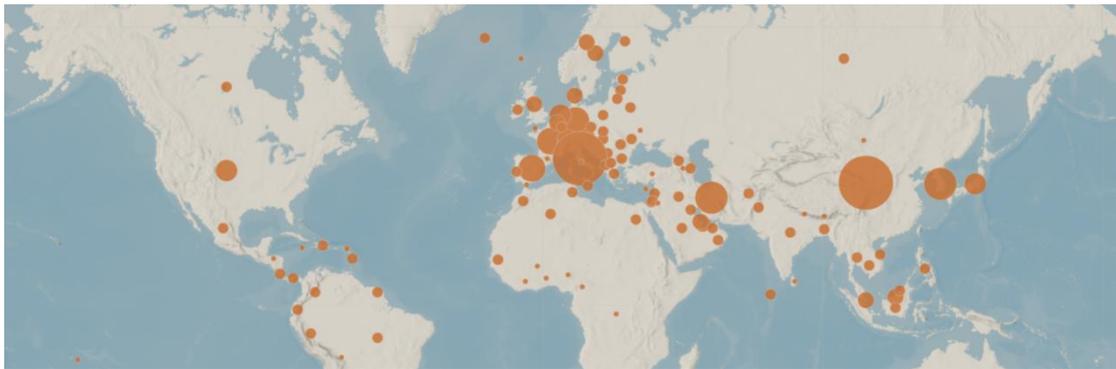


针对疫情的城市功能-空间应对策略 - 城市应急管理手册

Urban Function-Spatial Response Strategy for the Epidemic
- A Concise Manual on Urban Emergency Management

(Revised Edition)



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Preface

From the end of 2019 till now, the outbreak of 2019 Coronavirus Disease (COVID-19) becomes a worldwide epidemic. WHO announced it as “Public Health Emergency of International Concern” in 31 Jan. 2020, and “Pandemic” in 11 Mar. 2020. After a painful period, the situation in China has come down in general now. Chinese health authority said in 18 Mar. 2020 that it received reports of 13 newly confirmed cases and 12 of them imported. Since beginning of 2020, a total of 80,894 confirmed has been reported in mainland China, and 3,237 died.

Today, more countries are suffering from the epidemic with rapid increasing confirmed cases. And different response strategies are taken in different countries. In China, a combined top-down and bottom-up approach works well during the whole process against the epidemic. Levels of governmental departments, medical facilities, cities and communities work all together closely using all possible resources efficiently and quickly into the anti-epidemic battle. While in some other counties, individuals are of major force for this.

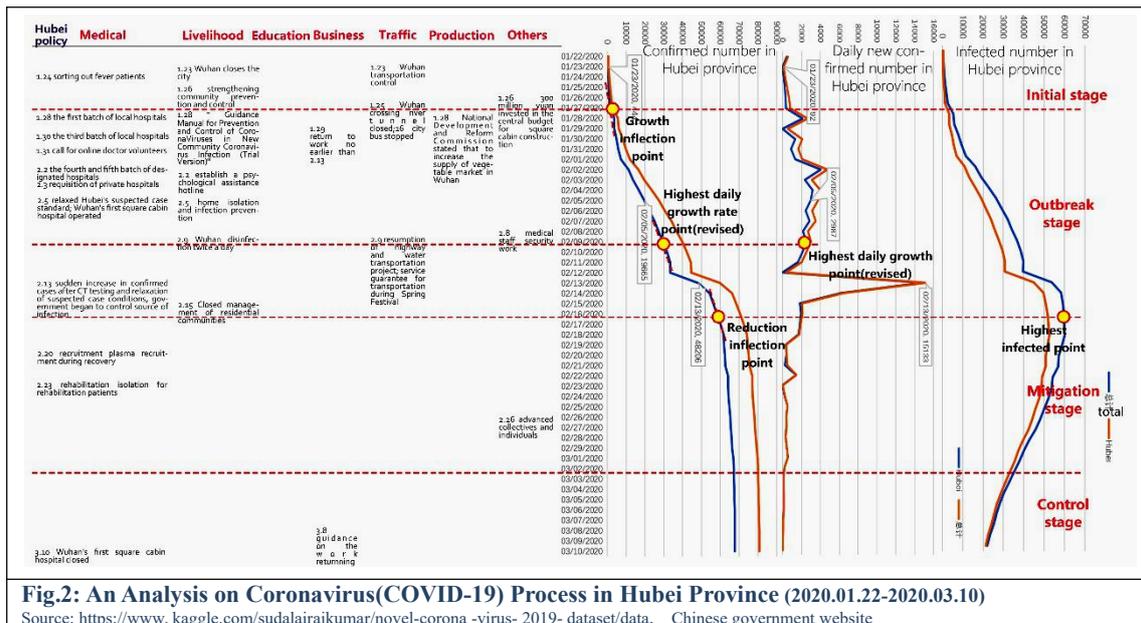
For instance, “Herd Immunity” or Horde Mode had been thought as a possible way seeking for a steady development of epidemic in a society during a longer period of time. Whether it’s true or not, the basic conception of this might be for maintaining the normal operating condition of the present social, economical, and medical systems as well as individual life without being exhausted during the epidemic. The big advantage of this may be that the socio-economic order seems to be less chaotic, however the pandemic will cause slow and protracted stress. Time will tell.

There may also be more combinations between state intervention and laissez-faire policies. In many cases, city is both a stricken center and the disaster relief center. A city is a huge complex system that hold up human daily life and various spatial functions. Its functional-space structure has developed in a long historical process, and should meet the daily needs of the city, as well as constantly optimized with the development and transformation of the city. This is a continuous, progressive and stable urban evolution process.

Entering 2020, with the sudden emergence of COVID-19, we found that many modern cities still lacked of the basic capacity responding to emergencies and disasters. As a matter of fact, in *Sustainable Development Goal (SDGs)* formulated by United Nation in 2016, it has already involved the contents of urban safety, health, sanitation, sustainability, and emergency in response to environment issues. Among the goals, sustainable development goal 3,6,7,9,11,13,16, and 17 all raise the deficiencies of current human society development and the direction that should strive from different aspects.

From a medical point of view, it is necessary to test the susceptible population, quarantine the suspected, and offer treatment to the infected and confirmed, as well as block the transmission route in the shortest time and limited space. Thus, the urban function-spatial structure should be adjusted accordingly, from the goal of satisfying daily life to meeting the needs of both daily life and that of responding to the epidemic. This may affect the normal life of some people, but if the transmission of the epidemic cannot be effectively stopped before the outbreak, more and more people will be infected, which will affect the lives of all. Therefore, when dealing with a dangerous infectious disease such as COVID-19, both the state and the city governments need to make correct policy choices in a timely manner, and more importantly, everyone needs to make choices that are in line with the common interests of society. Only when the city and the individual's will and strength form a joint force can the epidemic be effectively overcome.

Accordingly, in reaction to what functional-spatial urgent actions should be taken by cities in response to COVID-19, this manual combines some experiences in China to make some responses.



From the perspective of urban operation, responding to the epidemic requires close coordination and cooperation between different levels of the city sections and different departments, which requires the instant deployment of medical resources, including doctors, equipment, and supplies, to the most needed locations. Cities should reserve plans for medical locations, professional transportation, storage locations, transportation personnel and methods, and traffic management in emergency situations. The key to controlling the epidemic is to reduce population movement, especially to limit the movement of suspected infected people in public places. And how to limit the population movement is very difficult problem, and each country should look for reasonable, feasible and effective solutions under its own institutional conditions.

In the development of the epidemic, each city should first base itself on self-rescue, and external support is needed only when its own capacity is no longer sufficient to deal with the spread of the epidemic. However, for the national government, once any city suffered with epidemic, it is necessary to formulate emergency countermeasures in a timely manner, allocate necessary resources, guide local preventive control measures, and limit the epidemic situation to the minimum extent.

We hope that this manual will not only help to overcome the epidemic situation of this time, but also contribute to the future urban renewal and function enhancement for many cities targeting UN's Sustainable Development Goal (SDGs).

ii. Analysis of the shortcomings of urban function-spatial structure

It is normal for cities to appear inadequate in emergency situations. Once this situation occurs, it is necessary to improve the function and adjust the spatial structure in the shortest time. This function-spatial adjustment process is carried out with the development of the epidemic situation, so it is necessary to make a promptly assessment of the city function-spatial structure in advance, understand the problem and prepare for emergency plans.

City Case 1: Chongqing, The Municipality Directly under Central Government

Populated with 31million in 82400 km², Chongqing is the largest industrial and economic center in southwestern China. The city has over five million floating population every year seeking work or as tourists, especially during Chinese New Year when the epidemic started growing.

On January 21, Chongqing confirmed the first case. On January 24, Chongqing government launched level 1 response, and a district based medical system and community based control and service system were linked together soon. Such a linkage mechanism ensure the city maintain a low level of coronavirus growth, even though there were millions population moving between Chongqing and Hubei province during January and early February. After February 13, the number of new cases in Chongqing remained below 10. And since February 24, the number of new cases maintained zero. Until March 14, the total case are 576, and among them 566 cured, 6 died. So far, most enterprises in the city have restarted, and everyday life gradually returned.

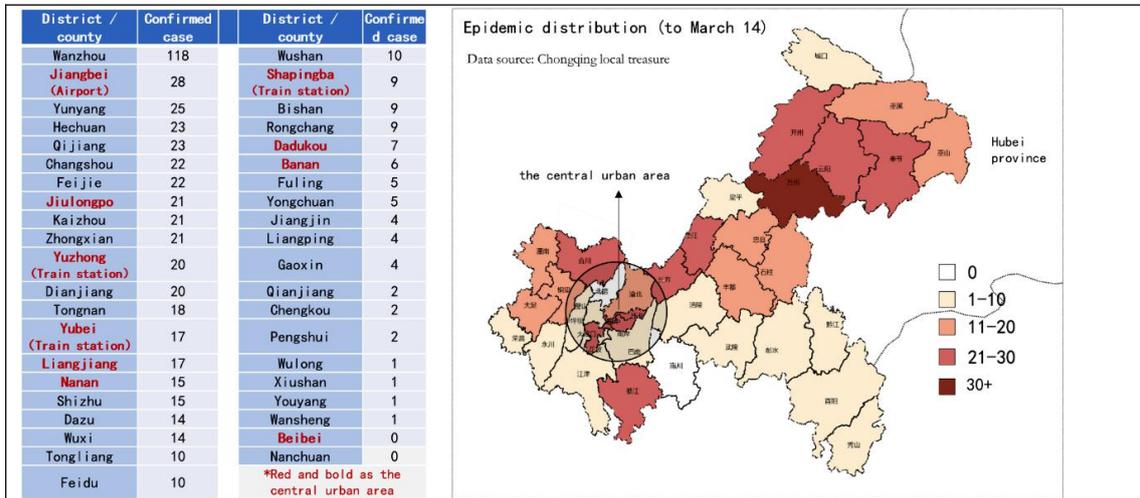


Fig.3: Distribution of Coronavirus(COVID-19) Cases in Chongqing City, China

Source: Chongqing Municipal government website

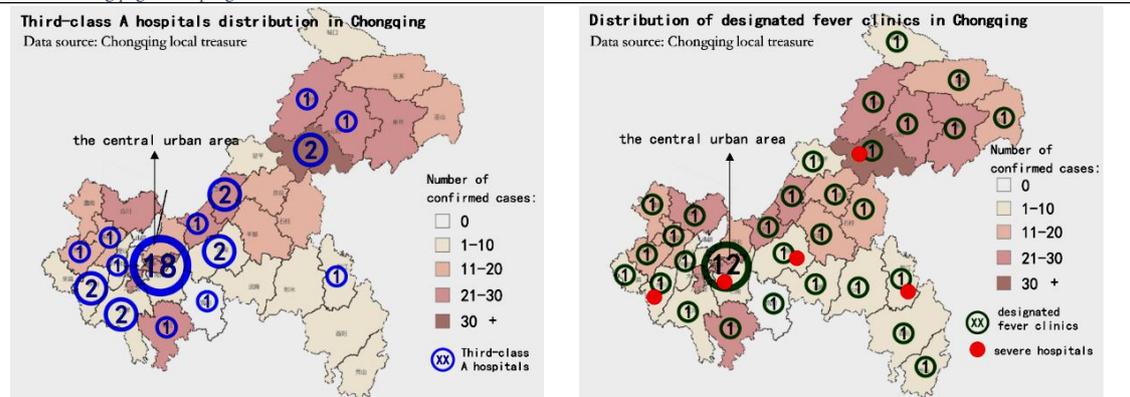


Fig.4: Distribution of Multi-level Medical Facilities in Chongqing City, China

Source: Chongqing Municipal government website

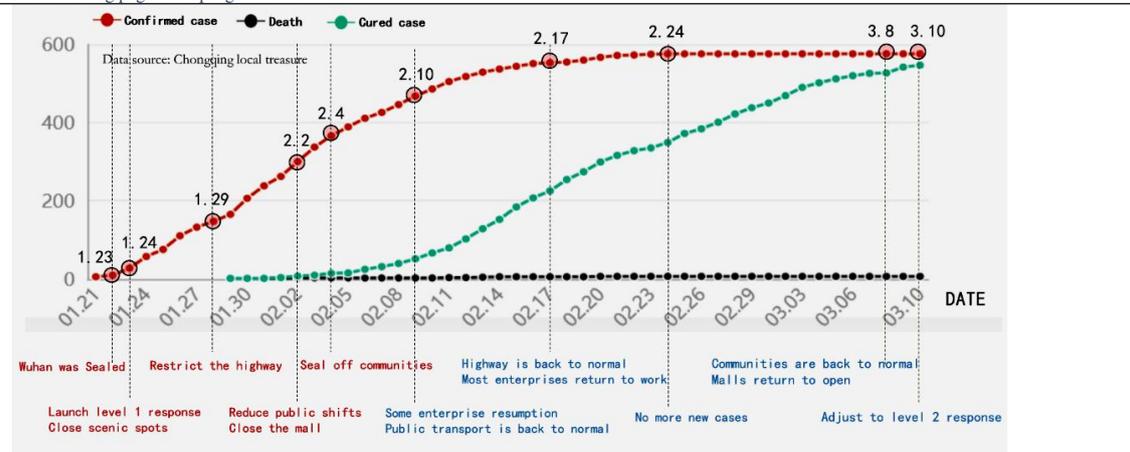


Fig.5: Daily Growth of epidemic in Chongqing City, China (20200121-20200310)

Source: Chongqing Municipal government website

City Case 2: Harbin, Capital City of Heilongjiang Province

Populated with 10.1million in 53100 km², Harbin is the capital city of Heilongjiang Province of Northeast China.

