

Epidemic Prevention Evaluation and Improvement Measures of Urban Hospitals: A Case Study of Two Wuhan Hospitals

Xinren Zhang^{1,*†}, Yulai Ji^{2,†}, Wangneng Shi^{3,†}

¹The Bartlett Centre For Advanced Spatial Analysis, University College London, London WC1E 6BT, United Kingdom

²Architecture and Building Environment, University of Nottingham, Nottingham NG9 2GG, United Kingdom

³ Cheung Kong School of Art & Design, Shantou University, Shantou 515000, China

*Corresponding author. Email: ucfnxz1@ucl.ac.uk

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1. Introduction

In early 2020, a huge infection, COVID-19, swept through the globe. During that earliest and most serious COVID-19 period, the Chinese were required for home quarantine. The country was in a mass, people could not go out to buy groceries, masks had to be looted, and even entire cities were closed off to entry and exit. Cities cannot manage to respond quickly to stress, or urban resilience, specifically the speed with which a city responds to stress and can recover when it is over. People's quality of life has plummeted due to the lack of resilience in cities.

The worst part of the city is the hospitals, where the number of infected patients far exceeds the maximum number, that hospitals can take in. Because of the widespread infection, the hospitals cannot accept any other patients. With critical healthcare services affected in 90% of the world's countries, even the strongest healthcare systems are having a hard time with the outbreak [1-2].

With increased awareness of viruses, hospitals are gradually building their response systems to the outbreak[3]. This includes the transition from the usual situation when an outbreak resumes in a city. Most hospitals have set up a basic incoming primary screening, more infectious isolation wards, and extensive sterilization systems.

However, most hospitals are still at a relatively low level of epidemic preparedness and will have difficulty accepting general patients in the event of a resurgence. Two examples were found to be excellent, which are the Wuhan Changfu Hospital (WCH) and Wuhan Tongji Space City Hospital (WTSCH). They are more advanced hospitals, most notably in terms of the combination of normal and epidemic. This study firstly conducts a nationwide study to assess residents' satisfaction with the hospitals to reflect the current situation of hospital construction in China. By analyzing the

measurements of WCH and WTSCH hospitals responding to the epidemic, this study summarizes their strengths and weaknesses and provides some suggestions for other urban hospitals.

2. Methods

2.1 Case selection

WCH and WTSCH are selected as case studies for comparison and analysis of the utilization of the natural environment against the epidemic during the rapid spread of COVID-19. How to switch smoothly between the daily state and the emergency state in the hospitals to meet both the needs and experiences of patients during special times is also investigated.

2.2 Questionnaire design

In order to investigate the citizens' expression of hospital emergency plans and their recommendations during the COVID-19 period, an online survey was carried out using the "Questionnaire Star" through social media and professional networks. Overall, the survey focuses on the attitudes of citizens toward hospital management measures.

A total of 292 valid questionnaires were received after being screened. The questionnaire consists of three main sections and is administered to Chinese residents for a period of two months starting from January 2022.

The first part of the survey contains socio-demographic aspects such as age and the main occupation of the respondents (items 1-3, Table 1). The second part is about the basic conditions of urban hospitals (items 4-9, Table 1). It discusses people's satisfaction with the hospital environment and infrastructure during COVID-19 to provide basic data on how to build resilient hospitals.

The last part mainly focuses on people's demands for hospital infrastructure and emergency measures (items 10-18, Table 1). For example, item 11 aims at how to improve the environment and services for access to health care during COVID-19, with citizens' demands and suggestions as a priority for improving hospital resilience. Item 13 explores public perceptions and demands for hospital parking facilities to meet the increased demand for parking spaces resulting from the growth in private car traffic. Item 15 aims to explore the nuisance of waiting queues in the context of community distance requirements to improve the public's experience of access to care. Item 17 aims to explore ways to improve the transparency and speed of information dissemination in the face of the information lag caused by the quarantine policy.

Table 1. Questionnaire specifics

Item	Questions
Part 1 of socio-demographic aspects	
1	What is your address?
2	How old are you?
3	What is your current occupation?
Part 2 of the basic situation of urban hospitals	
4	Are the hospitals in your city fully equipped with admission triage screening, temperature measurement and other facilities?
5	Are the signs for the department you are going to clearly marked and are the aisles clearly marked?
6	Is there a social distance requirement for densely populated areas of hospitals in your city?
7	Does your city have direct access to nucleic acid sites by high speed rail or airport?

