EXPERT COMMENTARY

# Planning and Designing General Hospitals in Smart Technology Contexts

Muqing Niu[1]

**Keywords**: New era; High quality hospitals; Planning and design; Life-cycle health care area; Coordinated development.

International Healthcare Review (online)
eISSN: 2795-5567
**How to Cite**
Niu, M. Planning and Designing General Hospitals in Smart Technology Contexts. International Healthcare Review (online). https://doi.org/10.56226/59
Published online: 16/May/2023


**Corresponding Author:**
Muqing Niu
Vice President, The First Affiliated Hospital, Henan University of Science and Technology.
Email: niumuqing@163.com

## ABSTRACT

Taking high-quality development of hospitals as the new era and the key health management direction, the paper draws lessons from advanced planning and design experience from an international perspective and discusses the construction of hospitals to be compliant, orderly, efficient and focusing on providing high quality care. The article formulates an overall strategy for the planning and development of the hospitals keeping in mind the whole life cycle based on current technological trends, practical, forward-looking and developmental space, as well as promote the organic integration of high-quality care and hospital buildings with the surrounding environment, so as to drive an overall coordinated development of the region where hospitals are located.

**Author's Affiliations:**
[1] Vice President, The First Affiliated Hospital, Henan University of Science and Technology, Luoyang, Henan, China

**What do we already know about this topic?**
By the end of the 20th century, hospital design and planning gradually evolved into an efficient approach that uses biological and clinical perspectives to understand life and emphasize the dynamic balance of health and disease. After entering the 21st century, with the introduction of the concept of the impact of comprehensive environment and impacts on physiological, psychological and social factors on human health and disease, the concept of ecological hospital has been gradually established.
**What is the main contribution to Evidence-Based Practice from this article?**
The article contributes to the international debate on Planning Smart Hospitals and related healthcare management challenges. Hospital Managers around the World get a fresh perspective on Planning and Design smart hospitals.
**What are your research's implications towards theory, practice, or policy?**
The planning and design of large general hospitals should undergo systematic changes in the new period. The trend of hospital design in the future

**Author' Contributions Statement:**
Muqing Niu conceptualized and wrote the whole article.

## INTRODUCTION

Large general hospitals in the New era Hospital is an overall concept [Qi, 2016]. It is an innovative, coordinated, green and intelligent hospital in line with the basic medical system of socialism with Chinese characteristics under the background of the new era, "Healthy China 2030", post-epidemic, new infrastructure and informatization and digitalization [Wang, 2008; Chen et al, 2022]. It covers the site, construction, construction equipment and medical equipment, hardware and software support system, operation and maintenance management, etc. (Zhao & Niu, 2022)

### 1 Future-oriented hospital planning model for the new era

The transformation process of hospital design concept: in the middle of the 20th century, was mainly a traditional hospital with scattered machinery, which mainly emphasized the function of medical treatment, ignored human emotion and took the disease as the foundation. By the end of the 20th century, it gradually developed into an efficient hospital that uses biological and medical perspectives to understand life and emphasizes the dynamic balance of health and disease. After entering the 21st century, with the introduction of the concept of the impact of comprehensive environment on physiological, psychological and social factors on human health and disease, the concept of ecological hospital has been gradually established.

The planning mode of hospitals in the new period can be divided into four forms [Liu, 2018;]: centralized, decentralized, centralized and decentralized comprehensive, and centralized+ modular unit.

Centralized+ unit modularization means that the units of various medical departments are modularized, and the departments of medical technology and service support are intensified and arranged in the core position of the hospital. By means of three-dimensional transportation organization [Ren, 2020], the unit modules of medical departments are connected with them. The form should be a radial, combined ring layout around the medical technology services and other departments, or a grid layout. At the same time, it is necessary to provide extended and expanded channels for the future development of the hospital.

For the urban center area with limited land use, centralized planning mode should be adopted. Outpatient departments, medical technology, hospitalization and logistics should be concentrated in one building. Related medical functions should be arranged around the functional core and transportation center. The problem of resource sharing among outpatient, inpatient and medical technology departments should be solved well. When the site is extremely tight or the hospital building is directly adjacent to the city road, the first floor can be raised to extend the entrance square to the inside of the building, so as to form a good transition between the hospital and the city.

The construction plan should be in accordance with a planning, overall construction or phased construction, reserved for development space. Near-and long-term comprehensive consideration, and mainly in the near future. On the premise of first meeting the recent basic requirements, attention should be paid to the growth

and evolution of hospital space, and strive to achieve a plan, phased implementation.