The first case in Heilongjiang Province appeared in Jan. 21, 2020, and it reached to the peak at Feb.20 with 476 cases, including 194 in Harbin. After that, there is no new case during the past 25 days, and the city life and economy are revitalized step by step. An interesting experience from the city is that many kinds of medical facilities are close to urban public spaces like parks, sports centers, etc. This makes these hospitals have good enough buffer zone or extra out space for emergency use when necessary. Also, those public spaces offer all kinds of people, including whom in quarantine

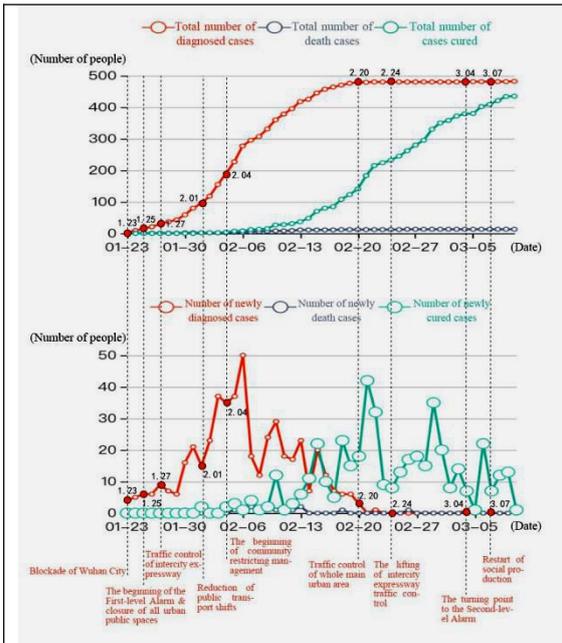
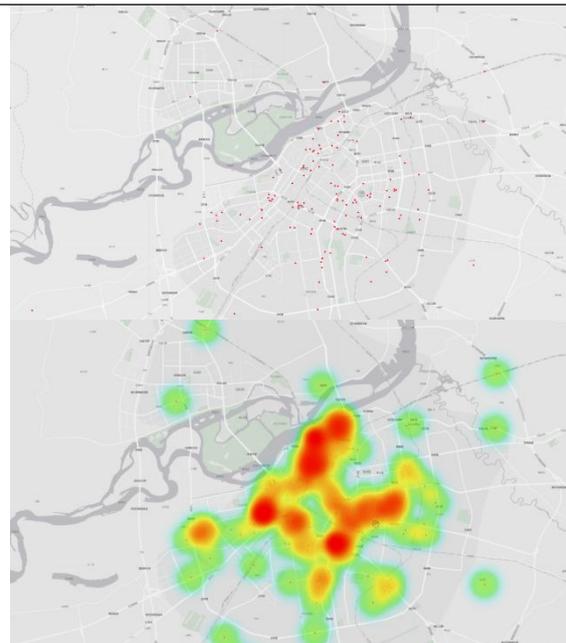


Fig.6: Tendency and New Cases in Heilongjiang Province, China

Source: modified data of "lilac doctor" data platform



**Fig.7: Above-Distribution of Confirmed Casess in Central Harbin (up to 14th March)
Below-Risk Assessment in Public Places in Central Harbin, China (up to 14th March)**

Source: Chongqing Municipal government website

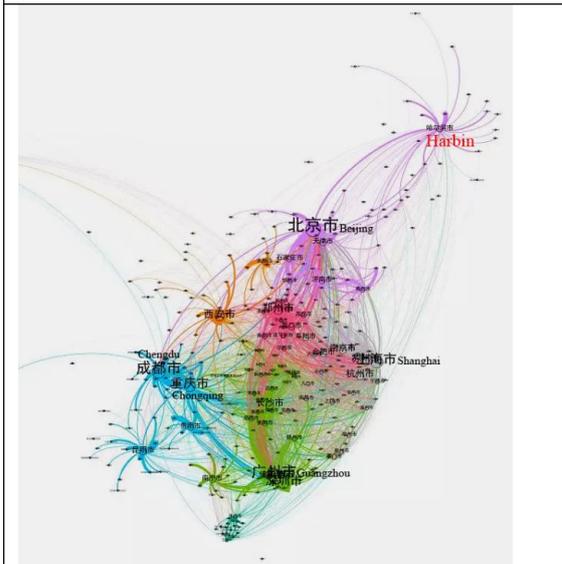
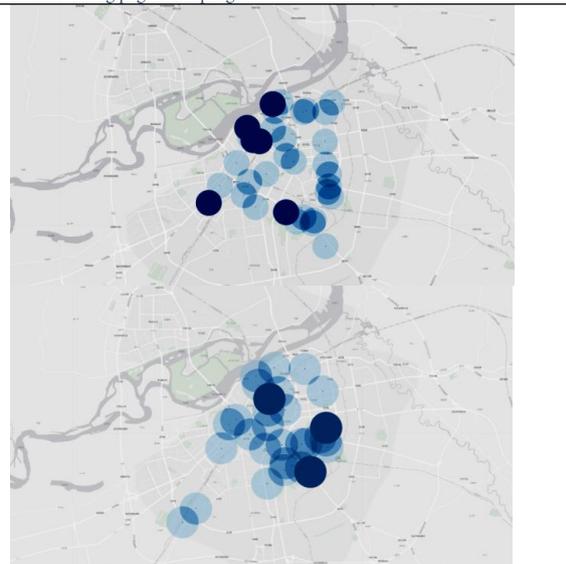


Fig.8: Trends of Moving Population During Chinese New Year (east part of China)

Source: guangming.com - Assessment of the risk of epidemic transmission in cities after the resumption of work and production after the Spring Festival



**Fig.9: Above-Major Hospitals in Central Harbin
Below-Distribution of District Medical Facilities in Central Harbin**

Source: Chongqing Municipal government website

City Case 3: Zhenjiang, A Middle-Size City in Jiangsu Province

Populated with 3.2million in 3847 km², Zhenjiang is one of the most famous historic Canal Cities in China. At the only meeting place by the Grand Canal and Yangtze River, Zhenjiang is located 240km west of Shanghai at the south bank of Yangtze River.

The city is composed of three towns, and separated by rivers and mountains in between, and has 18 major hospitals and 10 of them settled in downtown area. There are 12 confirmed cases in total up to now, so the city has adequate medical resources to deal with the epidemic. Even so, the city did a plan to connect all kinds of hospitals and clinics with nearby communities to form a hospital-community integrated network covering the whole city (figure 10 and 11). This makes each community can get quick response in case someone detected or infected at any time and any place.

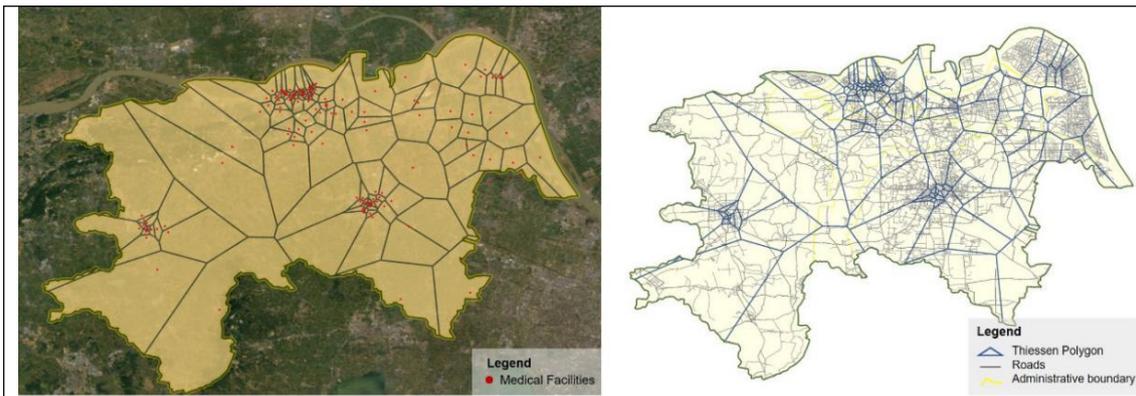


Fig.10: Voroni Diagram of Medical Facilities of Zhenjiang City, China

Source: Self- Illustrated

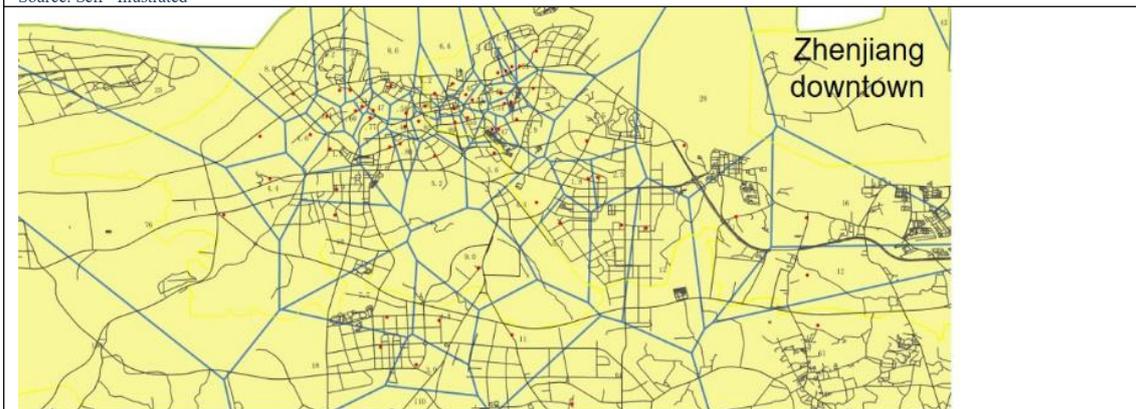


Fig.11: Distribution of Medical Facilities in Central Zhenjiang, China

Source: Self- Illustrated

In most cases, urban function-spatial problems in face of an epidemic include:

1. **Inadequate medical facilities.** This deficiency is mainly manifested in total medical institutions' insufficient, uneven distribution, low capacity, and lack of resources dealing with emerged cases. Among the medical facilities in some developing countries, the community-level primary medical institutions may be inadequate. The lack of community-level medical institution will lead to the postponement of the city's response time to the epidemic, so it is very likely spreading to larger-scale before various urban system to take action.
2. **Excessive of urban population density.** This problem is particularly acute in developing countries in Asia, Africa, and South America. The virus of *coronavirus disease* has the characteristics of strong infectious capacity, long incubation period and human-to-human transmission. It is more likely to spread in cities with high population density. In these cities, it is more difficult to control population movements, cut off the virus transmission route, and other urban systems will face greater pressure after the necessary quarantine is implemented.

3. **Traffic congestion.** Causes of traffic congestion include disordered city road hierarchy and low level of road facilities. The urban transportation system is important to ensure the timely transportation of medical personnel, patients, and various emergency materials when an epidemic occurs. It is the lifeline of the city during the epidemic period and its accessibility should be guaranteed first.
4. **Insufficient open space.** It is mainly reflected in the uneven distribution of large open spaces, the small number of small open spaces, and the small scale. During the epidemic, the open space in city can be set as a temporary storage spot for materials and temporary patient receiving spots. Insufficient open space also means that the overall scale of the city's treatment is reduced, and the potential for coping with risks is relatively reduced.
5. **Low level of public services.** Similar to medical facilities, other public service facilities in some cities also have problems such as small total volume, small scale, and uneven distribution. Some large public service facilities, such as gymnasiums, exhibition halls, schools, and other public services can be converted into temporary medical facilities under emergency conditions to ease the pressure of patients' placement, treatment and isolation in the city.
6. **Weak public awareness of the epidemic.** Although this point does not seem to have much to do with urban function-spatial issues, in fact, from the current situation in some countries, this lack of understanding will seriously affect the normal functioning of urban function-spatial emergency. It has led to the loss of precious early response opportunities for cities, which has caused them to become a large-scale serious event when they begin to respond to an epidemic. When the epidemic breaks out, without the proper guidance by the public sector and the media, the public's tolerance for the crisis will become very low. There are various factors leading to this problem, but the main reason is that government departments, the media, and professional organizations have not provided accurate information in a timely manner. If people could get the right information in time, then cities can effectively avoid unnecessary social panics and even riots, and make limited public resources play their due role.

With the "smart city" network system built in various places in China in recent years, it should have been able to cope with most of the above problems. Under normal circumstances, the greatest effectiveness of the "smart city" public health network system is that early warning can be issued in time when an epidemic occurs, thereby providing the city with valuable response time. Then one can use the big data to find out the location and distribution of infected people quickly, so that cities can deploy human and material resources to take isolation and treatment measures. But in fact, when the epidemic happened, this system in many cities did not be fully used. Relevant departments should respond in time and carefully check the problems in accordance with the epidemic situation. In any case, collecting the necessary information in a timely manner and using it properly is the basis for solving these problems. To this end, China's response is to adopt a social mobilization and urban emergency management approach that is closely linked between top-down and bottom-top approaches, which has proven to be a very active, efficient and sustainable method.

With city cases above, we learned that in facing with the epidemic, a city's functioning and spatial system should make necessary change to respond the urgent requirement. On one hand, to make the city-level hospitals become the operation centers and secondary hospitals/clinics the district and community isolation hospitals. By doing so, a basic network of the core force for epidemic is almost ready. But it is not enough, an assistance system is crucial for the network to enhance its endurance. That may include large public facilities such as sports complex, parks, squares, etc. and all kinds of medical equipment as well as major roads for urgent transportation.