8	Are there enough hospital nucleic acid testing sites in your city?
9	Is there a shortage of medical staff in your city?(e.g. having to wait too long due to lack of medical staff)
Part 3 of people's satisfaction and appeals	
10	Are you satisfied with the environment and facilities of the hospital in your city (including the greenery near the hospital and the sanitation inside the hospital)
11	Do you have any experience of poor hospital environment and facilities, or do you have a complaint?
12	Are you satisfied with the traffic and parking situation of hospitals in your city? (including parking efficiency, parking space, traffic near hospitals)
13	Do you have any experience of the hospital traffic and parking situation, or do you have any expectations or requests?
14	Are you satisfied with the queuing time at the hospital in your city? (including offline queuing time, time for appointment, waiting time for report)
15	Do you have a poor experience of queuing times at hospitals, or do you have any expectations or complaints?
16	Are you satisfied with the disclosure of information about your hospital? (including hospital reporting of new cases, disclosure of information about adjustments to hospital consultation or appointment times)
17	Do you have any poor experience of hospital information disclosure, or do you have any expectations or requests?
18	Do you have any poor experience of hospital information disclosure, or do you have any expectations or requests?

3. Results

These respondents cover most of the Chinese cities such as Jiangsu province, Guizhou province, and Zhejiang province (Figure 1). Most respondents are aged between 18 and 24, followed by 41–50 (Figure 2).

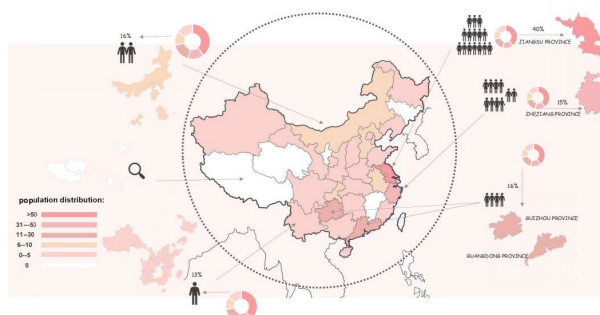


Figure 1 Locations of survey respondents

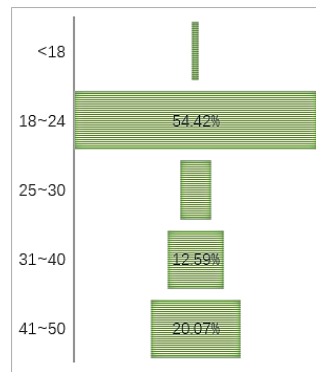


Figure 2 Age distribution of survey respondents

Students account for the largest proportion (57.14%, Figure 3). Second are enterprise managers (including grass-roots and middle and senior managers) and ordinary workers (factory worker/manual laborer; Figure 3).

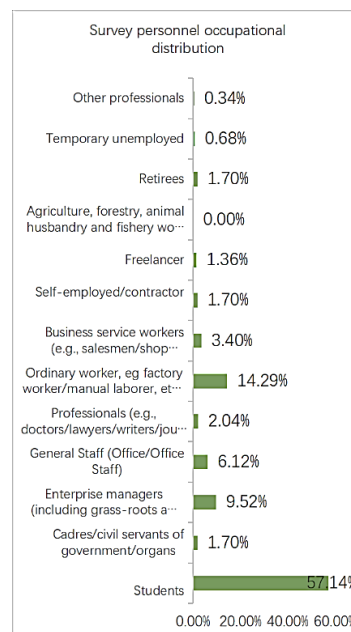


Figure 3 Survey personnel occupational distribution

Table 2 shows two parts of the questionnaire content, one part is the investigation of the basic situation of urban hospitals and the other part is about people's satisfaction and appeals. The first three rows of the table show the first part, and the rest of the lines are all about the second part (Table 2).

