A Preliminary Study on the Architectural Design of Chinese Hospitals in Virus Era

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Abstract. After the new Corona Virus Disease 2019 (COVID-2019), we have many new ideas for architectural design, more emphasis on epidemic prevention issues, designers in the functional design to meet the needs of medical staff and patients to use the design of the hospital, The assembly of hospital buildings is not only a transformation of construction methods, but also an upgrade of design concepts, which is a direction for future hospital development.

1. Integrated form
At the end of 2019, a sudden outbreak of a new Corona Virus Disease 2019 (COVID-2019) broke out, and the Chinese people actively participated in the work of epidemic prevention. The outbreak of infectious diseases has become an enemy that all mankind needs to face together. It has changed the development of many industries, as well as people's ideology and social habits. The threat of the global outbreak of the virus epidemic has led to the reform of medical architecture and its interior design in China.

During the outbreak of the COVID-2019, Wuhan’s "vulcan mountain" and "Raytheon mountain" hospitals rose rapidly, and prefabricated buildings provided a new option for the construction or expansion of the hospitals. The future hospital will be based on the national building development policy and the nature of the hospital building itself, gradually mature and in-depth development, the functional space of hospital building will be constantly subdivided, forming a specific medical behavior, the standard mode of inherent space. In the future, hospital buildings will develop towards the direction of integration, modularization and customization.

1.1. Formatting author names
In order to cope with the sudden outbreak of major infectious diseases, temporary emergency infection hospitals should be built quickly in an integrated way. Integrated buildings produced by factories can be adopted to meet the requirements of rapid on-site assembly. The quality of parts produced by the factory is guaranteed, which can effectively reduce construction errors. The inside part of industrialization of interchangeability and commonality, easy maintenance and repair replacement.

The hospital building is composed of numerous medical functional units, including emergency department, outpatient department, inpatient department, medical technology department, security system, administrative management and hospital living room and other seven facilities. Each specific internal medical space becomes a whole module, and a specific internal medical space is formed. The internal installation system of integrated hospital building includes: light partition wall, integrated ceiling, overhead floor, integrated toilet, integrated furniture, integrated storage, integrated pipeline, etc. The integrated type toilet is produced by the factory floors, walls (plate) suspended ceiling and sanitary equipment and pipeline integration design etc., and mainly USES the dry method of assembly
into the toilet. Integrated bathroom overhead floor, ceiling and side wall with structural plate and side wall has a space, in overhead floor laid drainage pipe, electrical piping, equipment installed in the ceiling and partition wall space and air duct, etc.[1]

1.2. Modular
In the period when the government promotes prefab building, prefab hospital will be an important development direction of hospital building. Modular building refers to the prefabricated building which is assembled on the construction site with factory-prefabricated integration modules. The building unit is prefabricated in the factory and is a three-dimensional space body with integrated functions, which is composed of main structure, floor slab, wall slab, ceiling, equipment pipeline and inner parts, and meets various building performance requirements and hoisting and transportation performance requirements. The basic modules of a modular building are generally 3m*6m, with the basic modules as the combined standardized unit. According to the construction scale and site, different spatial combination planes are formed through the splicing and combination of different modules to meet the needs of medical functions. For example, Integrated MEP integration is the modular mechanical and electrical pipeline, with keel frame and then with water, electricity and heat professional pipeline layout of the composition of modular prefabricated parts, this technology not only helps to shape the space, and can avoid the collision of each installed pipeline, in the United States hospital building application is wide. Hospitals in China are widely used in the construction of joint bridge is integrated MEP keel module in the system.

1.3. Modular
The hygiene and health plan clearly points out the need to strengthen the construction of clinical service capacity. The state should strengthen the planning, guidance and support for the development of clinical specialties, and enhance the overall service capacity and level of clinical specialties. China to strengthen clinical key specialty construction, aiming at developing high-quality medical resources, construction of a batch of high level clinical specialist, key support fever clinics, tumor, cardiovascular, pediatrics, spirit, infection, such as maternity key specialty diagnosis and treatment, improve the capacity of weak areas play a demonstration, lead, driving and radiating effect, promote the coordinated development of health service system. Aimed at the status and development of provincial college needs to strengthen the construction of weak specialty ability, increase the high quality medical resources, promote specialized comprehensive service ability. In the recent outbreak of the new epidemic, the hospital is more acute due to the characteristics of infectious diseases. The hospital will combine its own medical characteristics to determine its own suitable architectural form, and the development direction of the hospital construction will be the professional and personalized building in line with its own medical characteristics[2].

2. Interior design of anti-epidemic hospital building
After the outbreak, the interior space design of the hospital should gradually return to the functional design, and how to avoid the infection during the visit will become the core of the hospital design.

2.1. Essentials of hospital entrance and exit design
In the indoor space of the entrance of the hospital, we should add temporary space or multi-barrier measures to make preparation, which will change the design mode of the public space in the medical room.