## 2 Planning ideas for hospitals in the new era facing urban space

The location of the main entrance of the hospital is coordinated with the urban spatial planning [Zhao Jie et al]. The location of the entrance and exit should avoid the urban main road, overpass, expressway and other roads with heavy traffic flow, and choose to arrange the entrance and exit on the urban secondary road with larger planning width.

The location of the main entrance of the hospital is as close as possible to the subway station, bus station and other public transport service facilities, which increases the dependence of hospital visitors on public transport, thus reducing the traffic flow and parking pressure of the hospital.

The planning of hospital parking facilities, people flow and traffic flow should be coordinated with the surrounding traffic outside the hospital and the medium and long term development planning of urban space.

## 3 Main ideas of hospital planning and design in the new era

### 3.1 Transportation organization in the hospital

Rationally set the direction and location of the entrance and exit of hospital projects [Zheng Jie, 2020]. Make full use of underground space, reasonable organization of traffic. Can use the pedestrian ground, car underground transportation mode. The garage entrance and exit are set close to the entrance and exit of the courtyard to reduce vehicles' walking through the courtyard. Ground vehicles should not exceed 20%. Emergency vehicle parking space should be provided at the entrance to emergency first aid.

Hospital circulation can be divided into three kinds of circulation, namely decontamination flow, doctor-patient flow and person-vehicle flow, and cross infection should be avoided. The partitions and medical rooms of the hospital should be equipped with obvious guiding signs to facilitate the quick diversion and evacuation of personnel. An entrance square should be set up at the outpatient, emergency and inpatient entrances as a buffer area for the admission of people. The planning of the streamline in the hospital should be for the purpose of realizing the integration of medical construction and clear technology, establishing multi-dimensional landscape and transportation organization, healing environment of ecology, science and education and humanity, and efficient, complete and plastic medical space.

### 3.2 Vertical design of the site

The design elevation of the site shall not be lower than the level of the city's designed flood control and waterlogging. The site can adopt flat slope type, step type, mixed type. When the natural terrain slope is less than 5%, it is appropriate to choose the flat slope; When the natural terrain slope is greater than 8%, it is appropriate to use the stepped type, and the platform joint should be set up retaining wall or slope protection. Important medical technology Settings and service support facilities should be planned as far as possible above the water level of the city's designed flood control and waterlogging, such as nuclear magnetic, transformer and distribution rooms. If it is really necessary to plan under the water level of the city designed for flood control and waterlogging prevention, special measures and plans must be taken to prevent flooding accidents.

Each unit module under the framework of general plan planning: the process design of main departments, namely the secondary process design [Li Guoxin, 2015; Lloyd Wiliams, 2022], is mainly to solve the relationship between each functional plate and each department. The three-level process design should solve the specific use process of departments and functional plates and rooms, including the main medical room design, at this time to coordinate with the structure, mechanical and electrical, plumbing professional, consider the factors of mutual constraints, to adjust the local room, these start from the preliminary design, continue to the construction drawing design stage, constantly adjust and optimize. The deepening design of medical special, including purification engineering, protection engineering, logistics system and other professional design should be carried out simultaneously.

### 3.3 Planning of building location

The planning of building location [Hu, 2015] should pay attention to the good orientation of main buildings, and the spacing of buildings should meet the requirements of health, sunshine, fire protection, lighting, ventilation and so on. The inpatient department should have good sunshine conditions and landscape vision, and the spacing between the front and back of the ward buildings should meet the requirements of sunshine and sanitary spacing, and should not be less than 12m. Natural lighting and

ventilation should be considered as far as possible in outpatient areas. When the morgue is set up independently, there should be enough space between it and the ward, kitchen and canteen. The residential area adjacent to the hospital must be separated and equipped with a separate entrance and exit. The infectious diseases department building and fever clinic were located downwind, which had the least impact on the hospital. The distance between the infected building and surrounding buildings was not less than 20m. It should be close to the emergency department and take into account the collaborative management of emergency. During the epidemic, it can operate independently and form its own zone in strict accordance with the design of "three zones and two channels". Reserve land for expansion nearby, and expand the emergency treatment ward when the epidemic occurs to meet the needs of treatment; Sewage from infected buildings is treated separately and discharged to the hospital sewage treatment station.

In the new era of "post-epidemic", attention should be paid to the "combination of epidemic response" [Wei Yanyong et al], and the general adjustment of epidemic and non-epidemic situations should be taken into account in the planning and design. First of all, in terms of regional division design, the hospital in non-epidemic period is divided into general treatment area, infectious disease treatment area and administrative office area. In epidemic period, the hospital should conveniently combine the general treatment area and infectious disease treatment area into the closed isolation area for infectious disease treatment. It is convenient to construct makeshift hospitals or administrative closed isolation areas in some administrative office areas. At the same time, both epidemic and non-epidemic situations should be considered in terms of functional streamline and isolation measures.