Table2. Statistics on the level of satisfaction with related issues

Questions	Satisfactory	Need to improve	Unsatisfying
Admission triage measures	85.71%	6.13%	8.16%
Indication in hospital	83.67%	13.27%	3.06%
Social distancing requirement	75.51%	17.35%	2.38%
High-speed rail and airport direct facilities to nucleic acid sites	72.79%	19.39%	7.82%
Nucleic acid testing sites	85.37%	9.86%	0.86%
Waiting time for medical treatment	64.63%	27.55%	0.86%
The queuing time in an urban hospital	67.34%	27.22%	5.44%

The surrounding greening situation and internal sanitary conditions of the hospital	53.74%	33.67%	1.02%
The traffic and parking conditions of the hospital	58.16%	35.72%	6.12%
The disclosure of hospital information	81.63%	16.33%	2.04%

As for the basic situation of urban hospitals, the results of the questionnaire show that 85.71% of respondents are satisfied with the admission triage measures, 83.67% of respondents are pleased with the indication in the hospital, and 75.51% of respondents are content with social distancing requirement (Figure 4).

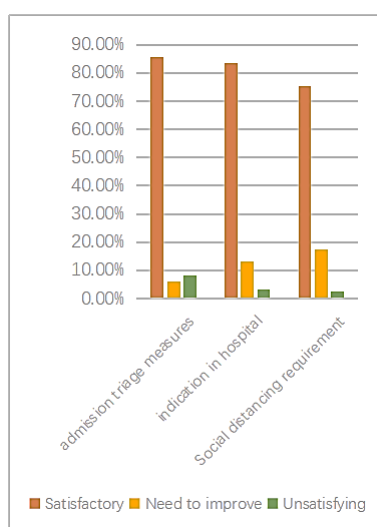


Figure 4 Satisfaction level with the situation in urban hospitals

Nevertheless, the second part of the questionnaires is about people's satisfaction and appeals. Only 53.74% of respondents have a good impression of the surrounding greening situation and internal sanitary conditions of the hospital, and then about one-third of respondents had the desire to improve the surroundings and conditions. The traffic and parking conditions of the hospital are two aspects that people are not very happy with. Compared with other aspects, 35.72% think traffic and parking need to be improved, accounting for the largest proportion in questionnaires. Whether queuing time in urban hospitals or waiting time for medical treatment, almost a third of people think spending time in the hospital is a problem that needs to be solved (Figure 5).

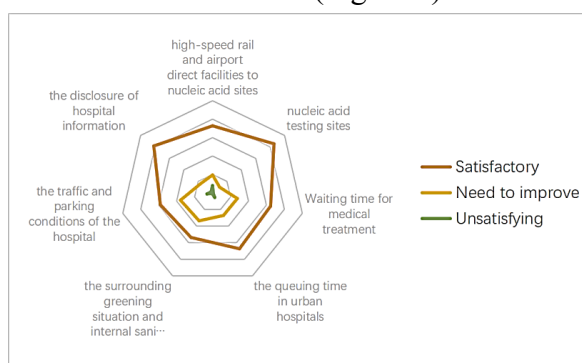


Figure 5 Summary of people's satisfaction and demands

At the end of the questionnaire, the respondents' suggestions to exhibit the grievances and appeals of investigators are collected. These suggestions are mainly about four aspects, environment and facilities, parking problems, hospital queuing time, and information disclosure. The detailed recommendations include the distribution of the monitoring sites reasonably, an increase of the bus or subway direct to the hospital, reduce of the queuing time in hospital facilities, improvement of the call system, as well as some improvements to the function of the hospital online APP, the clarification

of the indication signs of the hospital departments and passages, the design and management of the hospital parking lot, the mobile phone booking and queuing functions, the triage treatment of hospitals, and hospital online booking procedures (Figure 6).

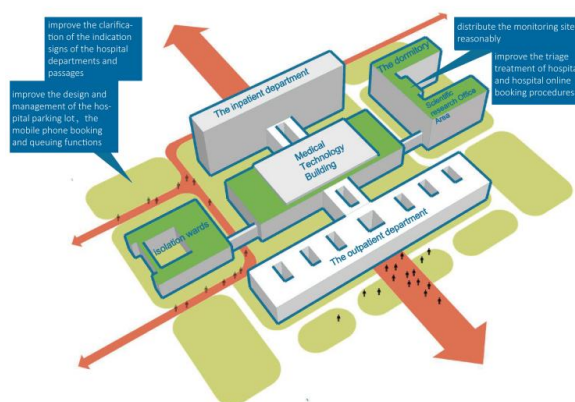


Figure 6 The main demands of the survey respondents on the hospital

4. Discussion

4.1 Evaluation of Wuhan Space City Hospital and Wuhan Changfu Hospital

WCH and WTSCH are two hospitals that were renovated after the epidemic. They have a lot of advantages in common. For example, both hospitals were renovated after the epidemic had stabilised. After recognising the importance of the infection unit, they were transformed into a ready-to-go battleground against the epidemic. All these benefits can enhance the resilience of the city and more of these hospitals could help make the city a better place.

