Importance of public health tools in emerging infectious diseases

Jin-Ling Tang and Li-Ming Li argue that despite the lure of vaccines and new drugs, established public health measures will remain our best tool to control covid-19 and future epidemics

Scientific advance occurs as the result of a passion for and continuing creation of new ideas, novel methods, and innovative technologies. This passion has made science the most successful of human endeavours and also made us tend to believe that new is better.

During the covid-19 pandemic, faith in new technologies affected our thinking about conventional tools. As Bruce Aylward, assistant director general of the World Health Organization, said at the beginning of the pandemic: “In the world of preparedness and planning, I suffer the same biases as, or maybe error of thinking as, many people. We don’t have a vaccine; we don’t have a therapeutic. And you hear it repeatedly in the news: people throwing up their hands.”1 However, China’s epidemic was effectively contained by using long established public health methods.

Conventional public health measures in the pandemic

In an epidemic caused by a new pathogen such as SARS-CoV-2 drugs and vaccines will not be immediately available. The only tools available to control the spread of disease are the public health measures that have been used for hundreds of years. These methods include, broadly speaking, controlling infection sources, blocking transmission routes, and protecting susceptible populations. Their effectiveness has been shown by the fact that infectious disease had been largely controlled by the middle of the 20th century, before antibiotics and vaccines became widely used.2

During the covid-19 pandemic, public health measures (now often called non-pharmacological interventions) have included mask wearing; identifying and quarantining infected people or close contacts; hand washing; social distancing, including closure of schools, entertainment venues, and public places; cancellation of public events; and restriction of travel.3 Nucleic acid testing and digital technologies meant public health measures could be mobilised fast, precisely, and efficiently.

The national campaign against the covid-19 epidemic in China started on 20 January 2020. Covid-19 was made a class B notifiable infectious disease (like measles and poliomyelitis) and responded to as a class A disease (like plague and cholera), with institution of substantial public health measures. Wuhan, the central epidemic area and a city of 11 million people, was locked down and put under quarantine on 23 January 2020. The entire country was subsequently brought into public health emergency response measures. The Wuhan lockdown was not a single measure but included multiple, rigorous public health and hygiene measures.4

The effectiveness of these measures is seen by the stabilisation and then decline in the daily number of cases a few days after they were implemented (fig 1). The delay in the effect is because of the incubation period of the virus, which is around six days. People infected before the national campaign on 20 January continued to infect others in the following six days, pushing the peak to 26 January. After that the daily number of new cases started to decline and continued so that there were virtually no cases by the end of March 2020.

How effective were these early actions? An early modelling study in the Lancet predicted that if the transmissibility of the virus and the mobility of people were not interrupted, the epidemic in Wuhan would peak around late April 2020 with some 30 000 new cases daily.5 The epidemic in Wuhan actually peaked on 2 February 2020, with 1967 new cases reported that day. This suggests that public health efforts after the Wuhan lockdown suppressed the peak number of daily new cases by over 93% and also ended the entire epidemic around two months earlier than predicted.6 Later modelling studies showed the interventions had prevented around 95% of infections.6 7 The travel restriction in Wuhan might have also reduced the number of cases outside China before March 2020 by 80%.8

Since April 2020, China has experienced 15 small outbreaks of covid-19, mostly imported, and it has shown repeatedly that these could be controlled with public health measures.

More evidence for public health measures

Public health measures have not been implemented so rigorously in all countries because of differences in culture and prevention strategies. Mask wearing, for example, is a common practice in China but highly debated in some other countries despite evidence of its effectiveness.9 10 As might be expected, the scale of the epidemic is largely proportionate to the rigorousness of public health measures in a country. For example, the epidemic has been mostly controlled to a small scale in Japan, Korea, and Singapore, where relatively rigorous public health measures were applied, whereas it has caused tens of millions infections and hundreds of thousands deaths in the UK and US, which were more reluctant to restrict people’s behaviour.

The effect of public health measures on the epidemic can also be seen in places where the strength of these measures fluctuated over time. For example, in Hong Kong the epidemic closely followed the rhythms of the ups and downs of preventive measures in the city (fig 2).11 When public health measures were relaxed, the epidemic started to rise; conversely when they were...
tightened, the epidemic started to decline. Studies have also showed that COVID-19 control measures greatly reduced severe cases and deaths from other respiratory tract infections.12-14 Some may argue that the evidence is only observational and should be interpreted with caution. However, in situations such as the COVID-19 epidemic that would have large scale, catastrophic consequences if not quickly and effectively controlled, we believe it is better to over-react than to be overcautious if the actions are affordable and have no obvious harms. Decisions should also be based on the best evidence available rather than best evidence theoretically possible.

**Contributions of new technologies**

New technologies also contributed to control of COVID-19. For example, nucleic acid testing has made it possible to diagnose the disease early and detect people with asymptomatic infections so that secondary infections can be further reduced. Testing has also been used to optimise the length of hospital stay and to manage travel, reducing the personal inconvenience and economic interference caused by the epidemic. Mass testing has been used to assess the potential risk of a population.

Digital technologies have also helped. For example, the internet has been used to facilitate reporting of cases so that decision makers can quickly assess and adjust policies; computers have been used to model the features and development of the epidemic to inform policies; and mobile phones have been used to trace and manage close contacts and to contact and consult doctors to minimise hospital visits.

However, new technologies are only supportive. Public health methods would still work without them, although they would not be so quick, precise, or efficient. Importantly, China’s experiences show that conventional methods enhanced by new technologies can eradicate an epidemic of new infectious disease in its early stages in the absence of effective drugs and vaccines. Conventional methods also provided time for the development of vaccines.