And on the other, the "life supporting system" of the city must be strengthened or re-established, to be sure a plentiful supply of living materials to each supply center or super market, making people can get the goods they need within the minimum distance from their community. If both the medical and life supporting systems could be closely connected from city level to community level as a whole, then it is easier to break the

transmission chain between whom with viruses and normal population in the city. And this is the crux of the urban structure and function be re-examined in facing the epidemic. Based on this understanding, a model for restructuring of urban function-spatial pattern is created here as epidemic Prevention Area (EPA). An EPA is in fact an integrated urban function-spatial responding system to the epidemic based on present resources. It relies upon the state and urban capacity to deal with emergencies and level of support from community.

iii. The community-based urban spatial strategy for epidemic prevention

In this outbreak, China mainly adopted the approach of centralized treatment and decentralized community management. Communities in various cities have mobilized social workers and volunteers to conduct universal EPAdemiological investigations under the guidance of local doctors. More people are tested and more designated hospitals are transfer for treatment. All of this benefits from community contributions.

An important experience in China against Coronavirus (COVID-19) is, to set up a complete emergent response system as early as possible. In fact, after a short hesitation at very beginning, it is efficient performed from community discovery, quarantine and follow-up study to centralized treatment at city-level. After a cured patient back home, the community will continue offering necessary service for 14days or more, to be sure this patient, his/her family and their neighbors are safe. This is what as people recognized, the Strength of Community.

For example, in Shenzhen City, Guangdong Province, samples are taken at the grassroots immediately after the epidemic outbreak, and sent to the local nucleic acid testing institutions. Confirmed cases then sent directly to the designated treatment hospital. The remaining personnel are divided into three categories. High-risk groups (suspected cases, close contacts, travel history in high-risk areas, etc.) need to go to designated medical institutions for centralized medical observation; medium-risk groups (discharged patients who have been separated from home for less than 14 days) , mainly asymptomatic infected persons who have been released from medical isolation for less than 14 days, are take home isolation; low-risk groups can travel and return to work after normal body temperature testing.

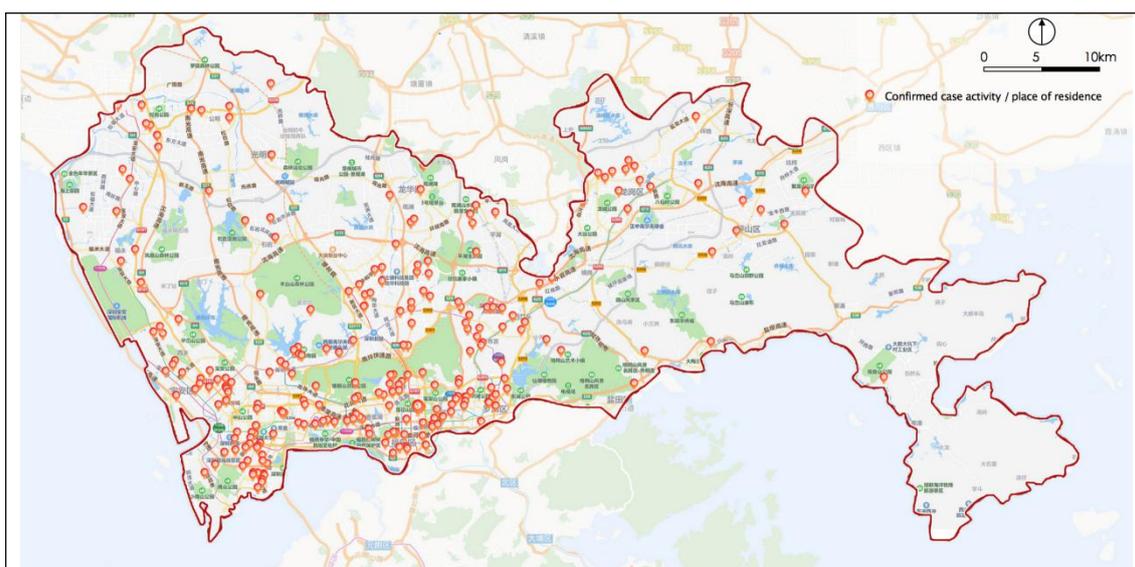


Fig.12: Distribution of confirmed cases in Shenzhen
Source: Self-illustrated based on released information by Shenzhen Municipality

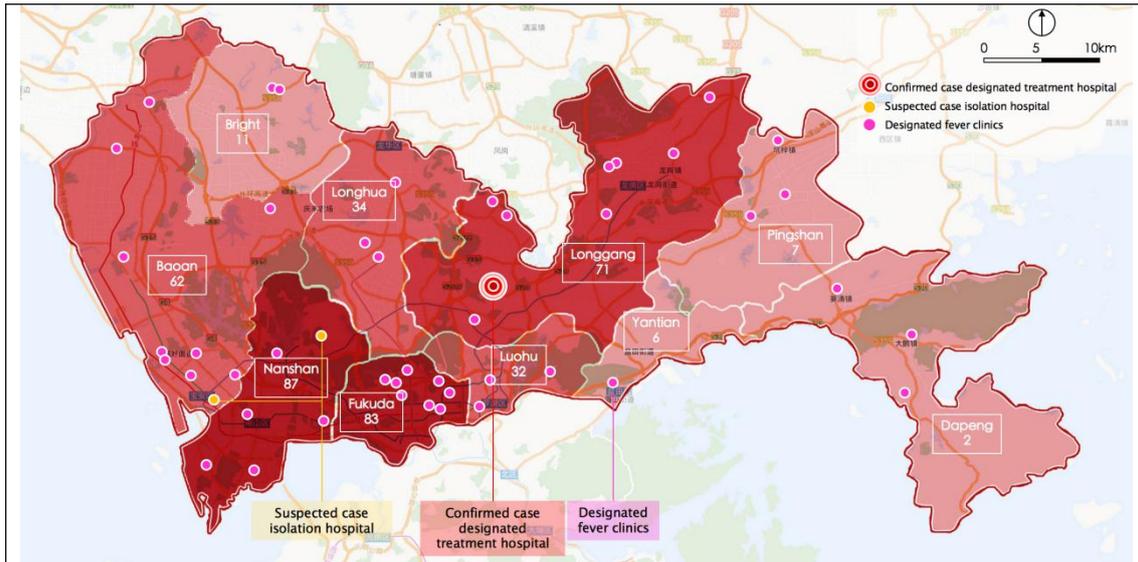


Fig.13: Overlay of distribution of confirmed cases, fever diagnoses, and designated hospitals in Shenzhen

Source: Self-illustrated based on released information by Shenzhen Municipality

This kind of epidemic prevention method needs sufficient medical resources and sufficient treatment space. However, for some developing countries, medical and spatial resources may not be enough for them to adopt centralized treatment. If so, a Disperse Cluster-Core model might be a choice. That is, a series of local medical clinics are organized as a cluster according to the urban structure and community distribution, and multiple of such clusters are formed in the city to be EPA. Based on this, a multi-level function-spatial epidemic prevention system could be established for the whole city. This EPA system can be either a city-community structure or city-district-community three-level structure. The basic principles of EPA system are to shorten the response time, improve the efficiency of medical treatment, save operating costs, and obtain public support. Thus the idea of “Early detection, early report, early quarantine and early treatment” as the Chinese wisdom could be realized.

To respond to the problems and virus characteristics, the main actions during the epidemic include:

- (1) **Advance the Response Level.** Primary medical institutions respond first and enter certain medical resources. This requires the urban health department to provide certain medical resources to grass-roots communities and improve the basic ability to respond to infectious diseases.
- (2) **Establish an EPA-based public health spatial unit.** It is important to establish a strictly controlled EPA system and use it as a basic spatial unit in the urban epidemic prevention process. If city has a specialized infectious disease hospital, it should be taken as basic medical base to connect with various districts / community medical institutions, and collecting information of infected/ diagnosed personnel and be ready to receive patients from each EPA. If there is no special infectious disease hospital or the hospital ability decreases, the primary community medical facilities should be taken as sub-centers. A community-level EPA is centered on community medical sites, including related public resources within the community it serves, such as ambulances, parks or squares that can be used to accommodate patients urgently, and temporary cabin hospitals can be built when necessary.
- (3) **Input Type Treatment.** All kinds of patients and resources are arranged into the nearby EPA for treatment first instead of being randomly exported to other places in the city for treatment.
- (4) **Urban System Guarantee.** The various systems of the city should guarantee the orderly and efficient provision of personnel, materials and facilities to the EPA by the non-infected areas. It is necessary to improve the holistic structure of city-level EPA

and community-level EPA and its management system. The reason for doing this is to make the patients being treated under the better condition as much as possible, and to minimize unnecessary personnel and material flow. Of course, the prerequisite for this is that the city must provide the necessary medical resources to the grassroots community.

1. Taking EPA as the basic function-spatial unit for treatment, meeting the needs of different stages of epidemic

A city could set up a three-level epidemic prevention system including urban medical center, district level EPA and community EPA. Where possible, it is better to make the community EPA first to cut off epidemic spread.

- (1) **Initial outbreak.** At the beginning of the epidemic, it may only appear in individual buildings. At this time, lockdown and disinfection should be implemented in time, patients should be transferred into designated hospitals for treatment, and the number of people in the vicinity should be minimized. At the same time improve the prevention level of surrounding communities.
- (2) **Outbreak stage.** When the epidemic situation begins to spread and there are scattered cases in different locations, it is necessary to quickly form a district EPA to quickly expand the scope of prevention and control. The basic idea of the EPA is to control the epidemic situation within a limited time and space as much as possible. And district level EPA is more comprehensive and easier to form a EPA group. The district-level EPA generally has 2-3 hospitals or several grass-roots clinics with supporting resources as schools, parks / squares, business services and government agencies and other facilities. It can mobilize certain professionals and volunteers. With the support of the city, a district-level EPA can maintain relatively independent operation and management under certain conditions within a certain time frame.
- (3) **Spread of the epidemic stage** The district-level EPA is characterized by the formation of a strong and systematic intervention system before the epidemic situation reaches a critical level, and the implementation of effective control and treatment. So that the city has the ability and time to quickly build a wider range of emergency medical care at the city-level system. It helps cities to concentrate their manpower and resources at the beginning of the epidemic, and to give play to the comprehensive benefits of existing medical systems, service systems and collective systems. But when the epidemic started to erupt at the city level, a single district-level EPA could not meet the needs. This is necessary to link multiple district-level EPA in the city to play a cluster role. For this reason, it is necessary to establish an effective emergency transportation system and close some secondary and capillary road networks at the same time, so that the traffic flow, logistics and pedestrian flow can always be controlled, even if this will cause some inconvenience. Therefore, a EPA cluster is a temporary adjustment of city management and function-spatial in emergency situations. Also, it concentrates and vigorously improves medical standards, and maintains normal community life at the same time.

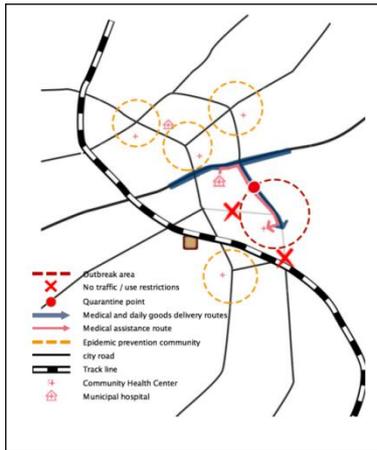


Fig.14:epidemic Prevention Area (EPA) - Management and control diagram
Source: Self-made

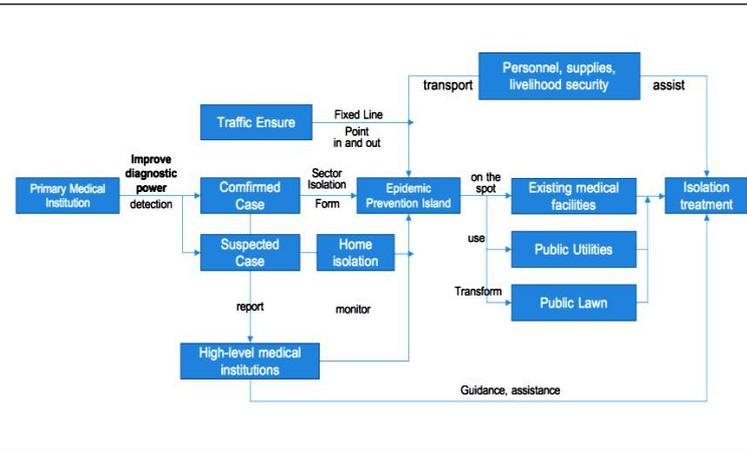


Fig.15: Flow chart of basic epidemic prevention unit measures
Source: Self-made

2. EPA Cluster

When the epidemic develops to an uncontrollable stage, the entire city needs to be divided into multiple EPAs to form a cluster structure to comprehensively respond in city-level. In this case, the city needs to divide the whole or most of the area into different EPAs based on community, and special attention should be paid to maintaining a strong links between them to dispatch medical and service personnel to the very places where they are mostly needed. At this time, each EPA needs to be designated some special places to accommodate suspected and infected people. If hospitals and clinics are inadequate, some public facilities such as parks, squares, sports fields, and schools need to be requisitioned as temporary points or mobile hospitals for patients.