### 3.4 Planning of building green space

Make full use of terrain, protective spacing and other open space to arrange green space, and there should be special green space for patients ' rehabilitation activities. Hospitals in the new era require to return to nature, emphasize people-oriented, create green environment, and form the concept of sustainable development. For patients suffering from pain, they need a good environment to help treatment and rehabilitation. The design takes the design of green environment as a key point and takes the concept of green ecological garden-style hospital as the leading role to carry out the green landscape design of the hospital area [Zhang Zhiqian, 2022]. The planning of the courtyard should be more for the consideration of the patients, the location should extend to the depth as far as possible, close to the patients and their accompanying families, and the visualized green square in front of the hospital should not be made, which is the essence of the return of landscaping to comfort the soul.

### 3.5 Medical process design

Medical process design [Li Huiyu, 2021] should determine the structure, function and scale of medical business, as well as related medical processes, infection prevention and control requirements, medical equipment, technical conditions and parameters. The building design shall be carried out after the approval of the user department. The key medical process shall meet the specific requirements of the local medical audit department. The large general hospital in the new period should focus on the first-level technological process of hospital construction and give proper consideration to the reasonable planning of the second-level process. All departments should not only meet the current demand for medical technology equipment, but also reserve space for the upgrading of medical technology equipment in the future.

The main entrance and exit of the single building must have a parking area for motor vehicles, and the pedestrian ramps should be designed as barrier-free ramps. More than half of the wards should get good sunshine and landscape. In accordance with the relevant regulations of local planning and health authorities. Large medical equipment should be located on the ground floor or outdoors, and departments with more inspection frequency should be located on the lower level. Rationally allocate the number of beds in inpatient nursing units. Do doctors and patients partition shunt, do not interfere with each other.

## 4 Architectural design and interior design

The architectural design of the hospital should be incorporated into the overall image design of the urban space. The concept of urban design should also be introduced into the overall exterior image design. The characteristics of the surrounding urban environment should be fully analyzed, the favorable environment, space and other elements should be

made good use of, the spatial streamline should be set reasonably, the beautiful urban contour should be enriched, and the architecture should be integrated into the urban environment.

The new and old buildings should have a dialogue with each other, with both contrast and coordination. It not only shows the image of a new modern hospital, but also reflects the heavy disciplinary history of the hospital.

The historical context of the city should be respected to reflect cultural confidence [Cui Jianfeng et al]. For example, the requirements for architectural style and regional planning control of a city in central China are shown in
Table 1.

Table 1. Related requirements of architectural style and regional planning control

| Area and position | Specific historical features and coordination areas | | Modern new Tang style area | | Modern style |
|---|---|---|---|---|---|
| Roof form | Ming and Qing dynasty style (hard gable roof) | Su Yuan style (simplified red machine tile slope top) | Sui and Tang style (full slope roof) | There are no restrictions on the roof of the building, but it should be changed | There are no restrictions on the roof of the building |
| Wall façade | Pay attention to the form and proportion of the window, pay attention to the lighting and ventilation area | "Three-stage" separation, appropriately matched in brick red | Pay attention to the form and proportion of the window, and decorate the Tang style element symbols in appropriate positions | The façade reflects proportion and rhythm through the form of windows | The wall is made of modern styling elements to reflect the sense of the times |
| Building base layer | The base layer of the building can be combined with the site, and wall skirts can be set up | Properly refine the detailed elements of Luoyang architecture during the Suyuan period | The base layer of the building can be combined with the site, and the base can be set up, and the separation | The base layer of the building can be combined with the site, and wall skirts can be set up | The base layer of the building can use gray space and combine functions to make shape changes |

The minimum indoor clear height is 2.60m in the examination room, 2.80m in the ward and 2.80m in the medical technology department, or as required. Public walkway 2.30m. The permissible noise level of the ward shall meet the relevant requirements. It is advisable to choose standardized main structural components, and modular and assembled enclosure materials. The selection of building materials and structural design should meet the requirements of scrubbing resistance, corrosion prevention, leakage prevention and easy cleaning and maintenance.

## 5 Planning a smart hospital

The connotation of smart hospital should include: to provide warm and comfortable medical treatment and working environment. Reduce energy consumption, green, energy saving, environmental protection. Facilitate medical treatment, improve the response speed and service level of medical services. Improve clinical work efficiency and medical quality. Reduce management personnel, reduce management costs, improve management level. To achieve safe, reliable, efficient and stable operation of the hospital.

