https://doi.org/10.21122/2227-1031-2019-18-4-311-318

UDC 725.51

# Common Features of Architectural Design of the Medical Purpose Building

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**Abstract.** The paper considers principal features and specific character of architectural design for health care institutions. Main designing stages, missions and complexities for every successive designing step have been revealed in the paper. The paper presents specific features, main stages and design approaches to designing of modern health care facilities, comfortable architectural environment of health institutions, which have been formed on the basis of the analysis of advanced international experience in the field of designing healthcare facilities. The proposed approaches are based on modern experience in designing medical buildings over the past decade in the developed countries. A special attention has been paid to obsolete methods for architecture-planning organization of healthcare facilities and modern approaches to arrangement of engineering and other systems which significantly influence on economical efficiency, quality, comfort and effectiveness of architectural environment in healthcare institutions. Every healthcare facility, every separate department are considered as unique in their essence, for this reason it is not so easy to reflect modern technological solutions and architectural tendencies. The paper contains an attempt to attract attention of architects to the complexity in designing of a building to be constructed, to find ways which will help to reach its step-by-step solution. It has been noted as well that there is a necessity to arrange interaction between an architect and a medical technologist. Modern medical departments and hospitals have been recently designed and built in the Ukraine, but they are in increasingly short number. These facilities have been constructed due to decision makers who, in spite of diverse difficulties, lack of information and specialists, lack of proper funding, etc., are trying to do their best in order to reach the modern level of desingning and construction of hospitals. So-called "typical" medical projects of 70-ies and 80-ies continue to be implemented up to now. This is certainly due to inadequate funding, but such economy has at the end rather high cost.

**Keywords:** architecture, design, project stages, healthcare institutions, architectural environment of healthcare facilities, network of healthcare institutions

**For citation:** Bulakh I. V. (2019) Common Features of Architectural Design of the Medical Purpose Building. *Science and Technique*. 18 (4), 311–318. https://doi.org/10. 21122/2227-1031-2018-18-4-311-318

# Общие особенности архитектурного проектирования зданий медицинского назначения

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**Реферат.** В статье рассмотрены особенности и специфика архитектурного проектирования учреждений здравоохранения, выявлены основные этапы проектирования, задачи и сложности для каждого последовательного шага проектирования. Освещены особенности, главные этапы и проектные подходы к проектированию современных зданий медицинского назначения и комфортной архитектурной среды медицинских учреждений, сформированные из анализа передового зарубежного опыта проектирования объектов здравоохранения. Предложенные подходы опираются на современный опыт проектирования медицинских зданий, построенных за последнее десятилетие в развитых странах. Особое внимание уделено устаревшим приемам архитектурно-планировочной организации объектов медицинского предназначения, а также современным подходам устройства инженерных и других систем, которые существенно

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влияют на экономичность, качество, комфортность и эффективность архитектурной среды лечебных учреждений. Каждый медицинский объект, каждое специальное отделение уникальны по своей сути, поэтому не очень просто отразить современные технологические решения и архитектурные тенденции. Произведена попытка привлечь внимание архитекторов к сложности составления проектного задания, найти пути его поэтапного решения. Отмечена необходимость взаимодействия между архитектором и медицинским технологом. В последнее время на Украине проектируются и строятся современные отделения и больницы, однако их количество катастрофически мало. Важнная заслуга в их появлении принадлежит руководителям, которые, несмотря на разноплановые трудности, недостаток информации и специалистов, отсутствие надлежащего финансирования и т. д., пытаются достичь современного уровня проектирования и строительства больниц. До сих пор продолжают появляться «типовые» медицинские проекты 70–80-х гг. прошлого века. Конечно, во многом это связано с недостаточным финансированием. Но такая экономия, в конечном итоге, обходится очень дорого.