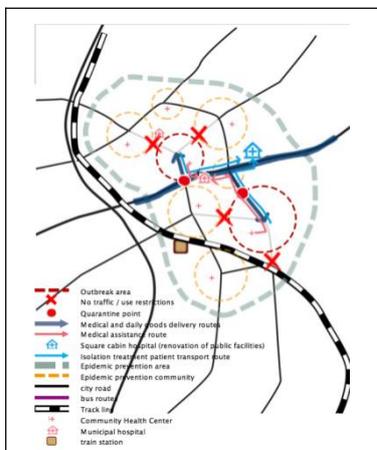


Fig.16:epidemic Prevention Area (EPA)Group - Management and control diagram
Source: Self-made

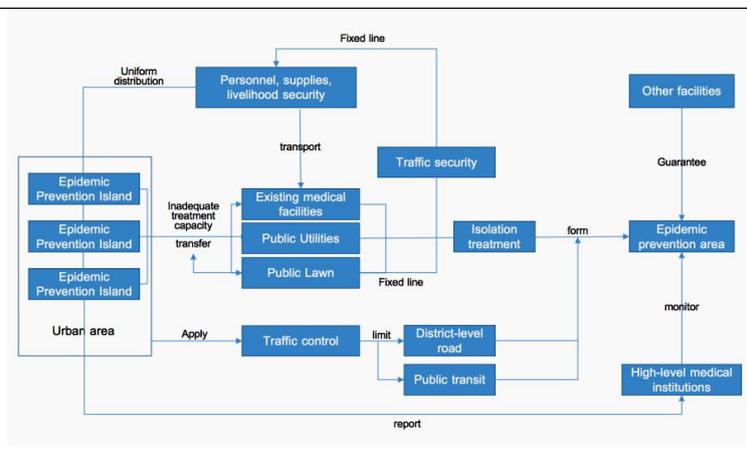
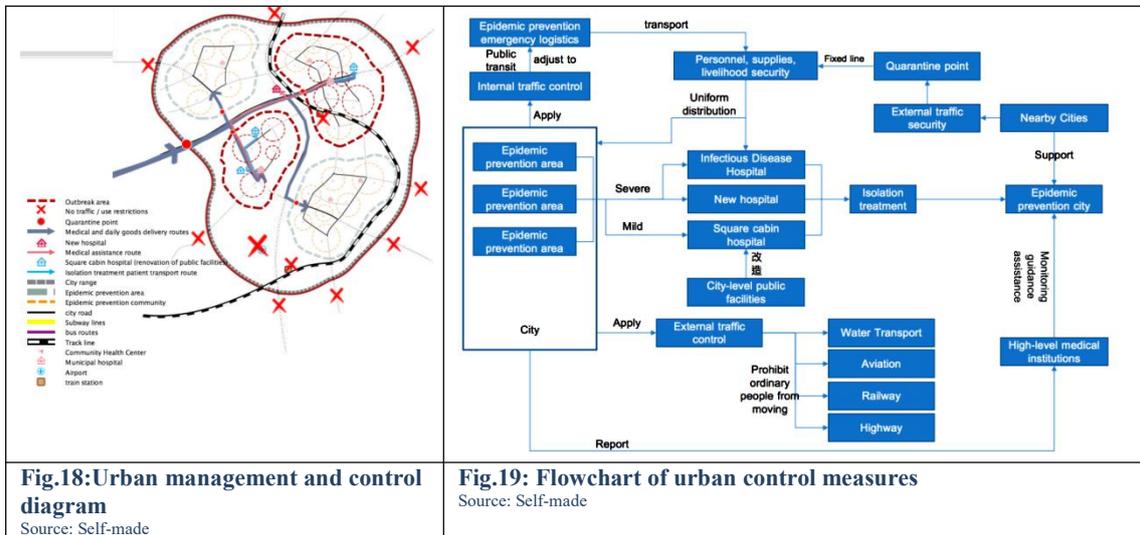


Fig.17: Flow chart of basic epidemic Prevention Area (EPA) Group measures
Source: Self-made

3. Urban management and control

Cities with epidemic conditions should enter an emergency state after an early warning is issued by the EPA. In the early stages of the epidemic, the epidemic situation of each EPA and EPA cluster will be continuously monitored to ensure the normal operation of the city's medical system, service system and transportation system, and preparations for the treatment of larger-scale numbers will be made in advance.

When the epidemic spreads throughout the city, the city management department should decide as soon as possible depending on the specific conditions whether to continue to maintain the independent operation of each EPA or to strengthen some of them and weaken the others to focus resources where they are mostly needed. It is necessary to coordinate the city's core medical facilities and transformation, and build new medical facilities to rationally allocation, quarantine and treat light and severe patients. The urban transportation system needs to be reorganized, blocking some internal roads, restricting public transportation operations, and adjusting it to an epidemic prevention emergency logistics system to provide guarantee for the transportation of various materials to various EPA. And also, the mobility of population should be reduced to a lower level.



4. Support system – transportation, public facilities, logistics supply and other infrastructure

During the epidemic, in order to ensure the effective responding, some capillary road networks in the EPA should be closed to reduce people moving within. At the same time, the trunk road network is unobstructed, so that all kinds of materials can be smoothly transported to the EPA. It is best for all vehicles to enter and leave the EPA on a fixed route to ensure that the process can be traced. In the early stage of the epidemic, the public transit system can choose measures to reroute or suspend some stations to maintain the safety of EPA.

Strictly control urban external traffic nodes, implement traffic control, and suspend the use of water transport, aviation, railways and some highways by ordinary people; set up quarantine points and emergency evacuation spaces at limited urban entrances and exits, and also set up quarantines points around train stations or airports where conditions permit to ensure the safe entry and exit of all types of personnel.

Allocate and classify emergency vehicles (such as taxis, ride-hailing vehicles, buses, logistics trucks), organize transportation of medical workers, police and other front-line workers to commute, medical supplies, civilian supplies, emergency personnel (such as non-infected patients with other chronic diseases) , other sudden illness patients, pregnant women, etc.

It is necessary to effectively ensure everyday life of residents and safeguard the normal operation of water, electricity, gas, and house and living things supply and communication; at the same time, monitor urban drainage systems to prevent aerosols or contact from spreading due to feces and urine.

iv. Reconstruction of urban public service system

The urban public service is used as a backup and support system for medical facilities in epidemics. Some large public facilities should be capable of quickly transformed into temporary medical treatment points that meet the admission and treatment criteria. Various markets should keep open for the daily lives of residents in each EPA area under the condition of eliminating the virus influence and control customer scale; hostels, hotels, etc. can be used as floating population or medical staff temporary residence.

- (1) **Building cabin hospitals.** It is understandable that a city's medical resource is easily exhausted quickly in facing a epidemic. Based on the limited resources of primary medical institutions, public facilities such as community activity centers can be transformed to be additional facilities for city. In China, one of the most practical experiences is to set up temporary cabin hospitals for the constantly emerging patients, which could be in public green space, sports center, vacated school, etc. to observe suspected cases and treat milder symptoms. The number of them is much larger than severe patients and easy to make any hospital into incapacity condition. Also, to collect them as much as possible into the temporary cabin hospitals means to cut off the chains of infection in the city. It is good to those people because they can get much better treatment than staying at home. By doing so, the formal hospitals in each EPA is capable focused on severe patients who need more attention.
- (2) **Using of public space and facilities.** Renovate district-level public facilities such as stadiums and exhibition halls as logistics service centers, epidemic monitory spots or additional public service centers when it is necessary. In a epidemic, such temporary facilities in public green space are of important, because they are more closer to people where they live. These public facilities can also be easily changed to be medical observation centers for those been identified close contacts.
- (3) **Keep children and young people safe.** Children and young people should stay at home when epidemic is serious. Educational institutions such as kindergartens, primary schools, and middle schools in the EPA may be suspended and some of them requisitioned as temporary treatment places for suspected cases.
- (4) **Improving urban rescue capabilities.** For the floating population in the city, if they don't have proper place to stay, the government should offer qualified hotels, hostels or any suitable places to arrange them. Observation and preventative quarantine are of importance.
- (5) **Strengthen urban warehousing and logistics facilities.** When epidemic is severe, a temporary shortage of materials may occur. Well organized logistics by large enterprises (such as JD, Alibaba, Cainiao, etc. In China) can play a crucial role for storage, transfer, distribution of living, medical supplies and various items. Many delivery man work as volunteer in China's Wuhan connecting above logistics with every community and households. All works rely upon the developed internet system.
- (6) **Strengthen the observation and protection of community care institutions.** Elderly people with poor physical immunity are particularly susceptible and easy to rapidly develop into severe illness, which deserves special attention. Focus on strengthening the observation and protection of the elderly community care institutions is government's responsibility. It is necessary to make investigation in a timely manner, establish a database of special needs groups, and provide necessary assistance for those people. Also, observation and protection of closed places such as mental hospitals and prisons should be strengthened.

v. An urban public security system serving for people

Since January 2020, China has quickly established a rigorous epidemic defense system

by means of national mobilization, which has effectively prevented the spread of the epidemic throughout the country with national strength. However, the cost of such a system is huge and it might unlikely to be replicated in other countries. The experiences that China can provide to the world are what to do when facing epidemics. First of all, it is necessary to respond quickly and globally, deploy medical forces at all levels in time, and establish a national joint prevention and control mechanism. Also, due to the coronavirus outbreak globally, the early warning system playing a vital role based on closed relationship between China and WHO. Important information on epidemic spread to all countries through WHO everyday; Secondly, government departments must promptly release correct and accurate epidemic information, provide the public with scientific knowledge, stabilize social emotions, and avoid social panic due to misinformation; Thirdly, quickly adjust urban functions-spatial systems and management mechanisms to form organized urban epidemic prevention spatial units, comprehensively improve the ability to respond to the epidemic; Last but not least, make use of the community's grass-roots organization and mobilization functions, so that all residents become a positive force for the prevention and control of the epidemic. Therefore, in response to the sudden outbreak of Coronavirus (COVID-19), each city must consider not only the interests of just one community or the city itself, but also the common interests of the country and the world. Under this premise, countries and cities should quickly establish prevention and control systems that meet their own characteristics, and exchange information and support each other. Only in this way can human beings save themselves fundamentally. In the face of this rapidly spreading plague, any short-sighted behavior that only serves the interests of small groups can endanger whole world.

In some developing countries the current public health systems, including number of primary medical institutions (community health stations, clinics, etc.), may be insufficient and unevenly distributed, making it difficult to achieve the ideal spatial epidemic prevention organization model. These cities can take short-term response. Firstly, a simple EPA system can be set up by taken the hospitals with better conditions to be centers for the treatment. In the meantime, additional medical facilities will be established in surrounding parks, sports venues, and squares as soon as possible for the rapidly increasing patients. While the community medical institutions play a supporting role to meet the needs of initial test to a large number of people who need medical observation. In each community, volunteers should be mobilized to provide necessary services to those who are stay at home or in quarantine. Such a supporting system can reduce the pressure on major medical institutions, and form a perfect operating model for entire city. Secondly, the diagnostic capabilities of medical facilities in each community EPA should be improved to ensure that patients can be diagnosed and quarantined quickly. At the same time, the city authority should provide necessary medical resources to the community EPA in a timely manner to treat patients. However, due to uneven distribution of medical facilities, inadequate diagnosis and treatment capacity may occur in large areas. In this case, a closed linkage between different EPAs can strengthen the capacity of whole city. When necessary, suitable large-scale public buildings can be selected as temporary treatment points to improve the capacity of treatment within the unit and minimize the scope of the epidemic infection.

For each city, the construction of its public medical system is constantly evolving and may not be sufficient in any emergency. But this does not mean that it is useless, it just shows that this system needs to be improved continuously under different emergency situations. It must be pointed out that the urban public medical system is not set up for only one goal or event, but needs to consider urgent issues in all aspects. In response to the epidemic, the key to the improvement of the system is to improve its systematic, reliability and durability.

- (1) **Systematic:** In terms of urban function-spatial structure, it is necessary to strengthen the system of EPA clusters covering the entire city, and ensure close linkage between each of them, as well as of different levels and departments in the city. At the same time, strengthen the structure of city's support system for EPA clusters, and especially ensure the communication of epidemic situation information. This can maximize the system's efficiency, reduce costs, and unnecessary personnel movement.
- (2) **Reliability:** It is necessary to avoid the emergence of functional problems such as shutdown, ability decreases, etc. during the emergency operation of the public medical system, as well as the spread and infection of coronavirus in the medical

process. epidemic prevention and control is a process of high consumption of materials, manpower, and financial resources. To this end, emergency management agencies, service offices, and volunteer service stations must be established from community level to city level, and necessary checkpoints must be set up on main roads to ensure relief supplies and personnel fast flow. Promote online office, information exchange and shopping in the community.

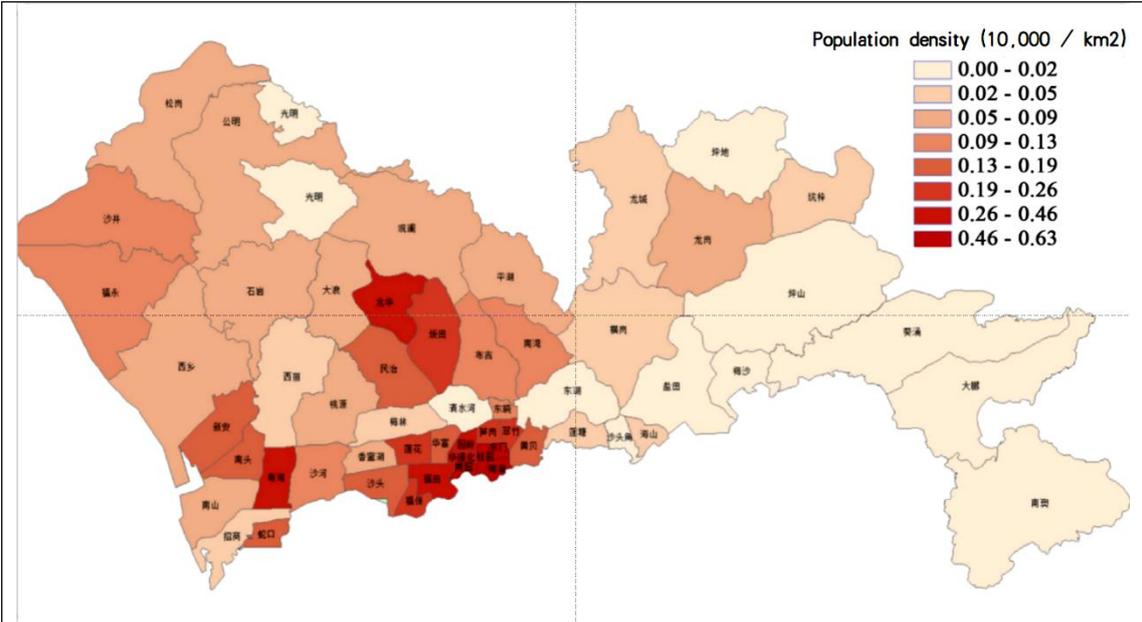
- (3) **Durability:** The least durable in public medical systems is human resources, some important facilities and equipment and their supply systems. These resources must be specially protected to ensure the rotation and rest of medical and service personnel. Given the shortage of supplies, priority should be given to ensuring the various needs of medical personnel, including necessary supplies, to ensure that cities have sufficient capacity to overcome the epidemic.

