hacking, and battery life and load capacity, which inhibits their capability to cover long distances and make multiple deliveries at once (V. Chamola et al, 2020). Drones are not widely used in COVID-19 due to a variety of factors, and further progress which we look forward to is needed to address the challenges of healthcare.

3.3 Electronic nose

Developing rapid diagnostic tools is key to dealing with the COVID-19 pandemic. At present, there are three dominant techniques available, nucleic acid amplification tests (NAAT), antigen tests and antibody tests. However, none of them can meet the needs of public health. NAATs are high-sensitivity, high-specificity tests for diagnosing SARS-CoV-2 infection, but they are very expensive, take times to obtain results, require biosafe lab, and may occur false positive. Antigen tests are immunoassays that detect the presence of a specific viral antigen, which are cheaper and cost less time, but they have limited value as an epidemiological tool. As for serological or antibody test, the test might not detect antibodies in someone with a current infection. In addition, it is not currently known whether a positive antibody test result indicates immunity against SARS-CoV-2 (CDC, 2021). Therefore, scientists urgently need a new type of testing tool that is not expensive, fast, accurate, and does not require biosafe labs.

Electronic nose stimulates people's interest. By analyzing the E-Nose data along with body temperature and other non-invasive symptoms, NASA's expertise in advanced machine learning methods will allow for more accurate on-the-spot answers (NASA, 2021). Hopefully, this breakthrough will enable health systems to have a better understanding of COVID-19, treat infected people in a timely manner and control the further spread of the pandemic, supporting the next step in public health strategy.

3.4 Stem cell therapy and Monoclonal antibodies

We learned about stem cell therapy from leukemia, Crohn's disease, COPD, Parkinson's and more, it is a form of regenerative medicine that replaces damaged cells in the body (Louis A. Cona, 2021).

Mesenchymal stem cell can be injected locally to target specific sites, using their self-renewal, immunomodulation, anti-inflammatory and other characteristics to alleviate symptoms and improve the quality of life.

Monoclonal antibodies are like the antibodies your body makes to fight viruses and other bugs, but they are made in the labs of pharmaceutical companies (Donavyn Coffey, 2021). They're designed to target the coronavirus spike protein. When the antibodies bind to the spike protein, they block the virus from entering your body's cells, says Lindsay Petty, MD, an infectious disease doctor at the University of Michigan. Monoclonal antibodies strengthen the immune system after you become ill, speeding up your immune response to prevent COVID-19 from getting worse.

In clinical trials, both stem cell therapy and monoclonal antibodies are useful for treating SARS-COV-2 infections. And they can save more lives by clinical treatment faster than new drug development. In addition, scientists are struggling for research in interdisciplinary fields, such as SC-based nanotechnology (Desai, D. and Shende, P., 2021). We can see the challenges and future perspectives, looking forward to more effective technologies.

3.5 Pan-viral vaccines

Vaccines are currently the best and most powerful way to fight COVID-19 and prevent widespread transmission. The world is racing to get vaccinated to achieve the goal of mass immunization and pandemic control. However, the virus has been mutating, and new variants may reduce the efficacy of existing vaccines (WHO, 2021). WHO has been tracking mutations and variants since the start of the COVID-19 outbreak, but the pace of vaccine development is still not keeping pace with the rate of virus mutation. Moreover, the introduction of "Disease X" makes it inevitable that we will welcome a more dangerous virus than SARS-COV-2. It is unrealistic to constantly adapt the vaccine, and the key is the development of pan-viral vaccines.

This pan-coronavirus vaccine can protect against most or all variants. Tantalizing evidence shows that serum from people who'd been infected with SARS-CoV during the 2003 SARS outbreak demonstrated cross-reactive neutralizing activity against the SARS-CoV-2 spike protein, while serum from people recovered from COVID-19 showed cross-reactive neutralizing activity against both SARS-CoV and MERS (Rubin R., 2021). Researchers are developing it from different inlets, and it is good to see that many laboratories are working toward the same goal. Each breakthrough in vaccine research has boosted researchers' confidence in the pan-viral vaccine, which is expected to be available within 10 years.

3.6 Telehealth

Attribute to stay-at-home orders and the overload of health care, most common patients have difficulty registering and getting a doctor's prescription. At this point, the advantages of telehealth are reflected. People can consult a doctor online without contact to make a preliminary diagnosis of their symptoms and whether they need to go to the hospital for further treatment to avoid the risk of infection (Betty Pfefferbaum et al, 2020). Where COVID-19 differs from standard disaster management is the pathogenicity and virulence of the virus. As such, telehealth is ideally suited to meet the demands of inpatient care while at the same time reducing virus transmission, stretching human and technical resources, and protecting patients and healthcare workers in the inpatient care setting (Wosik, J. et al, 2020). Telehealth provides a buffer for outpatients' services, screening patients who are in urgent need of face-to-face treatment among a large number of patients and advising the general patients.