The improvements to medical facilities adapting to both the epidemic and non-epidemic periods are the commonality and the greatest strength of WCH and WTSCH. In addition to the fixed beds in the infectious disease wing, the other general beds in both hospitals can be quickly converted into infectious disease rooms. It means that for both hospitals, a total of 1,000 infectious disease beds can be converted throughout the hospital in time to meet the treatment capacity required for the highest-level response to a public health event in the event of an epidemic. Likewise, they would achieve different responses for different scales of epidemics, calling on appropriate general wards for use as infection units, achieving cascading prevention and control, and responding flexibly to different levels of emergencies[4-5].

The use of the surrounding environment to improve hospital performance is a unique advantage of WTSCH. Lots of green areas between the buildings are used for separation, which is to prevent the rapid spread of the virus between each building during the epidemic period. In non-epidemic times, the natural environment would be seen as an environmental improvement. However, in the epidemic period, it can instantly become a barrier to the virus, which is a testament to the resilience of the city. At the same time, a courtyard with natural ventilation and lighting is placed in the medical street, and passive ventilation technology could be used to improve the medical treatment environment in the medical area. Maximizing the use of natural resources to reduce cross-infection in mechanical ventilation ducts is a sensible approach during the epidemic period. It indicates that the hospital could quickly turn into a major battleground for the infection department during the pandemic, and recover after the pandemic, increasing the resilience of the city.

In addition to utilising the environment, adapting to it is also important to the design, and WCH has this outstanding merit. The whole design of WCH follows the function of buildings, creating a rich facade image and a multi-dimensional combination of courtyard spaces. At the same time, the overall building is matched with the colours of the surrounding green landscape, forming the main colour palette of blue, white, and green, closer to nature and more harmonious and integrated.

4.2 Problems of urban hospitals

In the survey on the basic conditions of urban hospitals, respondents are dissatisfied with admission triage screening, comprehensive consultation facilities, clarity of department and access signs, social distance requirements in densely populated areas of hospitals, adequacy of nucleic acid points, adequacy of medical and nursing staff. It indicates that the hospital environment and facilities could be improved to cope with emergencies and the hospital's resilience.

In the question on public satisfaction with hospitals, survey respondents' expectations and demands for urban hospitals were mainly focused on hospital environment and facilities, transportation and parking, queuing time and information disclosure. There are two main reasons leading to these problems. Firstly, there is a lot of overcrowding in hospitals and they are unable to cope with rapid outbreaks of epidemics. Secondly, the initial design plans did not allow for emergency space, resulting in hospitals being unable to meet the requirements of special times. This indicates that existing urban hospitals are unable to respond to sudden epidemic outbreaks in a timely manner with the available facilities and space. Therefore, this study focuses on the above four issues, with two reasons as the starting point to make recommendations and strategies for hospitals to improve their ability to handle emergencies.

4.3 Suggestions for improvement of hospitals

Based on the advantages of the WCH and WTSCH as well as the survey results, it is proposed that urban hospitals can consider building ecological car parks (Figure 7). It could be used as an alternative site to the 'medical white space' as a quarantine zone or isolation zone during special periods, so that relevant isolation facilities can be built on the site if necessary and different areas can be divided for control.

Considering the reasonable and forward layout of the WTSCH responding to emergencies, the urban hospital could be divided into three zones with two axes[4]. Horizontally, the hospital is divided into three zones: the isolation zone, the main medical zone and the administrative and logistical zone, each of which can be interconnected and separated by ecological isolation zones. Vertically, they are linked together and the inpatient and outpatient departments are separated to reduce the risk of infection. In addition, the inpatient and outpatient departments are separated to reduce the risk of infection. The infection wing and the emergency department are planned in adjacent sites to facilitate the timely transfer of pre-screened febrile patients and reduce the risk of cross-infection. This layout allows for the gradual opening or closing of different areas according to the epidemic situation, allowing for flexibility in responding to different levels of emergencies[6]. Depending on the condition of the hospital and the prevention and control policy, urban hospitals could be planned and constructed in a more detailed and rational way, based on the specific geography, size of the site, and surrounding conditions. Finally, the case study of WTSCH shows that its passive ventilation technology plays a crucial role in improving the air quality in hospitals, so urban hospitals could also focus on the design of natural ventilation corridors, which not only improve the medical environment but also beautify the hospital environment and relieve the emotions of patients and doctors.