The design of smart hospital is mainly realized by using computer, communication, network, informatization, digitization, automatic control, big data, A and I, logistics network and other advanced technological means. Intelligent system of intelligent hospital has the characteristics of multiple subsystems, complex structure, high requirements, high technical difficulty, strong function and extensive involvement.

The future development direction of smart hospital [CAI, 2023;] will be based on the efficient integration of BIM, 5G, data center, industrial Internet, Internet of things, cloud computing, artificial intelligence and other high-tech technologies. Therefore, hospital design based on BIM+ big data + cloud platform combined with evidence-based design theory will be one of the main methods of hospital design in the future.

In the Outline of the Healthy China 2030 Plan, it is required to build an integrated medical and health service system with complete systems, clear division of labor, complementary functions, close cooperation and efficient operation. Basic medical and health resources within counties and cities should be rationally distributed according to the resident population and service radius to ensure equal access to basic medical and health services for all. At the provincial level and above, regional medical resources should be allocated in a coordinated way, regional medical resources should be integrated and shared, and high-quality medical and health resources should be allocated evenly, so that everyone in the province

can enjoy uniform diagnosis and treatment of critical and difficult diseases and specialized medical services. It has established a three-in-one mechanism for the prevention and control of major diseases involving specialized public health institutions, general and specialized hospitals, and community-level medical and health institutions, established an information sharing and interconnection mechanism, and promoted the integrated development of chronic disease prevention, treatment, and management, so as to realize the integration of medical treatment and prevention. In order to achieve the above goals, the planning and design of smart hospital will become an important carrier to realize the Planning Outline.

BIM and other advanced engineering management technologies are integrated into the whole process of hospital planning, design, construction and handover, and the hospital construction has been promoted with high efficiency and precision. After the handover, BIM technology is used to realize the digital operation and maintenance management of the whole life cycle of the hospital [Zhao Haipeng, 2022].

## 6 Conclusion

Through the above described elaboration of the planning and design concept of large general hospitals in the new period, from the perspective of the development of hospital planning and design, the planning and design of large general hospitals should undergo systematic changes in the new period. A key trend in hospital design in the future may also follow Professor Badenin's claim that the hospital will be a whole integrating the truth of science, the goodness of humanity and the beauty of art.

To sum up, taking human needs as the core, operation as the leading, integrating culture, science and technology, art and design wisdom, to design an intelligent and optimized complex, which will be the trend of planning and design of large general hospitals in the new era.

RECEIVED: 10/April/2023 ● ACCEPTED: 16/May/2023 ● TYPE: Expert Commentary ● FUNDING: Authors declared No Funding received for the development and publication of this article ● DECLARATION OF CONFLICTING INTERESTS: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ●

# References

Cai Zhifang, Xu Junhui. Discussion on the application value of BIM technology in the construction of intelligent hospital[J]. China Hospital Architecture and Equipment,2023,24(01):78-81.

Chen, Y., Moreira, P., Liu, W., Monachino, M., Nguyen, T. L. H., & Wang, A. (2022). Is there a gap between artificial intelligence applications and priorities in health care and nursing management? Journal of Nursing Management, 1–7. https://doi.org/10.1111/jonm.13851

Cui Jianfeng. The development dimension and action strategy of public cultural governance from the perspective of cultural confidence[J]. Theoretical Discussion,2023(02):62-68.

Cui, X., Su, T., & Wang, M. Y. (2022). A Study on the Roles of Online Social Tools for the Prevention and Control of Covid-19 Pandemic: The case of WeChat. International Healthcare Review (online). https://doi.org/10.56226/41

Dsouza, B. (2022). On Sustainable Health Systems: A Research Emergency in Pandemic times. International Healthcare Review (online), 1(1). https://doi.org/10.56226/ihr.v1i1.7

Dsouza B, Prabhu R, Unnikrishnan B, Ballal S, Mundkur SC, Chandra Sekaran V, Shetty A, Moreira P. Effect of Educational Intervention on Knowledge and Level of Adherence among Hemodialysis Patients: A Randomized Controlled Trial. Glob Health Epidemiol Genom. 2023 Mar 31;2023:4295613. doi: 10.1155/2023/4295613. PMID: 37033597; PMCID: PMC10081894. https://ops.hindawi.com/author/4295613/

Ferreira, J., Horta, P., & Geada, F. (2023). Internal Audit Process in eHealth: A case study. International Healthcare Review (online). https://doi.org/10.56226/50

Han T, Han M, Moreira P, Song H, Li P and Zhang Z (2023) Association between specific social activities and depressive symptoms among older adults: A study of urban-rural differences in China. Frontiers in Public Health 11:1099260. DOI: 10.3389/fpubh.2023.1099260

Hu Shixian. Discussion on the Influence of Architectural Location on Architectural Form Design [J]. Shanxi Architecture,2007(33):60-61.