Besides, telehealth plays an essential role in mental health. Prolonged isolation and increasing numbers of infections and deaths, the public is in a state of unhealthy chronic stress. The accumulation of bad emotions is difficult to digest and requires the intervention of psychologists and the guidance of positive energy. Through online questionnaires and mental health education, the public can access to psychological assistance with a certain privacy. They can consult an online doctor as usual, and even meet patients in the same psychological predicament to work out bad emotions together. Telehealth penetrates into public life and can effectively carry out medical consulting services and safety drug education for the benefit of the public.

4. Significant Effects of Technology on public health

With the application of modern technologies, we know more about the virus, the diverse methods of coping with COVID-19 and get the life track as much as we can. It is also public health that has changed dramatically. In the past 100 years, the field of public health has entered a new stage, meeting most of the needs of public health research, and letting people look forward to the future more confidently.

Modern technologies give public health a pair of bright eyes to observe the public. A core public-health function of outbreak management is understanding infection transmission in time, place and person, and identifying risk factors for the disease to guide effective interventions (Budd, J., 2020). Digital epidemiological surveillance is being used extensively in the pandemic. And health workers can identify the virus and take appropriate measures in response to the public response to COVID-19 via the data. That's more reliable than when the Spanish flu erupted in 1918, when it was visible to the naked eye. For the infected cases, there are some diagnostic methods for identifying and isolating them quickly to reduce further transmission and understand how the virus spread. In the COVID-19 pandemic, digital contact-tracing apps have been developed for use in several countries (Budd, J., 2020), which ensure public health workers to lock in close contacts and isolate them, as well as further screening of people who pass through these places.

Modern technologies promote public health and public communication. Effective implementation of interventions during a pandemic relies on public education and cooperation, supported by an appropriate communications strategy that includes public trust. Almost everyone has social software through which people get the latest news and data, and government and health officials can post instant messages and countermeasures to alert citizens. Messages can spread at an extraordinary rate, and the public can provide feedback on measures to inform public health plans for the next step. Developed communication technology enables decision-making departments to communicate with the public in an effective way and can adjust and appease in a timely manner and successfully tide over the pandemic. However, the spread of harmful misinformation, excessive advertising and uneven resources continue to pose challenges to communications.

Modern technologies are powerful weapons to help public health respond to pandemics. They make public health more sensitive and responsive to health emergencies. We have highlighted the potential of digital technologies to support epidemiological intelligence with online datasets, identify cases and clusters of infections, rapidly trace contacts and enable public-health messaging at scale (Budd, J., 2020). Technologies have made public health stronger, more regulated, more comprehensive, and no pandemic has ever shaped public health in this way. Success in technology like pan-viral vaccines may also prove invaluable in dealing with “Disease X”, generating immunity that prevents it from successfully jumping into us. COVID-19 teaches us that we should prepare for the next "Disease X", and we don't expect it once for all, we just want to be prepared to deal with it next time.

5. Conclusion

COVID-19 is an unprecedented challenge to the world, the fight against the virus is a major issue of human survival and development, and public health is a pivotal part in the future. COVID-19 has taught us a lot, and has allowed the public health system to grow rapidly, the future of public health is digital, and technology companies should be long-term partners in the preparations to tackle the next one. This is not an issue of a person or a country, but a common responsibility that we need to face since the globalization and technological revolution. The addition of modern technology has provided many conveniences for the comprehensive response to pandemic diseases and the supplementary of traditional public health measures, greatly reducing the impact of pandemics on the economy and society.

Barriers to the application of technology emerge at the same time, data quality, legal ethics and privacy issues, resource inequality still need to be addressed. The governments should also take actions to improve the corresponding policies and countermeasures, develop science and technology education

and serve the public. Progress always happens in the test, whether the past flu, current COVID-19, or future "Disease X", all we need are trust and cooperation to minimize harm and prepare for other infectious diseases.

References

[1] Kumar, A., Gupta, P. K., & Srivastava, A. (2020). A review of modern technologies for tackling COVID-19 pandemic. Diabetes *& Metabolic Syndrome: Clinical Research & Reviews*, *14*(4), 569-573. doi:10.1016/j.dsx.2020.05.008

[2] Nguyen, T. (2020). Artificial Intelligence in the Battle against Coronavirus (COVID-19): A Survey and Future Research Directions. *ArXiv*, *abs/2008.07343*.

