



Article

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Comparative analysis of international and national standards in the field of healthcare facilities design.

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Abstract. The article is devoted to an analytical analysis of the key principles of designing medical and wellness facilities in accordance with current international standards and requirements (JCI - Joint Commission International, FGI - Facility Guidelines Institute, iHFG - International Health Facility Guidelines). The study examines approaches to the formation of architectural and planning solutions that affect the safety, efficiency, and manufacturability of healthcare facilities. Special attention is paid to the influence of medical technologies, sanitary and epidemiological requirements, and socio-economic factors on the design. The article also shows the difference between national and international approaches. In national practice, a medical institution is more often considered as a civilian building with an established list of regulatory requirements. International standards, on the contrary, proceed from a comprehensive understanding of the hospital as a high-tech facility, where the planning structure is directly related to medical processes. The research results can be used both by design organizations for a more accurate understanding of the process of developing architectural and planning solutions, and by government agencies for making changes and additions to existing norms and rules due to their inconsistency with modern high-tech processes.

Keywords: design of healthcare facilities, international standards, functional purpose, architectural and planning solutions, factors, architecture, regulatory framework, ergonomics.

Introduction

The Republic of Kazakhstan has entered an active period of globalization and cooperation in the international arena, and accordingly, this implies the need to review approaches to the design of healthcare facilities.

The rules and regulations for the design of medical infrastructure facilities must comply not only with national but also with international standards that can ensure a high level of safety, energy efficiency, and ergonomics. During the implementation of national healthcare projects, the architectural design of perinatal centers becomes crucial: after all, it is here that the fundamental demographic development and health of the future nation are formed.

Modern challenges in the design of healthcare facilities in Kazakhstan

The Decree of the Government of the Republic of Kazakhstan dated November 24, 2022 [1] exposes the key problems of the medical infrastructure:

- unsatisfactory state of the material and technical base, including the organization of obstetric care (in 2021 - 76.9%);
- 40% of the buildings of the SES (sanitary and epidemiological service) do not meet the requirements and standards; - low level of material and technical condition of obstetric institutions, their non-compliance with modern requirements, insufficient medical equipment, understaffing, including specialized specialists (obstetrician-gynecologists, anesthesiologist-resuscitators, neonatologists) of maternity organizations;
- insufficient level of integration of PHC (primary health care), maternity and specialized hospitals.

These and many other factors directly affect the quality of medical services, which require advanced and high-tech solutions, infection control, and flexible architectural and planning solutions.

The relevance of the research topic lies in the rapid development of the healthcare system, which is caused by the advent of modern medical technologies, changes in the epidemiological situation in the regions, and increasing demands on the safety of patients and staff. In modern architectural practice, the design of healthcare facilities has ceased to be considered only as the creation of a "civil purpose" framework to accommodate offices that strictly meet the requirements of norms and regulations. Today, the process of designing medical facilities is considered a high-tech process, where spatial solutions directly affect the effectiveness of medical treatment, the psycho-emotional state of patients, and the reliable functioning of the organization.

In the international arena, standards and norms in the field of design, such as JCI - Joint Commission International, FGI - Facility Guidelines Institute, and iHFG - International Health Facility Guidelines, set the direction of the approach from strict subordination to national standards and requirements for Evidence-Based Design (EBD). This method allows you to create architectural and planning solutions based on scientifically proven data on how the environment affects the recovery of patients, the effectiveness of staff, and their safety. At the same time, strict norms and rules in the field of design are in force in the Republic of Kazakhstan, which impose strict restrictions that limit designers in flexible approaches to solving a particular task.

The purpose of this article is to analyze and systematize international experience in the design of medical facilities. The article considers three main directions of development in the field of medical design. The first is related to the transition from traditional divisions of infectious pathways due to the construction of complex corridors to infection control due to modern engineering systems that control airflow and pressure. The second direction concerns the planning structure - instead of rigidly limited areas, it is necessary to apply functional planning solutions

that are formed around the patient's area of activity. The third is the introduction of patient safety principles into the architecture of the building, which are formed according to the analysis of their routes inside the premises.