According to the questionnaire results, some respondents were dissatisfied with the hospital isolation measures and online services. Based on the questions, measures such as online consultation, regional isolation and epidemic priority were mainly proposed to ease the pressure of clinical work[7], reduce cross-infection and enhance protective measures for high-risk individuals. Firstly, public hospital information and related health promotion were improved and updated to facilitate patients' timely access to medical and health information. Also, the online clinics and web-based consultations is proposed to facilitate patient registration, consultation and rationalisation of consultation times and reduce the number of people gathering in hospitals. Secondly, temporary classification and segregation of areas are established. Patients should be pre-screened for proper triage, different protective measures should be taken for different departments to reduce the risk of cross-infection and patient waiting time. A fast and effective green channel should be established for the symptomatic treatment of suspected patients to reduce the risk of infection. Thirdly, the hospital chain of command

should be improved and strengthened, and an effective coordination and allocation policy should be implemented. For example, priority should be given to providing personal protective equipment and devices for health care workers in the emergency department and hyperthermia unit to protect staff safety[8].

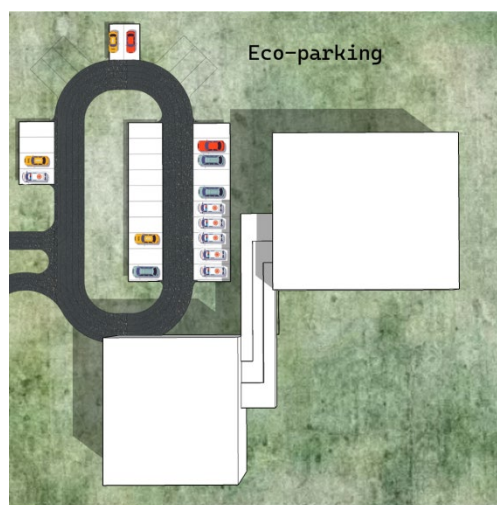


Figure 7 Ecological car park conversion plan

5. Conclusion

The study was conducted through an online questionnaire on the level of satisfaction of Chinese citizens with the environment and infrastructure of urban hospitals. In the first part of the study, the questionnaire data is processed and analysed and the citizens' suggestions for urban hospitals are summarised. In the second part of the study, detailed analysis and comparison are made between the WCH and WTSCH in terms of the adjustments and advantages of the hospital environment and facilities in the post-epidemic era, so that hospitals can better respond to infectious diseases while maximizing the protection of health care workers and patients. It concludes with recommendations for the post-epidemic era, both in terms of suggestions from survey respondents and in terms of learning from the strengths of WCH and WTSCH.

The great thing about WCH and WTSCH is that they are ready to transform from ordinary hospitals into epidemic-fighting hospitals, based on their unique design. In the same way that WTSCH makes maximum use of daylight and natural ventilation, the design of WCH to adapt to nature is a reflection of sustainable architecture and improves significantly to the resilience of the city. It is worthwhile to be widely used in the construction of future hospitals.

By analysing the questionnaires and summarising the advantages of WCH and WTSCH, strategies for improving the environment and infrastructure of today's urban hospitals are proposed in the face of infectious diseases. There is no doubt that in the post-epidemic era, through an intensive layout and the creation of ecological car parks as natural isolation zones and ventilation corridors. Urban hospitals can not only maximise their daily duties, but also serve as places for emergency command, triage screening, non-contact nucleic acid testing, and other compatible infection buildings in the event of an epidemic[9]. In short, hospital emergency plans are one of the particularly important protective measures in special times. It can reduce the workload of health care workers while protecting them, and be effective in controlling transmission and infection in the event of an outbreak similar to COVID-19. Improving the resilience of hospitals is a very important aspect as an improvement to the resilience of cities.

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