**Ключевые слова:** архитектура, дизайн, этапы проекта, учреждения здравоохранения, архитектурное пространство медицинских учреждений, сеть зданий здравоохранения

**Для цитирования:** Булах, И. В. Общие особенности архитектурного проектирования зданий медицинского назначения / И. В. Булах // *Наука и техника*. 2019. Т. 18, № 4. С. 311–318. https://doi.org/10.21122/2227-1031-2019-18-4-311-318

## Introduction

The current state of healthcare institutions network in Ukraine, its components – medical buildings, unfortunately, is in critical condition now. There are a number of factors, but first and foremost, the majority of medical buildings were erected in the Soviet and even pre-Soviet period of Ukrainian history and is still by the state budget. Inadequate attention and funding, lack of modernization and implementation of energy-efficient achievements have resulted to the fact that since the independence of the Ukrainian state there were global and irreversible processes of outdated medical buildings, their complete inadequacy to the world quality of health-care services [1, 2].

In addition, for the independent period of Ukraine existence, the state institution of architectural designing of healthcare facilities was completely destroyed. And there was no brand new formation of a powerful private sector of the project activity instead of this, which would have had the proper knowledge of the specific sector of the medical building's design. Our country has the imperious want in the revival of quality and present-day sphere of provision of health services. So, it is necessary to start with the study of the latest world architectural and design experience, the project approach analysis, the main stage in the design, aimed at the efficient, economical and progressive design of healthcare facilities. Understanding of foreign experience, best sides adaptation to regional features, and capacity of the Ukrainian state will provide to the renewal of architectural-spatial forms and planning of medical institutions. This, in turn, will have a positive impact on providing the necessity of medical care for the population of both Ukraine and most of the post-Soviet countries [3–5].

## Formulation of the problem

The main percentage of medical institutions functioning in Ukraine are in critical or similar condition now, like most CIS countries. The single healthcare facilities built over the last decade in the territories of Ukraine in the largest cities are approaching the lower boundary of modern world standards according to certain criteria. Ukraine has to restore the system of architectural designing of healthcare facilities today, despite the long-term economic, energy and political crisis, the military conflict in the east, rampant corruption [6]. This system should take responsibility for the issue of reorganization of healthcare facilities network, modernization, and enhancement of the energy efficiency of existing health institutions and the design new, modern, comprehensive facilities for the provision of high-quality health services [7].

## Research analyzes and publications

Foreign experience of the architecturally-spatial organization of medical institutions is highlighted in the works of many architects: Samimi Kimia, T. M. Creasy, I. M. C. Kras, etc. [8–10]. In particular about contemporary trends in the design of medical institutions is spoken in the work of Giuseppe Pellitteri, Flavia Belvedere, “Characteristics of hospital buildings: changes, processes, and quality” [11]. The impact of color and light in the design of healthcare institutions is explored

in works: Hilary Dalke, Paul J. Littlefair, David L. Read "Lighting and Color for Hospital Design", Faber Birren "Psychological Implications of Color and Illumination", Clark Linda and others [12–15].

**The purpose of the article**

The purpose of the article is to highlight the common features, the major stages and project approach to the design of modern healthcare facilities, a comfortable architectural space of health institutions, formed from the analysis of advanced foreign experience in the design of healthcare facilities.

**The main material**

The architectural and urban planning system of health care institutions is an integral to the general system of health protection of any country, which provides protective treatment facilities, diagnosis, care and rehabilitation of the population in a variety of medical institutions. The common features` study of architectural engineering of medical purpose buildings certainly requires a systematic approach to the consideration of the composite blocks of this system. Within the research framework at the urban planning engineering level, architectural and urban planning system of health care institutions is proposed to be considered as a hierarchical structure, which consists of subsystems components: the primary, secondary, tertiary network levels of healthcare provision. Individual groups include medical educational institutions, as well as institutions of the territorial administration of the health care system.