The results of this analysis can be used to form a further process of improving existing regulatory legal acts in the field of technical regulation of the design processes of healthcare facilities. The company considers the creation of medical facilities not just as civil engineering, but as a way to reduce technological risks during operation.

The methodology

This paper is based on the assumption that the architectural and spatial model of healthcare facilities can have a direct impact on the quality of medical care. When designing hospitals in accordance with international standards, the environment can not only support the medical component of the process, but also reduce the technological risks associated with the operation and maintenance of the building. At the same time, the existing reality of design in Kazakhstan, which is based on a regulatory approach and strict adherence to construction and sanitary-epidemiological norms and rules, often creates limitations in the field of scientific evidence-based design method. It is assumed that the process of transition from fixed limitations in regulatory indicators to adaptive functional modeling, which is used in the Joint Commission International (JCI) standards, will make it possible to adapt modern high-tech standards to the national regulatory framework without compromising the quality of medical care.

To verify this assumption, a comparative analysis of two alternative systems of norms and standards was used as the main material: the JCI international accreditation standards and the national Code of Building Regulations of the Joint Venture of the Republic of Kazakhstan. 3.02-113-2014 "Medical and preventive institutions".

The research methodology included three consecutive stages of analysis. At the first stage, differences in approaches to infection control were considered: from primarily sanitary requirements typical of building codes and regulations in force in the Republic of Kazakhstan to active engineering control applied in JCI standards and based on airflow control and automated pressure management to eliminate cross-infection. The second stage is devoted to a practical approach to the development of functional planning solutions, during which the planning structure is evaluated in terms of the actual work processes of medical personnel, and not only in terms of regulatory limited areas. At the third stage, using the method of analyzing the patient's route, problematic flow intersections within the perinatal center were identified, potentially affecting the safety and quality of medical care.

The applied analysis algorithm allows us to consider the design process of medical institutions not only as a civil engineering facility, but also as a complex system in which architecture is directly related to medical and technological processes. A comparison of the requirements of the building codes and regulations of the Republic of Kazakhstan with the safety criteria set out in the JCI standards provides a clear understanding of the existing regulatory constraints and provides a basis for developing recommendations for updating the national design system for medical institutions.

Findings/Discussion

In the course of a comparative analysis of the national building codes of the Republic of Kazakhstan (CH and JV RK) and the international standards of the Joint Commission International (JCI) and Facility Guidelines Institute (FGI) in the field of healthcare facilities design, fundamental

differences have been identified that go beyond the simple discrepancy of individual technical parameters. These differences were identified as conceptually different approaches to understanding the role of an architect and the very essence of architectural design at the stage of developing architectural planning and spatial solutions for medical institutions.

The identified discrepancies reflect not only differences in technical requirements, regulatory indicators and qualitative characteristics of the designed premises, but also affect the methodological approach to the design process itself. This approach determines the nature and depth of the relationship between the professional activity of an architect, the medical and technological process of providing medical care and key issues of ensuring the safety of patients and medical personnel in modern conditions of functioning of healthcare institutions.

Conceptual foundations of design: building volume vs technological process

Based on the results of the analysis, it was determined that the key difference between national and international standards lies in defining the primary design task and understanding the main function performed by various healthcare facilities. In Kazakh practice, medical institutions have historically been considered as one of the types of civil buildings with certain sanitary and epidemiological requirements, where priority is given to the reliability of the building and compliance with the requirements of regulatory documents [2, 3]. These standards pay considerable attention to the location of the building, fire and sanitary gaps, escape routes, minimum requirements for the area of the premises - parameters that are undoubtedly important for the safety of the building as an object of the structure, but ineffectively affect medical processes and the quality of medical care.