The hospital building space should be designed with a double-deck gantry to separate the main entrance of the crowd from the fire entrance, so as to provide guidance for the daily and emergency personnel; The main flow of people channel to avoid the direct connection of the door, to prevent the passage of drafts and harmful gases into the smooth; There should be a space for people to stop and turn around, so as to facilitate the congestion when a large number of people enter, and facilitate the detection of service personnel in the emergency period; The main entrance of personnel channel should
be designed as far as possible automatic door system, to prevent a large number of personnel to touch the cross infection; When possible, electronic infrared scanning and intelligent monitoring system can be added to facilitate personnel monitoring in emergency situations; Fully prepare for building indoor and outdoor safety first barrier, add the entrance automatic temperature measurement, joint entrance guard, ladder control, intelligent data collection report independently, automatic warning, background outbreak of big data analysis, key areas and key personnel control, etc.

Fever clinic was set up separately to avoid cross infection. The entrance design of fever clinic can refer to that of Japan during the epidemic. The front desk of fever clinic is completely closed. After ringing the bell, put the insurance certificate and written consultation form into the transparent folder in front of the window to avoid physical contact with the front desk staff. Patients can wait in their own car or, if they do not have a car, they will be arranged to wait in a separate room. The doctor calls the name of the patient through the wireless notification device. The front desk is a separate room, where patients are sterilized by ultraviolet rays, and nurses arrange patient testing by video phone in the room.

2.2. Operating room design points
First, the plane of the clean surgical department must be divided into clean area and non-clean area, and the contact between each other must be set up buffer room or transfer window. The second, the preparation room should be set as the buffer room at the entrance of the negative pressure operating room and the infection operating room, and the negative pressure operating room should have an independent entrance and exit. The third, when people, things with the elevator in the clean area, the elevator shaft and the non-clean area, the elevator exit must be set buffer room. The fourth, the air cleanliness level or bacterial concentration of a single index to replace the comprehensive performance of the comprehensive assessment of the test results may not be used to replace the comprehensive performance of the comprehensive assessment of the test results.
2.3. Hospital care area design points
The nursing area of the hospital is the most vulnerable place for doctor-patient infection, and the prevention and control of entrance and isolation should be considered. Separate isolation rooms should be added to nurses' stations to deal with patients with infectious diseases.

2.4. Medical waiting space design points
In the past, the waiting room of medical treatment emphasized the function of waiting for treatment once and neglected the function of waiting for treatment twice. Add medical intelligent information system and 5G technology to change the way of medical treatment, reduce and reduce the public space such as foyer and lobby where the original centralized entrance is connected with the main medical street, and solve traffic diversion through the function of decentralization, thus playing a role of temporary isolation zones for sudden infectious diseases. In the future, the waiting group can be divided according to the station-to-station system at a time of waiting for medical treatment, and more activity can be added to separate the seats of scattered staff and multi-barrier separation measures can be applied. The second waiting room is semi-open to facilitate air circulation, doctor-patient communication, prevention and treatment of cross-infection.

2.5. The design of the new office
After the outbreak of the epidemic, we should frequently use the flexible design mode of network, such as telecommuting, video conferencing, network management, BIM collaborative design, etc., breaking the previous work mode of on-site report, communication, cooperation and guidance. With the advent of 5G era and the collaborative office symbiosis system integrating data analysis and sharing, office collaboration will become a future trend. The new type of office has more functions and forms.

2.6. Other area design points
The design points of other departments and regions of the hospital include: whether the basic and local partitions are reasonable, and whether they can be effectively isolated; whether the various flows (processes) are correct; whether the corresponding functional areas are complete (including the ward, office, dressing and washing bathroom, toilet, cleaning room, garbage temporary storage area, buffer zone, the location of each entrance and exit, etc.); whether the basic facilities are in place, including ventilation and air purification facilities, disinfection facilities, hand hygiene facilities, etc.; Whether the important functional area area is sufficient, and has the appropriate reserved space, whether the main performance parameters meet the standards or meet the actual requirements, etc.

In special period, the hospital should set up anti-infection control station. Anti-infection control stations can be too large, but not in all parts of the hospital umbrellas, which are equipped with protective materials for people to use freely, have disinfectant masks, paper towels. Thereby reducing the risk of cross-infection.

3. Summary
After this outbreak, future laws and regulations will put more emphasis on epidemic prevention. Prefabricated hospital buildings are not only a change in the way of construction, but also an upgrade of the design concept under the outbreak. We architects should try our best to meet the standard requirements through flexible design, and meet the use needs of medical staff and patients, and at the same time more economical, not only for epidemic prevention, but also for normal use. In order to meet the requirements of future building system and component system, and build a long-life, high-quality green hospital, the design concept is an important direction of the development of the hospital building design in the future.
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