The systematic, reliability and durability of public medical systems depend not only on government departments, professional institutions and advanced technology, but also on the full maintenance and support of communities and citizens. Therefore, a rational and efficient spatial structure of the EPA clusters is the basic supporting condition to these criteria.

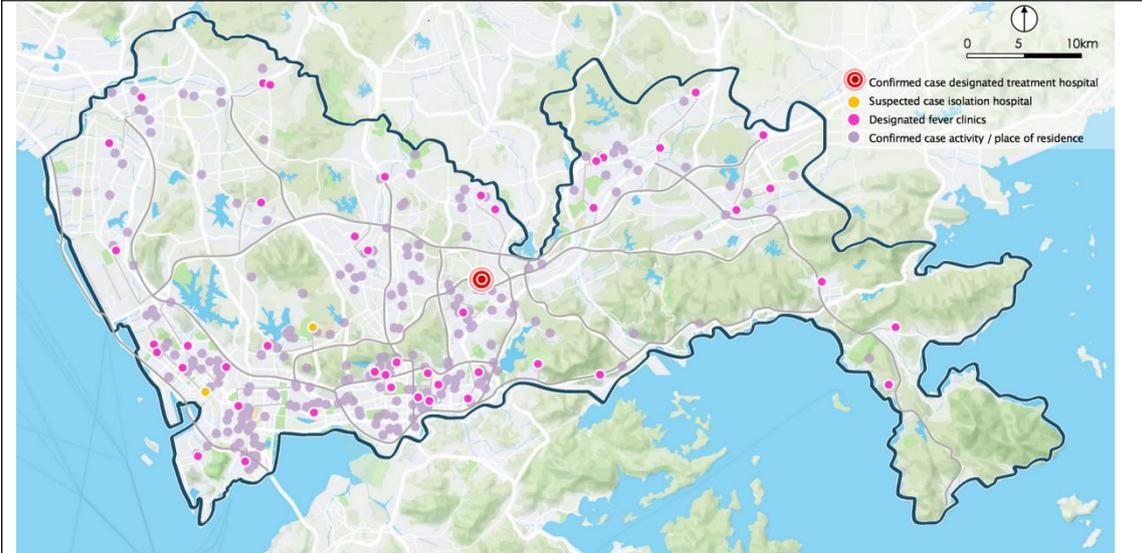
vi. Illustrative Case Reference

Chinese case 1: Shenzhen, Guangdong

Shenzhen is located in Guangdong Province, one of China's megacities, with a total area of 2050 square kilometers and a resident population of 13.0266 million in 2019. The level of medical facilities is relatively high in China. The distribution is relatively even in relation to population density. As of 24:00 on March 8th, Shenzhen had reported a total of 419 confirmed cases of Coronavirus (COVID-19). The distribution of confirmed cases of living / activity places also basically accords with population density, mainly concentrated in the old town.



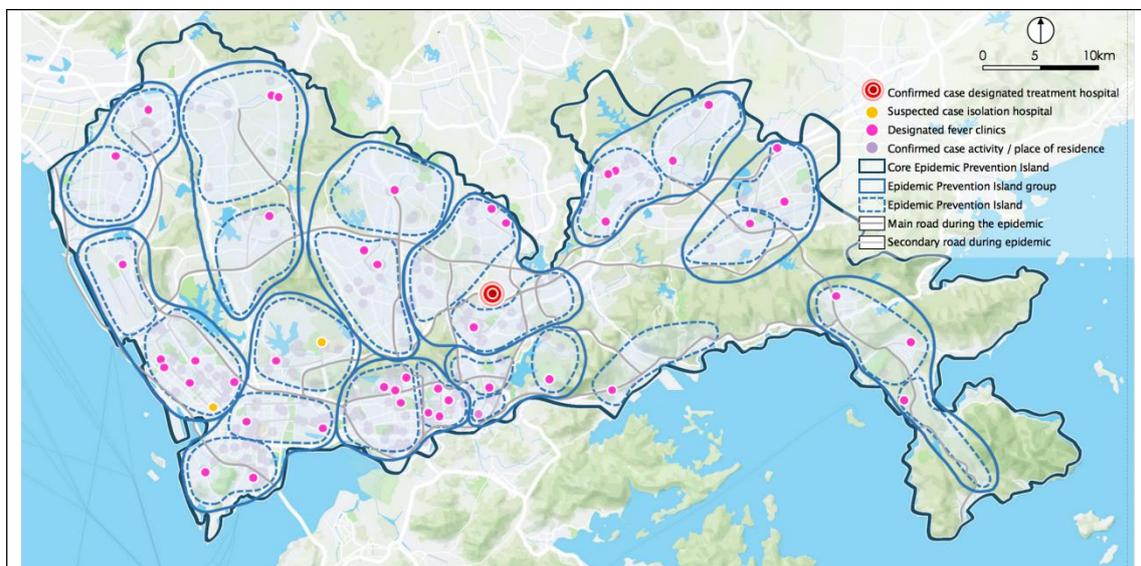
No.1: Shenzhen population density map
 Source: Residential and Travel Characteristics Analysis Based on Mobile Phone Signaling Data[J]. Hans Journal of Data Mining, 2018, 8(04): 162.



No.2: Distribution of fever and confirmed cases in Shenzhen
 Source: Self-illustrated based on public data of Shenzhen Health Committee

1. City level

"Concentrated admission" is the valuable experience in the fight against SARS. In the face of this epidemic, Shenzhen still adheres to the principle of "concentrating patients, experts, resources, and treatment" and scientifically deploying various medical resources. The first imported case was diagnosed in Shenzhen on January 19. Shenzhen Health committee then released a list of 49 medical institutions that issued hot clinics and launched a centralized quarantine point. In the beginning, the city's Third People's Hospital was selected as the centralized treatment point for patients with confirmed and suspected cases. The hospital is the only national infectious disease clinical medical research center in South China. With the development of the epidemic, in order to let the three hospitals focus on treating severe and critically patients, the Hezheng Ward of Shenzhen Medical Hospital of Southern Medical University and the General Hospital of Shenzhen University are designated as the "second" and "third" ward, which specifically receive nucleic acid testing Patients who are negative but still need treatment. At present, Shenzhen has designated a total of 29 public hospitals in the city and districts as the centralized hospitals for suspected cases of new coronary pneumonia in the city to screen and initially diagnose and treat suspected cases.



No.3:Shenzhen city-level epidemic prevention unit map
Source: Self-illustrated on public data of Shenzhen Health Committee

2. District and community level

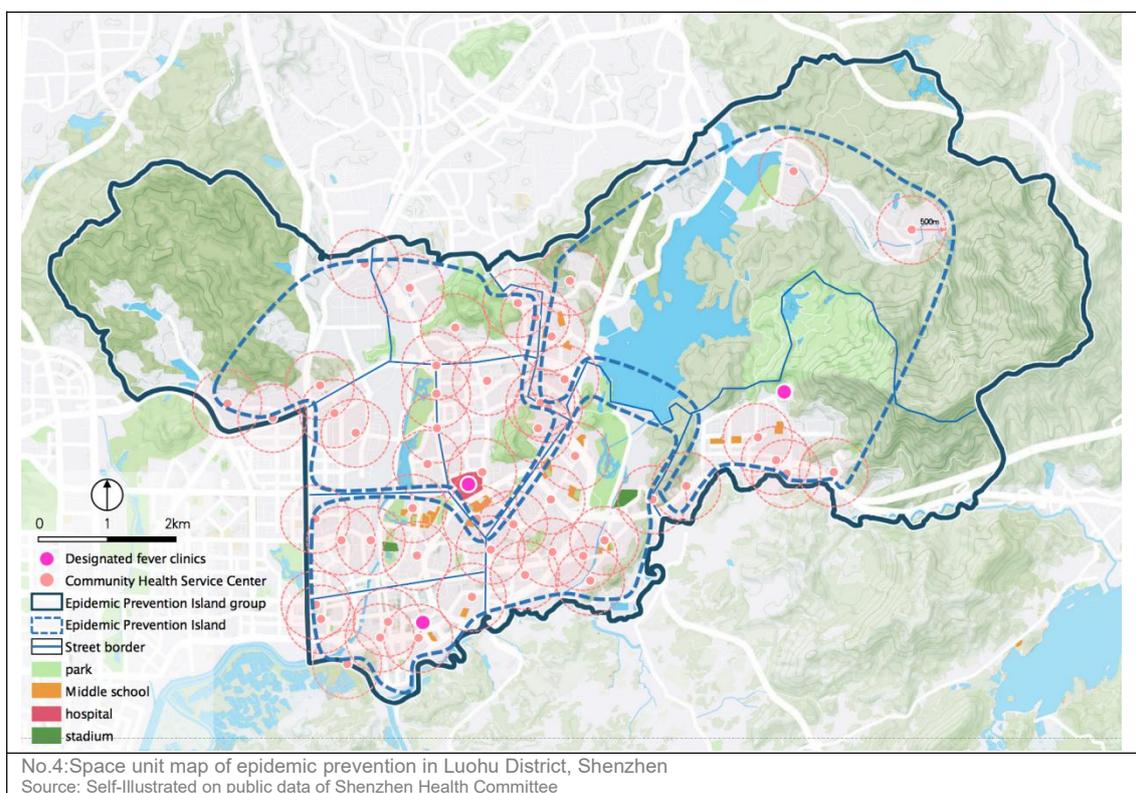
The community health service agencies in Shenzhen mainly provide basic medical services, basic public health services and family doctor services to residents in their jurisdictions. The community health service agencies are divided into first-class community health service centers, secondary-class community health service centers, and community health service stations. The number of consultations in the community health centers in all public medical institutions accounted for 40.1% of the city. Shenzhen is at the forefront of the country in terms of graded diagnosis and treatment.

In terms of prevention and control of grass-roots communities, Shenzhen has formulated grass-roots prevention and control work standards and community prevention and control guidelines, and all 662 social and health agencies in the city have participated in this outbreak prevention and control work. Various social and health institutions set up fever pre-checking and sub-diagnostic desks to detect fever patients and suspected patients in a timely manner, and isolate and refer them. Provide home-based isolation medical observers with home temperature measurement, health screening, distribution of home isolation medical observation notices, home protection guidance and other services. Assist in the development of nucleic acid testing, and cooperate with the close isolation and observation of close contacts.

Take Luohu District as an example to understand the structure of district-level public health facilities. The district is in the old town of Shenzhen, covering an area of 78.75 km² with 10 sub-district offices, 83 communities, and 1.04 million population.

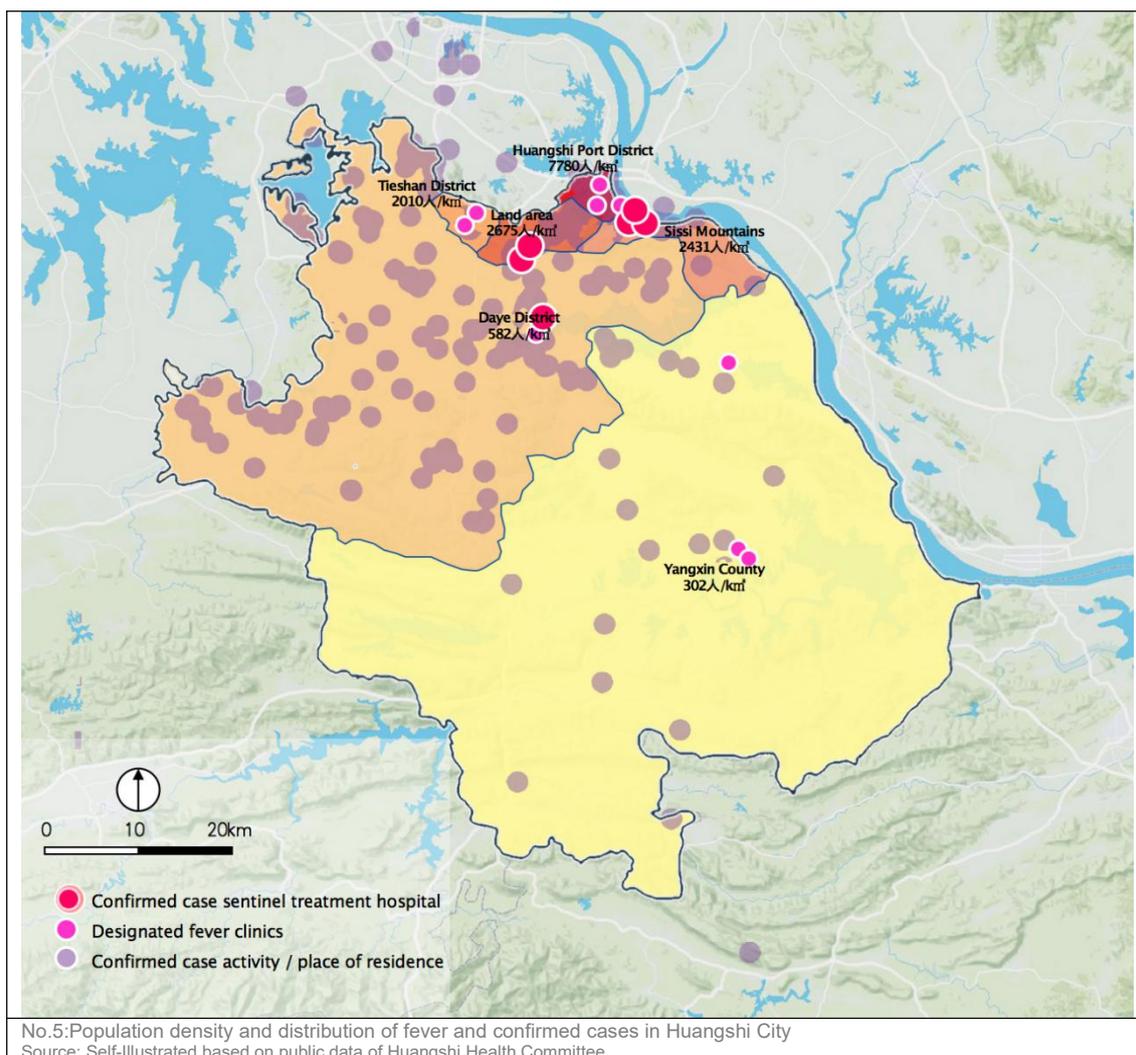
There are 3 designated fever clinics in Luohu District, and they are all municipal hospitals and relatively evenly distributed in the district. In addition, the District has 48 community health centers, which basically cover all built-up areas with a 500m service circle. The Community Health Center conducts dynamic health monitoring and management of community-based isolated medical observers, and immediately transfers those with early symptoms to centralized treatment medical institutions for initial treatment and screening. In this way, a community epidemic Prevention Area system based on district-level epidemic diagnosis and community health service centers has been basically formed.