[3] Vaishya, Raju & Javaid, Mohd & Haleem Khan, Ibrahim & Vaish, Abhishek & Iyengar, Karthikeyan. (2021). Significant Role of Modern Technologies for COVID-19 Pandemic. Journal of Industrial Integration and Management. 06. doi:10.1142/S242486222150010X

[4] Whitelaw, S., Mamas, M. A., Topol, E., & Van Spall, H. G. (2020). Applications of digital technology in COVID-19 pandemic planning and response. *The Lancet Digital Health*. doi:10.1016/S2589-7500(20)30142-4

[5] Newey, Sarah; Gulland, Anne; Smith, Nicola (25 July 2021). Plague and protests: how Covid has sparked a wave of unrest around the world. The Telegraph.

[6] Dong L, Bouey J. Public mental health crisis during COVID-19 Pandemic, China. *Emerging Infect Dis.* (2020) 26:1616–8. doi: 10.3201/eid2607.202407

[7] Sandeep Grover, Devakshi Dua, Swapnajeet Sahoo, Aseem Mehra, Ritu Nehra, Subho Chakrabarti. (2020). Why all COVID-19 hospitals should have mental health professionals: The importance of mental health in a worldwide crisis! Asian Journal of Psychiatry. doi: 10.1016/j.ajp.2020.102147.

[8] Chester County Hospital (July 21, 2020). Coordination and Collaboration Across a Health System: Chester County Hospital Shows How Waves of COVID-19 Promote Learning [Blog post]. Retrieved from https://www.pennmedicine.org/news/news-blog/2020/july/coordination-and-collaboration-across-a-health-system.

[9] Raju Vaishya, Mohd Javaid, Ibrahim Haleem Khan, Abid Haleem (2020). Artificial Intelligence (AI) applications for COVID-19 pandemic. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. doi:10.1016/j.dsx.2020.04.012.

[10] Abid Haleem, Mohd. Javaid, Ibrahim Haleem Khan, and Raju Vaishya (2020). Significant Applications of Big Data in COVID-19 Pandemic. doi: 10.1007/s43465-020-00129-z

[11] UNICEF (2020). How Drones Can Be Used to combat COVID-19. Retrieved from https://www.unicef.org/supply/media/5286/file/%20Rapid-guidance-how-can-drones-help-in-COVID-19-response

[12] V. Chamola, V. Hassija, V. Gupta and M. Guizani. A Comprehensive Review of the COVID-19 Pandemic and the Role of IoT, Drones, AI, Blockchain, and 5G in Managing its Impact. in IEEE Access, vol. 8, pp. 90225-90265, 2020, doi: 10.1109/ACCESS.2020.2992341.

[13] Centers for Disease Control and Prevention (Aug 2, 2021). Overview of Testing for SARS-CoV-2 (COVID-19). Retrieved from https://www.cdc.gov/coronavirus/2019-ncov/hcp/testing-overview.html

[14] NASA Ames (Apr 7, 2021). NASA's E-Nose Device Advanced to "Sniff" COVID-19 from Human Breath. Retrieved from https://www.nasa.gov/feature/ames/e-nose

[15] Louis A. Cona (July 14, 2021). What is Stem Cell Therapy? [Blog post]. Retrieved from https://www.dvcstem.com/post/stem-cell-therapy

[16] Donavyn Coffey (Aug 26, 2021). Monoclonal Antibodies vs. Vaccines vs. COVID-19: What to Know. Retrieved from https://www.webmd.com/vaccines/covid-19-vaccine/news/20210826/monoclonal-antibodies-vs-vaccines-vs-covid-19

[17] Desai, D., Shende, P. Nanoconjugates-Based Stem Cell Therapy for the Management of COVID-19. Stem Cell Rev and Rep 17, 231–240 (2021). https://doi.org/10.1007/s12015-020-10079-6

[18] WHO (2021). The effects of virus variants on COVID-19 vaccines. Retrieved from https://www.who.int/news-room/feature-stories/detail/the-effects-of-virus-variants-on-covid-19-vaccines

[19] Rubin R. The Search for a Single Vaccine Against Coronaviruses Yet to Come. JAMA. 2021;326(2):118–120. doi:10.1001/jama.2021.9477

[20] Wosik, J., Fudim, M., Cameron, B., Gellad, Z. F., Cho, A., Phinney, D., Curtis, S., Roman, M., Poon, E. G., Ferranti, J., Katz, J. N., & Tcheng, J. (2020). Telehealth transformation: COVID-19 and the rise of virtual care. *Journal of the American Medical Informatics Association : JAMIA*, *27*(6), 957–962. https://doi.org/10.1093/jamia/ocaa067

[21] Betty Pfefferbaum, M.D., J.D., and Carol S. North, M.D., M.P.E. (2020). Mental Health and the Covid-19 Pandemic. N Engl J Med 2020; 383:510-512. doi: 10.1056/NEJMp2008017

[22] Budd, J., Miller, B.S., Manning, E.M. et al. Digital technologies in the public-health response to COVID-19. Nat Med 26, 1183–1192 (2020). https://doi.org/10.1038/s41591-020-1011-4