Family doctors` offices (general practitioners), outpatient departments (up to five family doctors` offices, nursing staff, adequate level of diagnostic support), health centers of primary care (up to ten family doctors` offices, nursing staff, high level of diagnostic support) form an urban planning network of primary care facilities of the population. The proposed project-based approach involves a gradual renewal of the traditional for Ukraine, etc. post-Soviet states of polyclinic medical care. The further functioning of the latter, unfortunately, today is an outdated form of many features: the polyclinic buildings were estimated and designed according to the rules of pedestrian accessibility; considerable compaction of urban development and design of predominantly multistoried residential buildings is not taken into account; they fall short of standards the energy-efficient requirements in conditions of energy shortage and require significant financial resources for exploitation and many others. The new proposed project approach is based on the experience of European countries (Germany, France, Great Britain, etc.), helps to bring medical aid closer to the population, reduce the burden on the hospital, ensure gradual provision of medical care, eliminate excess specialization and duplication based on age (children and adults), creating medical care at the family level; regulate the need to create new medical facilities or their premises flexibly.

The following subsystem is an urban planning network of secondary health care facilities that provides for the design and organization of hospital structures. Hospitals offering secondary medical care are divided into five types: multi-field intensive care hospital (provision of twenty-four-hour medical care delivery to patients with acute conditions requiring high intensity of treatment and care); hospital for scheduled treatment of chronic patients (repeated courses of therapy or treatment using standard therapeutic regimens, without the need for intensive care and equipment for the treatment procedure); rehabilitation hospital (restoration of functions after diseases or injuries, to prevent disability and / or rehabilitation of invalids requiring special equipment); hospices (provision of palliative care and psychological support to final patients who need special equipment to provide such care and treatment, as well as specially trained, mainly nursing staff, and wide involvement of volunteers); hospital for medical and social assistance (care and provision of social and palliative care to chronic patients with minimal provision of diagnostic and medical equipment, middle medical personnel and social workers). For eliminating multiple duplication of medical institutions in one territory (departmental, district, city, regional, children's, adults, etc.), a network of secondary medical care hospitals is proposed to be formed by universal, without specialization, for signs. The calculation of the location of each type of hospital is carried out individually, it is recommended to set the following limits: the population maintenance is 150–200 thousand people, the service radius is 60–90 km.

The subsystem of tertiary level of medical care is proposed to be formed by highly specialized hospitals (territorial and nationwide), including children's hospitals, highly specialized dispensaries and medical diagnostic centers, which provide treatment for complicated, rare or expensive cases. These institutions should be distinguished by considerably better material and technical support, structure complexity and functions, as well as the radius and number of population services – about 1 million persons unlimited territorial. The main functions of the urban planning network of TMD institutions include: provision of highly skilled, specialized and unique medical care to patients; formation of research and clinical centers of innovative development of national science, education and production. The priority task is creation of university clinics that combine medical, educational and research processes. Every of the listed city-planning networks of health facilities, each separate healthcare facility is a complex "organism", which is closely intertwined with special requirements for the technology of medical processes, architectural and space planning, space planning decision, resistance to rapid changes in the medical equipment sphere, and as a consequence, there are changing requirements to the premises of medical buildings, their "flexibility".

Today healthcare facilities design is very specific and isolated architectural activity field that grows at a rapid pace. And it`s not every architectural design organization is able to carry out a project of a medical object that would correspond to the latest trends in world construction and design of this segment of buildings. Today in most leading European countries and in the United States, there is no typical approach to the design of healthcare institutions and there are separate architectural offices specializing in the implementation of health facilities projects. Thus it is necessary to identify a number of major stages, describing the model of the "ideal" process of designing a healthcare facility. And provided their consistent observance, there are conditions that ultimately make it possible to obtain an architectural and project design that meets all modern world requirements for the design of healthcare facilities [16].

The first stage of design (pre-design concept) implies that on the basis of a medical task and a business plan a plan-program task is prepared, which accurately specifies the useful areas of all medical and auxiliary units are determined the number of serviced population and territorial boundaries. At this stage, the estimated number of floors of the building, building boundaries, configuration, shapes, etc. are determined. It is necessary to determine with the offices' location, entrances, access ways, elevators, and stairs with sufficient accuracy. At the end of the first stage of design, it is possible to calculate the approximate amount of engineering resources that will ensure the functioning of the healthcare institution. This first part of the project work becomes basic and requires a very accurate elaboration of both the medical problem and the responsible work of the architect. Unfortunately, in practice, quite often, determining the areas of the future healthcare facility and its preliminary functional zoning relates solely to doctors who are guided by their own experience and certainly do not possess the necessary architectural knowledge, which is essential at the initial stage of design. In addition, specific knowledge is required about modern technologies (medical, engineering, etc.) that can significantly influence and correct the required estimated area of individual functional areas of the medical building.