In terms of land use, Luohu District has larger city parks such as People's Park and Donghu Park. However, due to the limitation of topographical conditions, open environments such as Yinhu Mountain and Wutong Mountain are difficult to meet the conditions for the construction of temporary hospitals in the event of an epidemic. Instead, it is possible to use high- and middle-school education facilities and gyms in the area as emergency space for quarantine and treatment. In addition, Shenzhen Reservoir, which is the main source of water for the city, must be protected during the epidemic to prevent pollution.



Chinese case 2: Huangshi, Hubei Province

Huangshi, located in eastern Hubei Province, is one of the cities with a relatively severe epidemic situation. It has a problem of uneven distribution of medical institutions. The development of the epidemic has roughly gone through three stages: after the emergence of early patients, they were not able to get help in community clinics in time, so the suspected went directly to district-level fever clinics for medical test, and resulting in nosocomial infections; as the epidemic spread, the increasing numbers of cases flooded into a small number of designated hospitals within a short period, making them exhausted quickly and unable to work for treatment; when a large number of patients continued to accumulate, eventually the whole medical system collapsed.



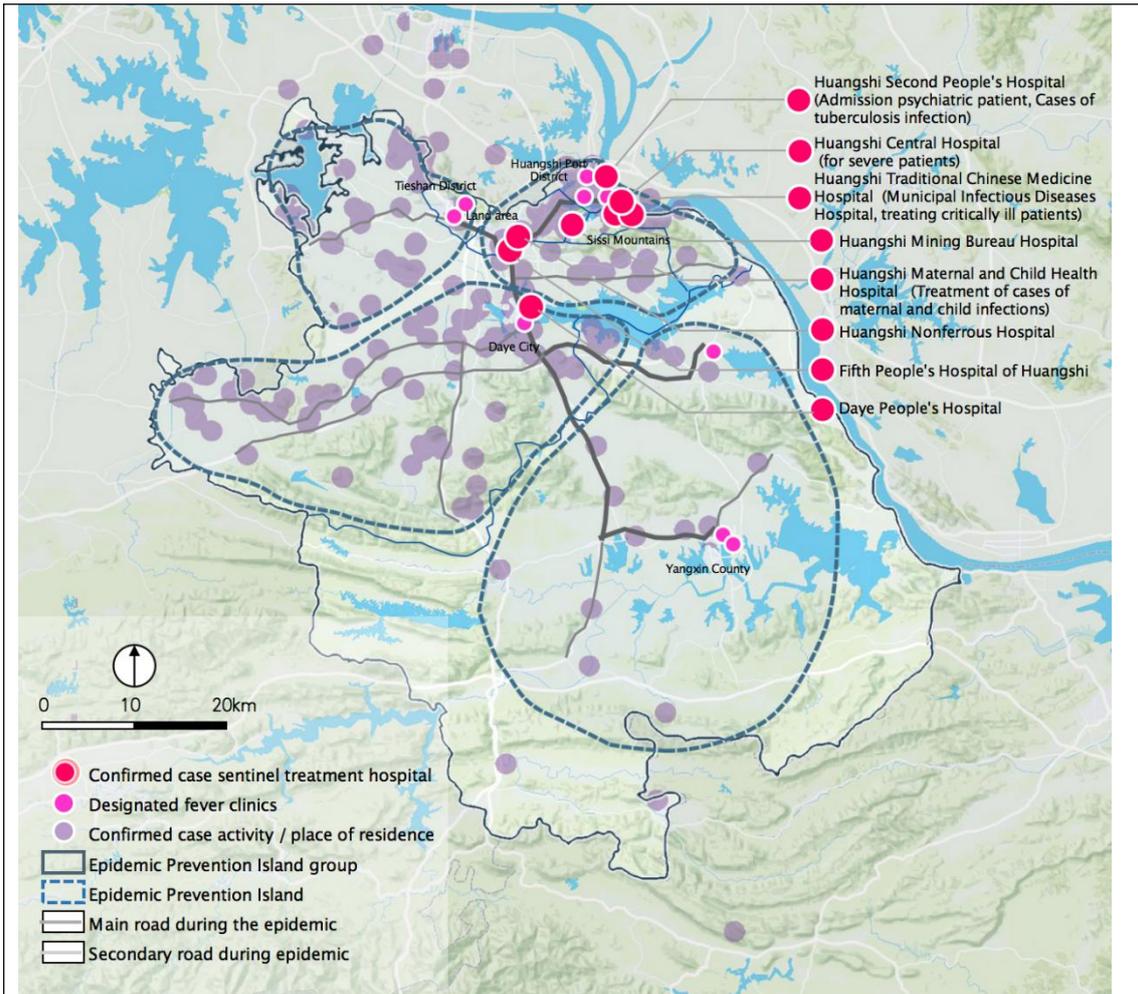
Due to the low quantity and quality of medical resources in the community of Huangshi, the epidemic broke out rapidly in urban areas. After that, Huangshi made adjustments quickly. According to the distribution of confirmed cases and the actual situation of medical resources, it strengthened 15 medical institutions that supporting local clinics. The absence of community-level medical facilities has made a wider range of spread, and more people have virtually affected. Finally, the city got strong external support for recovering the medical system. Measures were taken based on the principles of centralizing treatment, and resources into pointed hospitals.

1) **Community-based inspection.** Carry out lockdown management to the communities, conduct home-by-door temperature measurement day by day, and transfer patients with fever and close contacts in time to prevent the epidemic from continuing to spread.

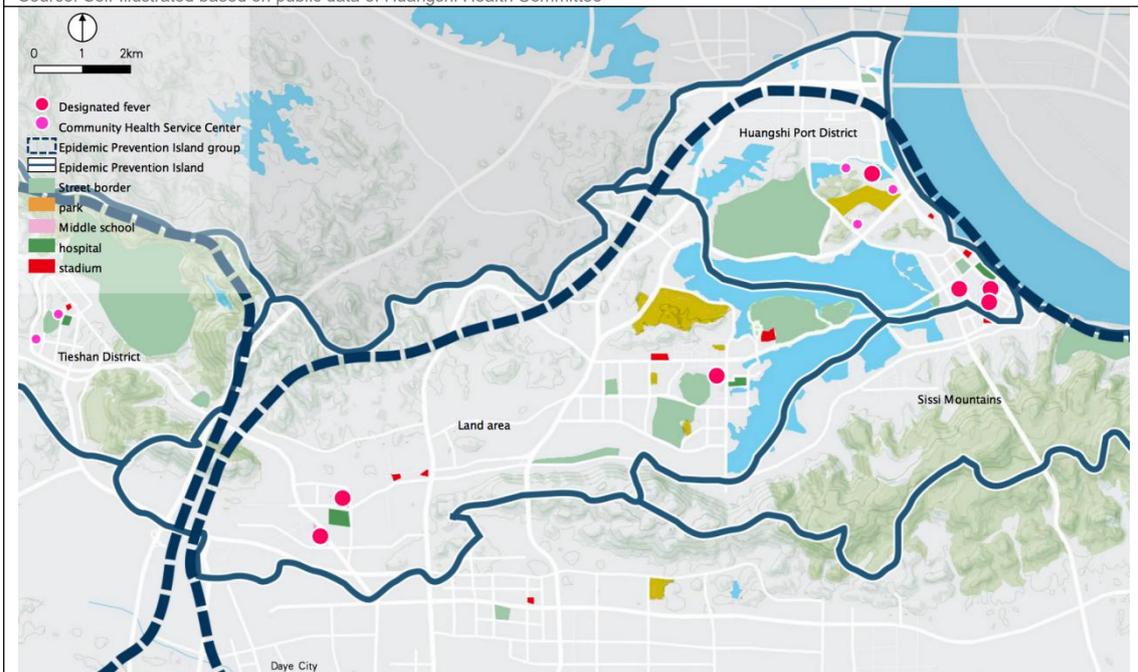
2) **Patients with mild, moderate and severe cases were treated separately.** Currently 7 designated hospitals serve for confirmed cases. Among them, Huangshi Central Hospital and Huangshi Traditional Chinese Medicine Hospital (Infectious Disease Hospital) are designated hospitals for severe and critical cases, and the rest are admitted for mild cases. From March 3, all severe patients were transferred to the central hospital.

3) **Concentrated quarantine for close contacts.** There are a number of concentrated quarantine points in the city. The largest quarantine point is the Golden Flower Hotel, and this initiative has taken advantage of existing urban facilities and achieved results.

4) **Follow-up management of cured patients:** The cured patients still need a quarantine for 14 days and follow-up management within their community.



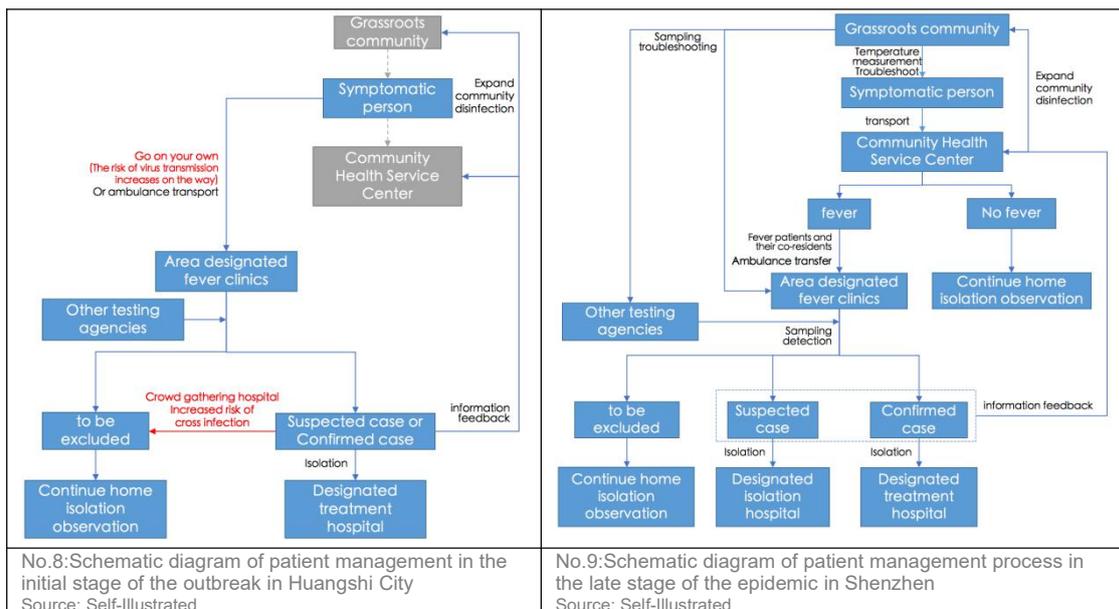
No.6:Huangshi city-level epidemic prevention unit map
Source: Self-illustrated based on public data of Huangshi Health Committee



No.7:Mapping of epidemic prevention in Huangshi City
Source: Self-illustrated based on public data of Huangshi Health Committee

A total of 1,015 confirmed cases in Huangshi since the outbreak. Through a series of powerful measures and active government-community cooperation, the epidemic was controlled. There are currently less than 100 confirmed in hospital.

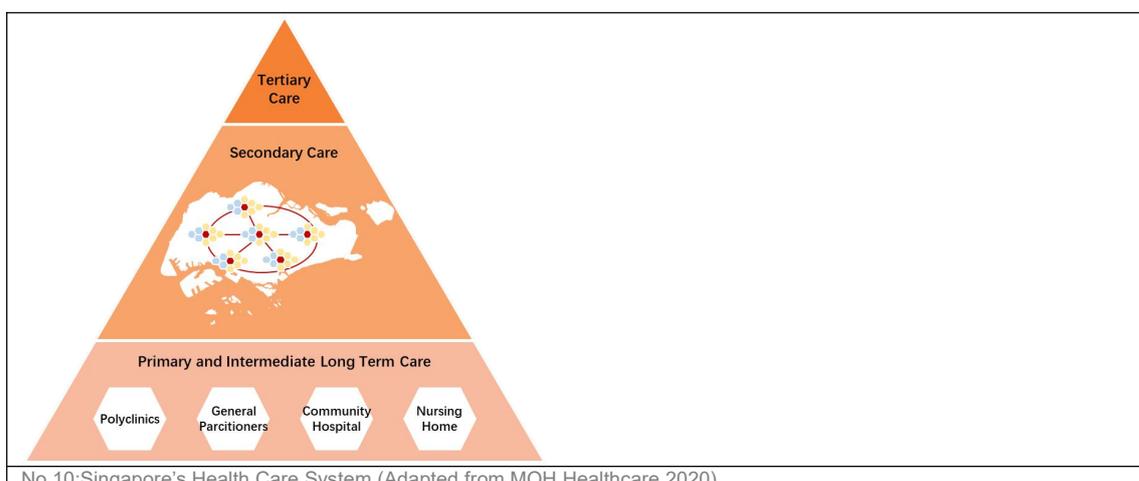
Quick response and information release are powerful means to fight the epidemic in Shenzhen. At the same time, grassroots communities have played a vital role in the prevention and control of the epidemic. Compared with the initial patient consultation and management processes in Huangshi, Hubei, it can be found that the epidemic will spread soon to the city level without the protection of grass-roots EPAs. Therefore, cities should improve the level of grassroots facilities, optimize the spatial layout structure of infrastructure to improve the overall emergency response capacity of the city, in order to face sudden emergencies that may occur again in the future.



International Case 1: Singapore

1. Singapore healthcare system

Singapore's healthcare system is known for its efficiency and is one of the most capable Asian countries to deal with a major medical crisis. The Singapore medical system provides three levels of medical services: primary and intermediate long-term care, secondary care and tertiary care.