Jacennik, B. (2022). On Digital Health Research Priorities: From Telemedicine to Telehealth. International Healthcare Review (online), 1(1). https://doi.org/10.56226/ihr.v1i1.13

Jacennik, B.; Zawadzka-Gosk, E.; Moreira, J.P.; Glinkowski, W.M. Evaluating Patients' Experiences with Healthcare Services: Extracting Domain and Language-Specific Information from Free-Text Narratives. Int. J. Environ. Res. Public Health 2022, 19, 10182. https://doi.org/10.3390/ ijerph191610182

Kehinde, O., Dixon-Lawson, K., & Mendelsohn, A. (2023). On Community Pharmacists and Promotion of Lifestyle Modification in Adults with Hypertension: Practice Protocol. International Healthcare Review (online). https://doi.org/10.56226/49

Li Guoxin. Discussion on the process and space design of medical technology examination Department in general hospital[J]. Chinese Hospital Architecture and Equipment,2015(05):79-81.

Li Huiyu. Special design management strategy of whole process consulting medical process[J]. Architectural Design Management,2021,38(08):39-52.

Lin Zhang; Jie Lei; Jintao Zhang; Longlong Yin; Yanjiao Chen; Yan Xi; Joaquim Paulo Moreira （2022） Undiagnosed Long Covid-19 in China amongst non-vaccinated individuals: Identifying persistent symptoms and impacts on patients' health-related quality of life。 Journal of Epidemiology and Global HealthPMCID: PMC9702954; DOI: 10.1007/s44197-022-00079-9

LIU Hao. Exploration on Planning and design of modern large general Hospitals [J]. Shanxi Architecture,2018,44(11):7-8.

Lloyd Williams, D. (2022). On Healthcare Research Priorities in the USA : From Long COVID to Precision Health, what else is new?. International Healthcare Review (online), 1(1). https://doi.org/10.56226/ihr.v1i1.14

Moreira, P. (2022). On New Clinical Research Methods and Technologies: From decentralised designs to Artificial Intelligence. International Healthcare Review (online), 1(1). https://doi.org/10.56226/ihr.v1i1.11

Moreira, P., Monachino, M., Williams, D.L., Dsouza, B., Chen, Y., Antunes, V., Ueyda, M., Nguyen, T & Jacennik B. (2022) Healthcare Research Priorities: an International Agenda for 2024. International Healthcare Review (online), 1:1, 1-8, DOI: https://doi.org/10.56226/ihr.vi

Qi Qi. Research on Transportation Organization of large general Hospitals Based on Systematization[D]. Beijing University of Technology,2016.

REN Qi. Research on Planning of Hospital logistics System under Hybrid Building Layout[J]. China Logistics and Purchasing,2020(15):22-23.

Wang P. Realizing sound and rapid development of medical and health services under the guidance of the theoretical system of socialism with Chinese characteristics[J]. Modern Hospital Management,2008(04):1-4.

Wei Yanyong, Song Ting, Hu Zhijia, Lu Furong, Hu Yuming, Luo Yong, Li Yongguo, Xu Ping. Reconstruction of old hospital building based on “combination of epidemic prevention and Treatment”[J]. China Hospital Architecture and Equipment,202,23(01):71-75.

Zhang Zhiqian, Yang Shujie. Practice exploration of landscape greening management based on the perspective of logistics service support[J]. Agricultural Science and Equipment,2022(01):21-22.

Zhao Haipeng. Digital development, operation and maintenance of the full life cycle of medical buildings[J]. Building Construction,2022,44(06):1391-1393.

Zhao Jie. Study on Adaptive design of large general hospital layout based on function and site cues [D]. South China University of Technology,2021.

Zhao, Z., & Niu, M. (2022). On the Treatment and Disposal of Clinical Waste based on Bluetooth and LoRa Wireless IoT: A case study. International Healthcare Review (online). https://doi.org/10.56226/ihr.v1i2.34

Zheng Jie, Xing Zhaoqiang, Chen LAN. Optimization of Hospital Traffic Organization: A Case study of Traffic Optimization Design of Affiliated Hospital of Qingdao University[J]. Chinese Hospital Architecture and Equipment,2016(06):73-75.