The issue of normative documents on the design of health facilities is required for the particular attention. The task of design is made by professionals who are forced to focus on existing rules and regulations, which are largely past practices. In Ukraine, for a long time the design of new and reconstruction of existing buildings and structures of all types of medical facilities, regardless of their subordination and form of ownership, was standardized by the requirements of DBN, V.2.2-10–2001 "Buildings, and structures, healthcare institutions with changes and additions". In 2018, the new state normative document DBN V.2.2-10:2017 "Buildings and facilities, health care institutions" came into force. At this first stage of the design of healthcare facility, unfortunately, as a rule, is not enough attention, time and money, at best, such pre-design developments are part of the works on the stage of the "Project" and architectural companies are forced to perform them only after the successful bid. As a result, the architect and medical technologist cannot match into the volume of the healthcare facility, which is calculated in knock out way. The further conse-

quences of this approach are clear. Much more often this stage can be performed when working with private structures [17].

An even drearier situation occurs during the reconstruction of healthcare buildings and during the renovation (adaptation) of non-medical buildings. In the latter case, we are talking about the architectural design of private medical projects. At first, the home is selected and bought, and only then is the question of writing a plan-program task or even proceeding with the reconstruction of the building without it. In addition to the areas under reconstruction, the possibility of obtaining enough electricity, supplying communications to this building is playing an important role. Only after the completion of the task, which contains data on the basic medical and technological equipment, is possible to calculate the aggregated engineering load. As a result, the previous concept and perspectives of the organization of the medical environment are undergone significant changes, which is also accompanied by a pre-investment of considerable financial costs and time, and ultimately can lead to the rejection of the planned project. At purpose-designed architectural offices in European countries and in the United States simultaneously work with specialists in both medical and architectural education, which allows together with the investor and doctors to create modern and rational architectural projects them from the very beginning, the implementation of which in the future does not lead to an increase in the implementation time and increase in value. In large leading specialized architectural organizations, mastery of designers is practiced by two diplomas (architectural and medical higher education) [18].

The second stage of the design of a healthcare facility begins after the approval of pre-project proposals and involves directly architectural design work. An interesting feature of the European project approach is that there is no clear distribution of the “Project” and “Detailed Documentation” stages. At this stage, the presiding architectural company receives and performs the function of general design contractor, performing all space planning decisions. The very important aspect of the project work at this stage is the joint work of an architect and medical technologist. Even an experienced architect is not able to design a medical facility as the only powerful mechanism without the introduction of all modern medical technologies that grow at very fast pace, cannot separate the flows of patients, materials, etc. It is possible to run the architectural design of a healthcare institution without fail only by being constantly aware of the medical world events, knowing the new equipment, new principles for the separation of streams, etc. [19].

It is important to dwell on the peculiarities of the planning decisions of healthcare institutions which are outdated and not relevant. The corridor-type arrangement was adopted in the middle of the last century no longer correspond to contemporary design requirements. Its appearance is associated with many factors – the lack of modern construction technologies, reliable means of vertical communications (elevators) and, of course, a lower level of “technology” in the patients' treatment. It is impossible today, for example, to put a modern surgery block, an intensive therapy unit, and others in most of the existing healthcare facilities in Ukraine. Requirements for people streaming, air purity, etc. have changed vary considerably that a fundamentally different building configuration is required now. In cases of long corridors, it is impossible to provide the “flexibility” that is needed in modern clinics and hospitals, the ways of medical personnel movement in the bed wards, diagnostic rooms, surgery blocks etc. are considerably lengthened. Also, in that case of long corridors are requires more maintenance (heating or cooling space, electricity costs). But the most important point is that the optimal flow distribution is possible only with a certain building configuration. Modern healthcare centers architecture, which at planning the factor updating the technological requirements has taken into account in advance, differs significantly from the usual rectangular elongated healthcare institution shape. The convenience of medical staff with a reduction in time spent on moving to a healthcare institution is paid a great attention to contemporary architectural projects. The movement routes of medical staff and patients with visitors are separated inside the modern ward office which is also possible only with a certain configuration of the building. The optimal building configuration essentially depends on the purpose of the facility. The greater the building saturation with modern diagnostic equipment, the more specialized offices in it, the surgery blocks, that needs a more complex configuration for the