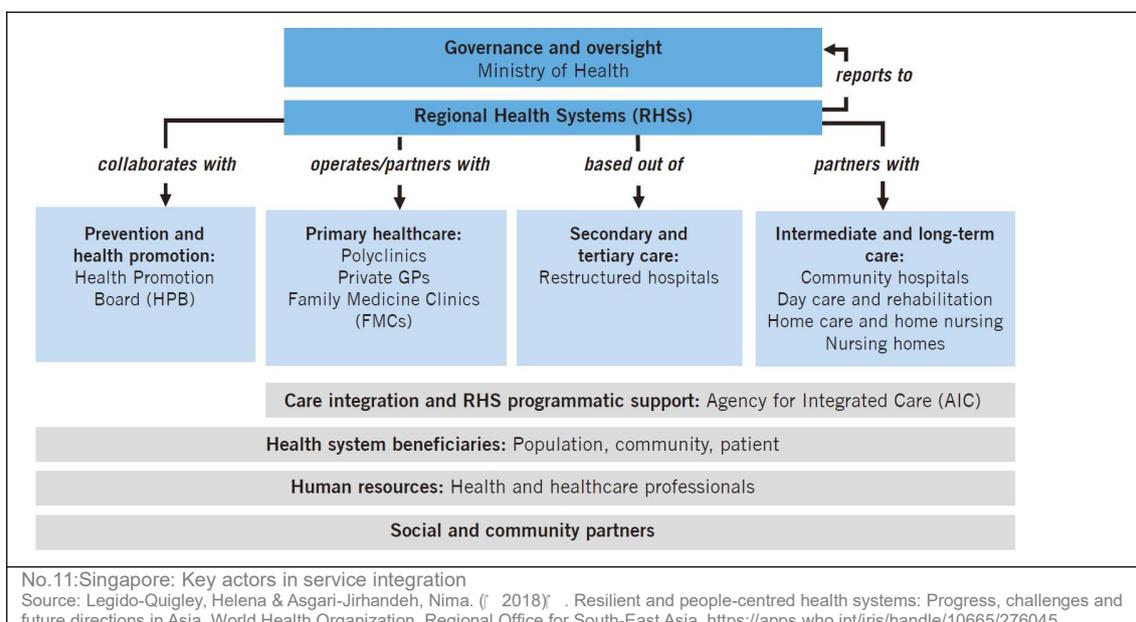


Specifically, primary-level treatment is provided by a wide range of private clinics in

various communities, mainly responsible for both preventive health care and health education. Hospital care is provided by seven public hospitals and six national specialist centers, representing the highest level of care in Singapore. Intermediate long-term care refers to a range of medical services required by hospitalized patients after their condition has stabilized, usually provided by civil society and private institutions.

A medical cluster with public hospitals as the core, surrounding polyclinics, community hospitals and nursing homes as the support is established. The cluster will integrate services, transfer services, share equipment, beds and electronic medical records, and give play to the comprehensive effect and economies of scale. These measures improve the efficiency of medical services and ensure the rational allocation of medical resources.

In order to avoid the waste of medical resources, the Singapore government uses administrative means and price leverage to divert patients with different medical needs. Generally speaking, if the patient does not need a first aid treatment, the doctor usually goes to the community private clinic or the community medical service institution that provides primary treatment first. Only when patients suffer from serious diseases, they can be transferred to larger public hospitals for treatment through the advice of doctors. For this reason, crowded queues are hard to see in Singapore's large hospitals.



2. Public Health Preparedness Clinic (PHPC)

The public health preparedness clinics program consolidates the response of primary health clinics to public health emergencies such as influenza pandemics, smog and anthrax into a single plan to enhance management. The smog allowance scheme has also been included in the public transport subsidy scheme. Although PHPC plays different roles in different threats, its general function is the same, to provide basic medical services to Singaporeans when the country needs.

As PHPC, when activated in a public health emergency, the clinic will be responsible for performing one or more of the following roles: dispensing drugs (e.g., Tamiflu, antibiotics), administering vaccines (e.g., influenza vaccines), and providing subsidized treatment (e.g., HSS).

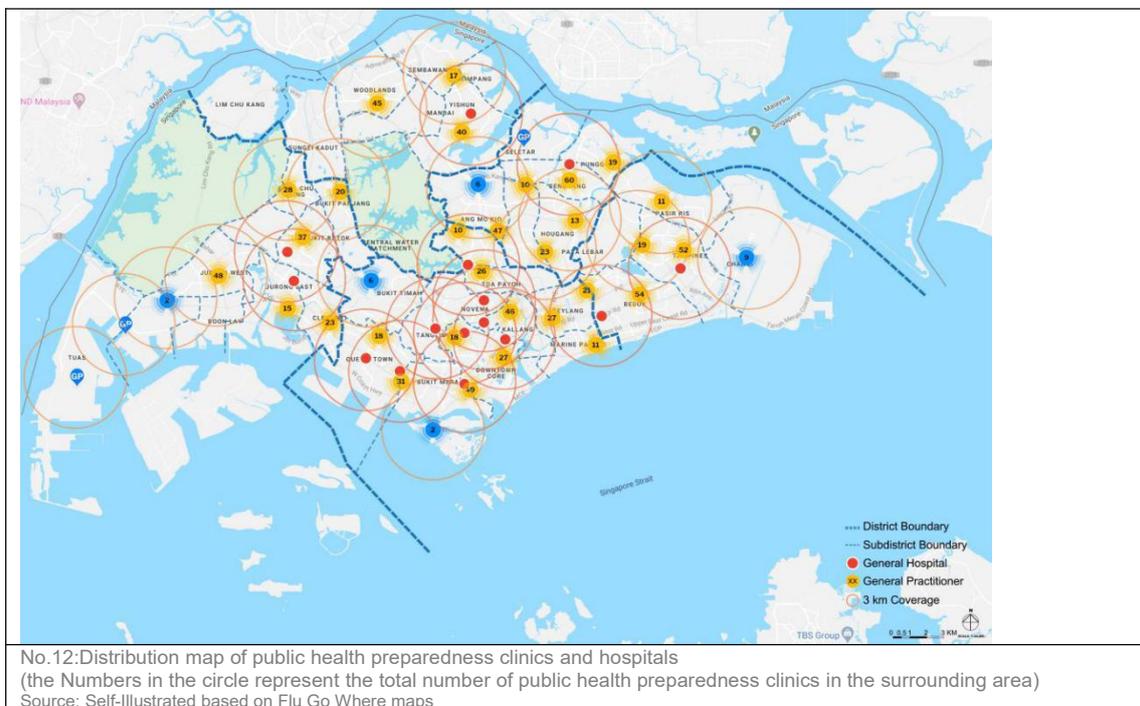
The ministry of health will provide logistical support (i.e., personal protective equipment and staff precautions) to the participating clinics to ensure adequate protection of doctors and clinic staff in the event of a public health emergency. In time of peace, training will be provided to PHPC to help them prepare for their role in public health emergencies.

As of March 9, 2020, there are a total of 905 public health preparedness clinics in Singapore, including 20 polyclinics and 885 private clinics (GPs). During this pneumonia outbreak, public health preparedness clinics played a huge role on the front line. Starting from 18 February, the public health preparedness clinic will gradually start working to care for patients with respiratory symptoms such as fever, cough, sore throat and runny nose. Patients with suspected pneumonia will be transferred to the hospital for further care.

3. City level

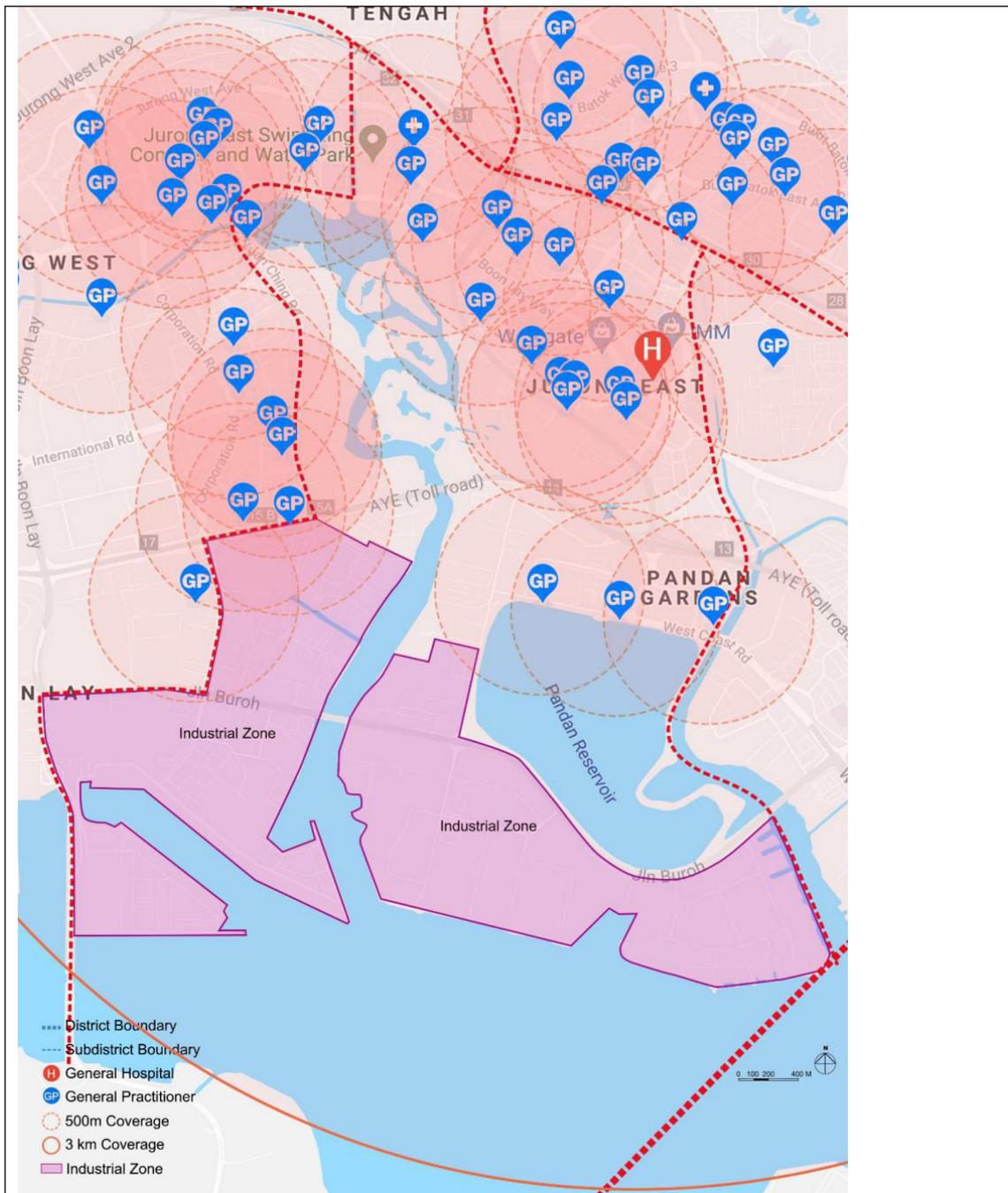
Singapore is known as a "city state". It covers an area of 719.1 km², about one-tenth the size of Shanghai.

Based on the distribution of public health preparedness clinics and hospitals and land use, it can be seen that except for large unoccupied open spaces, waters, strategic reserves and port land, Singapore's public health preparedness clinics basically cover all other areas and the density is positively related to the proportion of residential land in the area. There are also 1 or 2 clinics in the industrial park. Overall, an urban medical space network with general hospitals as the center and a relatively even distribution of primary-level clinics has been formed.



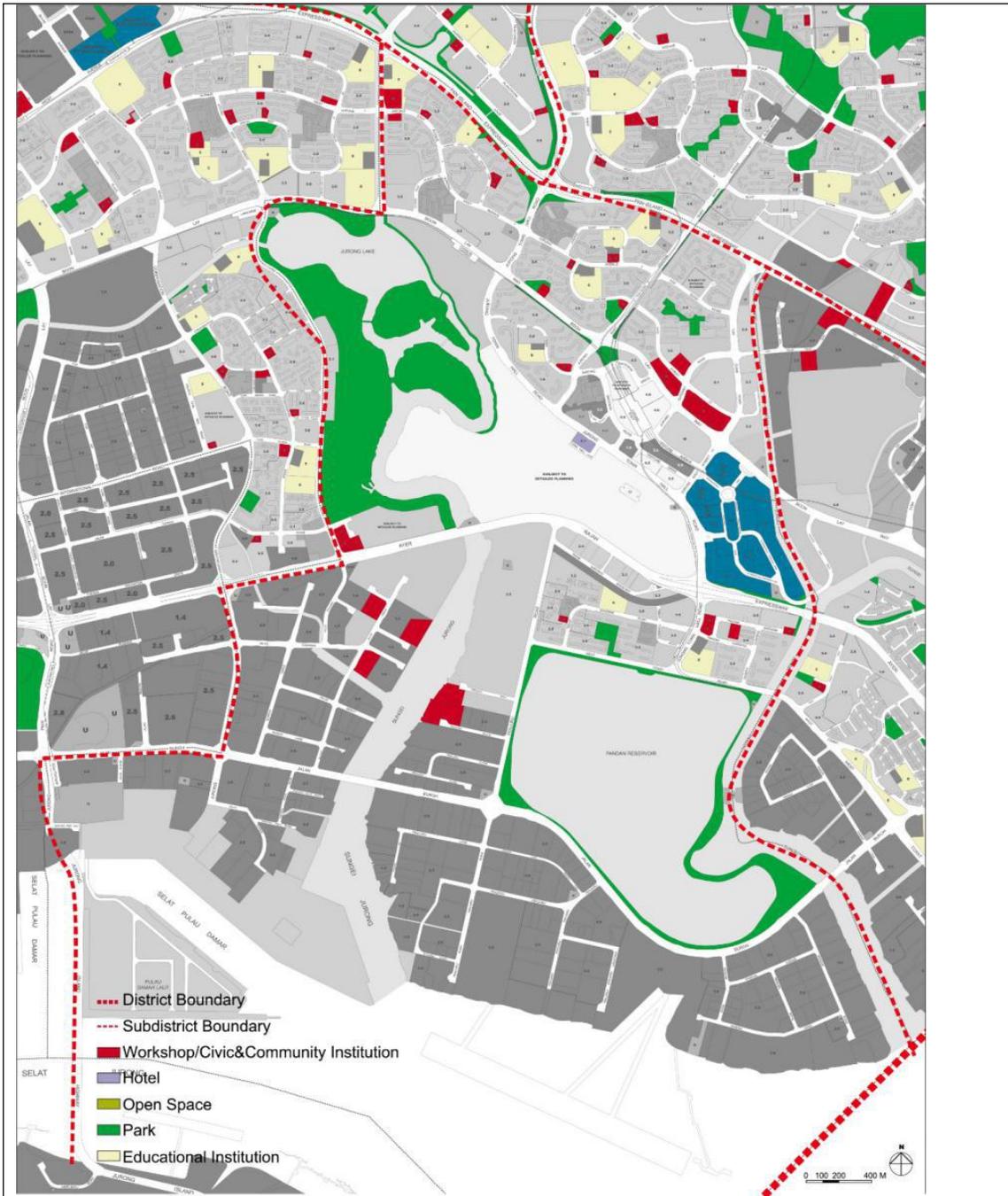
4. Area and community level

Take Jurong East in Singapore for example. Jurong East is part of the new town of Jurong. The area is equipped with 16 public health prevention clinics and 1 general hospital. Except for the southern industrial park, the rest of the community is covered by a 500m service circle. There are sufficient medical facilities in the area, which can form an EPA bounded by a single community, and general hospitals can also treat confirmed cases. This area is very complete as an epidemic prevention area medical system.