---

Fig 1 | Number of confirmed cases of COVID-19 in China by date of onset and date of diagnosis (or reporting) with time points of major related events (adapted from Liang et al)
Vaccines have now become the determining factor in whether we can eventually control the pandemic. However, it is unlikely that vaccines alone can end the pandemic. This is because vaccines are not 100% effective and breakthrough infections exist; the protection from vaccines may not last long enough; and vaccines may not be effective against new variants. Public health measures remain the manoeuvrable factors.

**New does not mean better**

In response to emergencies like the covid-19 epidemic, the belief that new is better may make us distrust and indecisive about conventional technologies. China’s experiences show clearly that conventional methods remain appropriate and powerful in such situations.

On the other hand, the belief that new is better has created a flood of new diagnostic and therapeutic technologies in medicine. They include technologies for detecting small cancers, those for measuring the same clinical conditions differently, new biomarkers and artificial intelligence for predicting prognosis and guiding treatment, minimally invasive methods for surgical operations, new drugs, and so on.

How often are the newer not better than the older? Table 1 shows examples in which newer technologies are no better or even worse than older or current standard treatments. A recent German study found that more than half of new drugs entering treatments. A recent German study found that more than half of new drugs entering new drugs, and so on.

| Trial | Clinical condition | New treatment | Comparison treatment | Outcome events | Conclusions |
|-------|-------------------|---------------|----------------------|----------------|-------------|
| Ramirez et al15 | Cervical cancer | Laparoscopic or robot assisted radical hysterectomy | Open radical hysterectomy | Disease-free survival and overall survival at 4.5 years | Laparoscopic hysterectomy was associated with lower rates of disease-free survival and overall survival than open hysterectomy |
| Patel et al16 | Abdominal aortic aneurysm | Endovascular repair | Open repair | Total and aneurysm related mortality at 6 months and 3 years | Endovascular repair has an early survival benefit but an inferior late survival benefit compared with open repair |
| Chimowitz et al17 | Intracranial arterial stenosis | Percutaneous transluminal angioplasty and stenting | Aggressive medical therapy | Stroke or death at 30 days | Aggressive medical therapy was better than percutaneous transluminal angioplasty and stenting |
| EI-Hayek et al18 | Coronary artery disease | Biodegradable polymer drug eluting stents | Second generation durable polymer drug eluting stents | Revascularisation, cardiac death, myocardial infarction, definite or probable stent thrombosis at 26 months | Biodegradable stents have similar safety and efficacy profiles to second generation stents |
| Gaudino et al19 | Coronary artery disease | Percutaneous coronary intervention (PCI) | Coronary artery bypass grafting (CABG) | Total and cardiac deaths at 5 years | PCI was associated with higher all-cause, cardiac, and non-cardiac mortality than CABG |
| ALLHAT20 | Hypertension | Angiotensin converting enzyme inhibitor or calcium channel blocker | Thiazide-type diuretics | Myocardial infarction, all-cause mortality at 4.9 years | Thiazide-type diuretics are superior in preventing 1 or more major forms of cardiovascular disease and are less expensive than calcium channel blocker or an angiotensin converting enzyme inhibitor. |

Prostate cancer screening is not a rare case. A systematic review of meta-analyses and trials of 39 tests for screening for 19 diseases or disorders found that reductions in disease specific mortality are uncommon and reductions in all-cause mortality are rare.25

**Focus on appropriate tools**

Science has made medicine much more powerful and effective and will continue to create new technologies, advance medicine, and benefit health. However, our faith in innovation should not prevent us from necessary use of appropriate conventional technologies, particularly in emergencies.

Faced with a similar epidemic in the future, traditional public health methods should be deployed as a first response since vaccines will not be immediately available. Public health measures enhanced by new technologies can eradicate such an epidemic even in the absence of a vaccine. Discounting conventional wisdom and over-promising for new technologies in such emergencies may result in disastrous consequences. Even outside epidemics, new tests and drugs should be rigorously evaluated before they are introduced into routine practice to ensure they truly benefit patients.

We thank Dayi Hu, Chen Mao, Zuyao Yang, and Lizheng Shi for suggesting the examples on comparisons between new and old technologies, and Ziyi Zhao for helping with the references and table. JLT is supported partly by Shenzhen Science and Technology Program (Grant Nos KQTD201909092172315662 and RXX202109015004012). LMI is partly supported by the grants of Peking University (PKU2020PKZKX002) and the China Medical Board (20036). Contributors and sources: JLT proposed the topic and drafted a manuscript. LLM exchanged ideas.
CHINA’S RESPONSE TO COVID-19

and revised the manuscript. Both approved the final version. JLT is the guarantor.

Competing interests: All authors have read and understood BMJ policy on declaration of interests and have no interests to declare. JLT is a clinical research editor for The BMJ.

Provenance and peer review: Commissioned; externally peer reviewed.

This article is part of a collection proposed by the Peking University Center for Public Health and Epidemic Preparedness and Response. Open access fees were funded by individual institutions. The BMJ commissioned, peer reviewed, edited, and made the decision to publish. Li-Ming Li advised on commissioning for this collection. Jin-Ling Tang, Di Wang, and Kamran Abbasi were the lead editors for The BMJ.

Jin-Ling Tang, professor1,2
Li-Ming Li, professor2

1Shenzhen Institute of Advanced Technology of the Chinese Academy of Sciences, Shenzhen, China
2Guangzhou Women and Children’s Medical Centre, Guangzhou, Guangdong Province, China
3School of Public Health, Peking University, Beijing, China

Correspondence to: JLT tang@cuhk.edu.hk

OPEN ACCESS

This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/