optimal functioning of all services and the provision of communications between departments [20–24].

The proposed project based approach to the design of primary health care institutions offered in this article allows dispose flexibly of the smallest project units (family doctors' offices) in new buildings, in particular, in the built-in-type form on the first floors of multi-storey residential and public complexes that have become an integral part of the modern urban environment most of the major cities of Ukraine. The design and dispose of outpatient facilities should be provided at the level of the microdistrict, and the primary medical care center with more powerful diagnostic equipment at the residential area level.

Practiced widely architectural projects of hospitals and healthcare facilities are often performed by foreign design companies, but it should be noted that in this case, the project company should work in strong collaborative relationship with national medical technologists and architects. Codes of the structural design of healthcare institutions, adopted in other countries, are quite different from Ukrainian and the adaptation of foreign projects to Ukrainian regulations is rather complicated and hard work. This also applies to space planning decision, preparation and legalization of project documentation, medical facility inspection for the possibility of its application in Ukraine. This way will significantly increase the cost of the project and extend a deadline the design time, but today such tactics are possible and sometimes necessary, as in our country there are very few specialized companies capable of independently, without the involvement of foreign specialists, to execute the project qualitatively [25].

World experience in the design of medical facilities indicates an increase in attention to engineering communications and in modern clinics the cost of engineering systems is 40–45 % of the total cost of construction of the facility. This is due to different circumstances: firstly, these are new requirements for ventilation and air purity in healthcare institutions. Secondly, it is necessary to provide for the possibility of upgrading or even increasing the amount of engineering equipment. For this purpose, the most appropriate is modern technology for laying engineering communications between floors. The height of such a technical floor is up to 2 m. This allows to install not only a much larger number of air ducts, electric cables, low-current systems, etc., but also has free access to all engineering communications and, if necessary, to improve them. At the same time, an important factor is that such a scheme allows planning more rational, applying an “individual” approach to the planning of each floor due to much fewer restrictions that arise with the only vertical arrangement of communications (lack of engineering mines) [26].

Another important. Medical technology develops at a very fast pace and requires appropriate engineering modernization, and the cost of major repairs and building adaptation to new technologies and tasks, with the traditional location of communications, is far more extensive. Also, an increase in the volume of construction does not lead to a proportional increase in its value. The design, construction, and laying of communications in such buildings with technical floors are much faster than usual, which significantly reduces the cost, especially if we aspect of modern engineering design of healthcare facilities is the economic component of such projects. If you consider a health facility as a long-term project, then, of course, this approach is more beneficial for many economic reasons. First of all engineering networks maintenance is carried out with much fewer expensestake into account inflation and wage costs.

The architect pays much more attention to the internal planning of space when designing. It should not be forgotten that more rational use of the area allows, in general, to reduce the total floor area in comparison with traditional planning. These reasons allow a number of Western architects even to talk about roughly the same total cost of medical institutions under the traditional and above-mentioned approaches. Such ideas have long been reflected in the surgery blocks design and construction when all engineering communications are located in built-up panel space. Increasingly important role in the design of healthcare centers is played by the requirements imposed on the comfort of both medical staff and patients. Modern medical institutions have largely resembled other public buildings in terms of comfort. It is well known that the psychological component plays an important role in finding a patient in a clinic. The creation of “home” or “hotel” space in

the offices and bed wards is extremely important now, as well as giving priority to the creation of single and double chambers.