No.13: Distribution of public health preparedness clinics and hospitals in Jurong East, Singapore
 Source: Self-Illustrated based on Flu Go Where maps

In terms of land use, community units centered on public services are equipped with high-quality open green spaces, commercial services, and medical services. There are large-scale public facilities such as Jurong Lake Park, Singapore Science Museum and commercial storage land in the area. Although the current outbreak of new crown pneumonia in Singapore does not exceed the upper limit of existing medical resources, it is certain that this land configuration can provide sufficient space for temporary medical facilities, storage of medical or living supplies in extreme cases. At the same time, the Jurong East Area is adjacent to Singapore's largest industrial park. Industry can provide protection for the production of materials during the epidemic prevention period. The regional transportation hub Jurong East Station also provides guarantee for the transportation of these materials to other areas of the city.



No.14: Distribution of public services and open space in Jurong East, Singapore
 Source: URA-Urban Redevelopment Authority- <https://www.ura.gov.sg/maps/?service=MP#>

Take the 37th confirmed case to explain how the network of medical facilities work. Case 37 is a 53-year-old Singaporean who worked as a private-hire car driver and lives at Jurong East Street 32. He reported symptoms on January 30 and visited two GP clinics on February 1 and 3. He entered to Ng Teng Fong General Hospital on February 6 for treatment and was transferred to the National Infectious Diseases Centre (NCID) of Singapore two days later with a positive test for a new coronavirus.



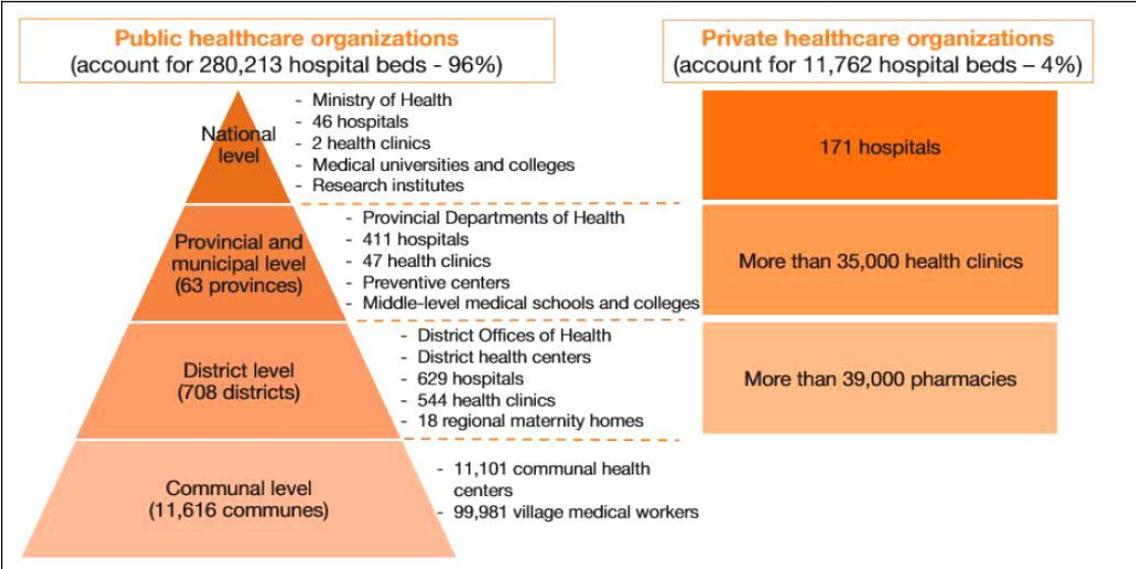
No.15: Pathways for the 37th confirmed patient
 Source: Self-illustrated based on Google Maps

As this patient had no connection with previous cases or recent travel history to China, as a Singapore citizen, he strictly abided by Singapore's medical triage system. When the symptoms were not serious, he went to the nearest GP clinic and the community doctors reported this case through administrative levels. This allowed the primary-level clinic to play a role as a gatekeeper for epidemic prevention.

International Case 2: Vietnam

1. Vietnam healthcare system

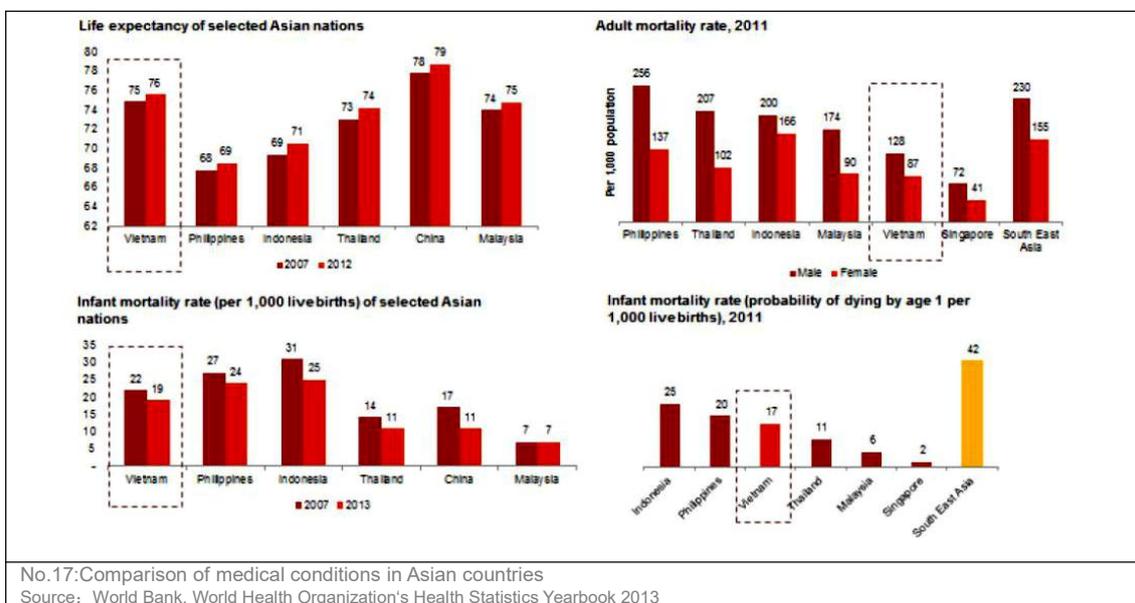
Vietnam's healthcare system consists of national, provincial and district health centers (DHCS) and communal health centers (CHCs). The national level is the Ministry of health and national hospitals; the provincial level includes the Provincial Department of health and provincial hospitals. Meanwhile, Vietnam has a large number of private medical institutions, including private hospitals, private clinics and private pharmacies.



No.16: Vietnam's public and private healthcare systems
 Source: Ministry of health, 2017

The Vietnamese government attaches great importance to the establishment of a fair and effective health system to achieve the national health coverage and sustainable development goals (SDGs), gives priority to strengthening the capacity of primary health services, and strives to provide better primary health care services.

According to the World Bank, Vietnam's per capita GDP ranked 135th in the world in 2013. Nevertheless, compared with other Southeast Asian countries, the overall quality of care, especially the quality of basic level care, seems surprisingly good.



No.17: Comparison of medical conditions in Asian countries
Source: World Bank, World Health Organization's Health Statistics Yearbook 2013

2. Communal Health Centers (CHCs)

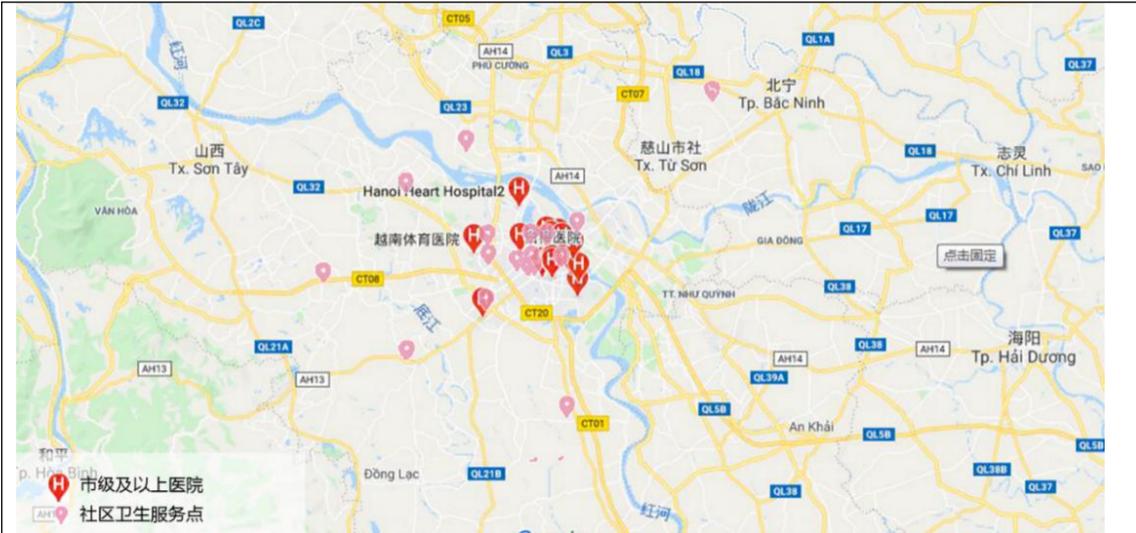
In most developed countries, general practitioners or primary care practitioners, including family doctors, serve people at the community level and play an effective role. In Vietnam, this is the role of communal health centers (CHCs). Each CHC serves 5000-10,000 people.

As the first technical hygiene level in Vietnam's healthcare system, CHC plays the role of "gatekeeper". It provides inspection and treatment of common diseases (such as upper respiratory infections, diarrhea, superficial wound closure), prenatal and postnatal care. CHC can cope with most of people's needs for primary health care. If there is an unmanageable condition, the community clinic reports to a superior hospital-DHC provides inpatient services for the patients, tertiary care is provided by provincial hospitals, the country hospital is the fourth level of referral center.

3. City level

Hanoi is the capital of Vietnam and the second largest city in Vietnam. It is located in the Red River Delta in northern Vietnam, with an area of 3340 square kilometers and a population of 7.56 million. Hanoi is divided into 12 urban areas, 17 suburbs, and 1 district-level town. The proportion of urban area is small.

Based on the distribution of hospitals and communal health centers, it can be seen that the hospitals in Hanoi are mainly concentrated in urban areas, and the communal health centers are distributed along the main road with the city center as the core, and the number is positively related to the population density. On the whole, an urban medical space network centered on general hospitals and radiant coverage of communal health centers has been formed. This layout model is also in line with Vietnam's national conditions as a developing country.



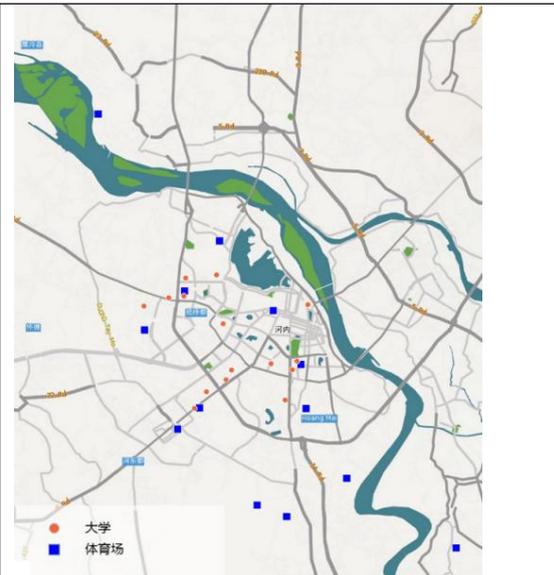
No.18: Distribution map of community health service points (CHCs) and hospitals in Hanoi
 Source: Self-illustrated based on Google Maps

4. Area and community level

Taking the urban area as an example, the communal health center serves as the first line of defense for nearby residents, and if a suspected case is found, it is quickly referred to a superior hospital. According to the official website of the Ministry of Health of Vietnam, there are 8 confirmed cases in Hanoi (all of which have now been cured), which are scattered and treated in 7 hospitals to ensure adequate equipment for treating patients. Hanoi's universities and large venues are evenly distributed and have a wide coverage. Even if the epidemic spreads, they have better location conditions to transform into emergency medical venues such as mobile cabin hospitals.



No.19: Distribution map of community health service points (CHCs) and hospitals in Hanoi city
 Source: Self-illustrated based on Google Maps



No.20: Distribution map of universities and large venues in Hanoi
 Source: Self-illustrated based on Google Maps

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