Time-saving, taking care of more efficient use of it, led to the emergence of a pneumatic tube system connecting the pharmacy, laboratory, etc.in which the medicines and materials for analyzes in containers from the appropriate services to the department are transmitted through. The development of information technology, the emergence of the possibility in rapid information exchange, clinical data, both inside the hospital and between health institutions dictate the need to create in any clinically significant in both the saturation and occupied areas of information and computer department. Designing a healthcare facility is necessary to take into account its possible expansion as a result of the emergence of new diagnostic and therapeutic methods, as well as due to the growth and aging of the population. It is necessary for architectural decisions to take into account the profile of the healthcare center, its throughput, even the location. It is impossible to solve these or other tasks by direct increase of the area.

It is necessary to follow all the normative documents working with foreign companies or executing the project on their own. And as noted above, they are not exactly complete; some of them have been taken a long time ago and do not take into account the rapid development of modern technology. Sometimes the established norms are somewhat different from each other in different documents. This also applies to the offices' placement, bed wards, services and the spatial requirements. Moreover, it can be seen as clearly insufficient areas, registered as normative for the placement of some units, and clearly overestimated. For example, the area of the modern sterilization center is almost always more than prescribed in the norms, and laundry, disinfection department require much smaller areas [27]. In cases where it can not be proved that, for example, when installing modern equipment or the location of certain offices inside the premises (without natural light), it is possible to significantly reduce the area of some departments, as a result, the overall size of the medical building will be significantly increased. At the same time, there is no noticeable improvement in its functioning, and the cost of the project increases.

**CONCLUSIONS**

1. In the conditions of reforming the health care system of Ukraine, the possibility of implementing more qualitative and effective architectural and urban approach to the organization of medical institutions, corresponding to proven progressive world experience. Changes are needed from the construction of a modern hierarchical architectural and urban planning system of health care institutions. To consider the hierarchical architectural and urban development system of health care institutions as a gradual subordination of networks of primary, secondary and tertiary medical care of the population is proposed from this position in the article. The first part of the system is the primary system of urban health care should be as close as possible to the population and cover up to 80 % of the prevention and treatment services of all age groups within the framework of family health care, which allows replacing the traditional hospital treatment approach and significantly reducing the burden to the hospital sector and accordingly to save financial resources. The existing hospital network in Ukraine needs, of course, a major cardinal renovation, which today is characterized as an overly specialized, repeatedly duplicating, ineffective and outdated structure with excessive number of hospital beds. From this position, it is advisable to organize a urban planning network of secondary medical care which includes five types of universal (on an age basis) intensive, rehabilitation, chronic, palliative and social medical services, as well as a tertiary health care network with highly specialized and unique hospitals. The number and location of hospitals should be individually determined for each individual region (hospital district), taking into account specific conditions (population, demographic projections, morbidity, natural and climatic conditions, topographic features and the state of the transport infrastructure, requirements and expectations of the society, etc. regional factors).

2. Typical for the Soviet period, a typical industrial approach to the design and disposal of health facilities in a number of economic, political, demographic, and urban factors, unfortunately, today can not meet the needs of society and does not match the capabilities of the state. Every healthcare facility, even every separate branch, is unique in its essence and within the article, it is impossible to reflect even a small part of modern

technological decisions, architectural tendencies. In this article was made an attempt to draw the attention of architects to the complexity of the project, to find out ways to a step-by-step solution and to note the need for interaction between the government, community, investor, architect and the medical technologist. Modern departments and hospitals are being designed and built in Ukraine recently, but their number is disastrously low. The main credit in their appearance belongs to facility administrators who, in spite of diverse difficulties, lack of information and specialists, lack of proper funding, etc., are trying to modernize the healthcare facilities design and construction. "Typical" projects 70–80-is of the last century still continue to appear. Surely, this is largely due to inadequate funding, but this cost is ultimately very expensive.

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Received: 15.11.2018
Accepted: 29.01.2019
Published online: 31.07.2019