The functional zoning of departments is mainly reduced to a formal division into "clean" and "dirty" zones without a detailed study of the logistical intersection of staff, patients and technological equipment, which does not allow effective management of the risks of nosocomial infections and medical errors. On the contrary, international practice defines a hospital as a complex high-tech system, where the architecture of the facility is subordinated to the medical process and the patient's safety objectives [4, 5]. The main tool is the Patient Journey Mapping method [6], in which the design begins with an analysis of all possible paths of movement of the patient, staff, equipment and materials. Each functional planning structure is evaluated in terms of the risk of medical error, which is directly related to the concept of patient safety, described in detail in the report of the US Institute of Medicine "To Err Is Human", which emphasizes the role of the physical and organizational environment in preventing errors [7]. In which, the architecture of the building is considered an active component of the patient safety system, which can not only reduce but also increase risks depending on the quality of design solutions.

This difference forms the different functions of an architect at the design stage: in national practice, he acts as a "translator" of building regulations and the creator of an architectural image; in international practice, a coordinator of medical processes and technological risks, an active participant in the formation of clinical processes through architectural and planning solutions. A good example is the placement of hand hygiene sinks, one of the most important elements of infection control. In the CH and SP RK, this is a conditionally defined plumbing point without a specific indoor location requirement, provided that the minimum quantity is met. In the JCI and FGI standards, the sink is considered an important safety unit and should be located in the direct line of sight of the doctor before contact with the patient, which reduces the likelihood of violation of infection control procedures by 30-40% according to research data [4, 5]. The architecture of the surrounding space "encourages" staff to behave safely, reducing the impact of stress factors on cognitive activity, and turning the right action into the most natural and convenient [8]. This

principle of "design for safety" is reflected in all aspects of international standards and is fundamentally different from the conventional approach of national standards.

Criteria	National standards	JCI/FGI
Methodology	Prescriptive method (fixed indicators)	Functional approach (derived from technology)
The area of the ward per 1 bed	12 m ² (fixed)	Calculated based on the equipment and areas of activity
Area of the operating room/intensive care unit	Legally limited	Up to 70-80 m ² when using high-tech equipment
Accounting for modern equipment	Limited by the standards of the mid-20th century	Adaptable to technological development
Justification of the area	Formal compliance with standards	Functional areas and clinical scenarios
Flexibility in expertise	Excess of the norm = rise in price	Reasonable increase for safety and effectiveness
Consideration of staff ergonomics	Minimal	A key design factor

Table 1. Comparative analysis of methods for determining the area of premises

Methodology for determining the area of premises

The comparative analysis revealed key differences in the methods of determining the area of the premises, which demonstrate different approaches to the functioning of the medical space. International recommendations use a functional approach, in which the area of the room is determined depending on the technological process and the dimensions of the equipment. The fundamental factor in determining the quantitative size of the area is the "activity zones", which include the patient's area, staff circulation, equipment placement, and family involvement, especially relevant for intensive care units and perinatal centers [4]. This method makes it possible to justify an increase in the area of premises to 70-80 m² for operating rooms or intensive care rooms during the use of high-tech medical equipment, ensuring the transition to technological development and changes in the treatment and diagnostic process. This takes into account not only the dimensions of the equipment, but also the ergonomics of the space for staff to work, the need for emergency access to the patient from different sides, the placement of monitors in the field of view, and additional space in the room for relatives to participate in the treatment process.

The fundamentals of the Joint Venture and the National Assembly of the Republic of Kazakhstan apply the method of directive indicators based on fixed areas of premises established several decades ago. Especially in the field of spatial planning solutions for medical institutions, this is the legacy of the Soviet rationing school of the 1970s and 1980s. The area of an adult patient's room per bed is normatively fixed at the level of 12 m² (with an airlock, toilet, and

shower) [2], which reflects the parameters of the equipment of the mid-20th century. Modern high-tech medical equipment often does not fit into these dimensional limitations, creating critical situations when emergency access to the patient is required. At the same time, exceeding the standard area during the state examination is perceived as an unjustified increase in the cost of the project, which puts the architect in a difficult situation - to comply with the norms or ensure the functionality of the premises. As a result, the architect has to "integrate" modern technologies into outdated spatial constraints, which reduces ergonomics, increases the risk of errors and creates uncomfortable conditions for staff and patients.

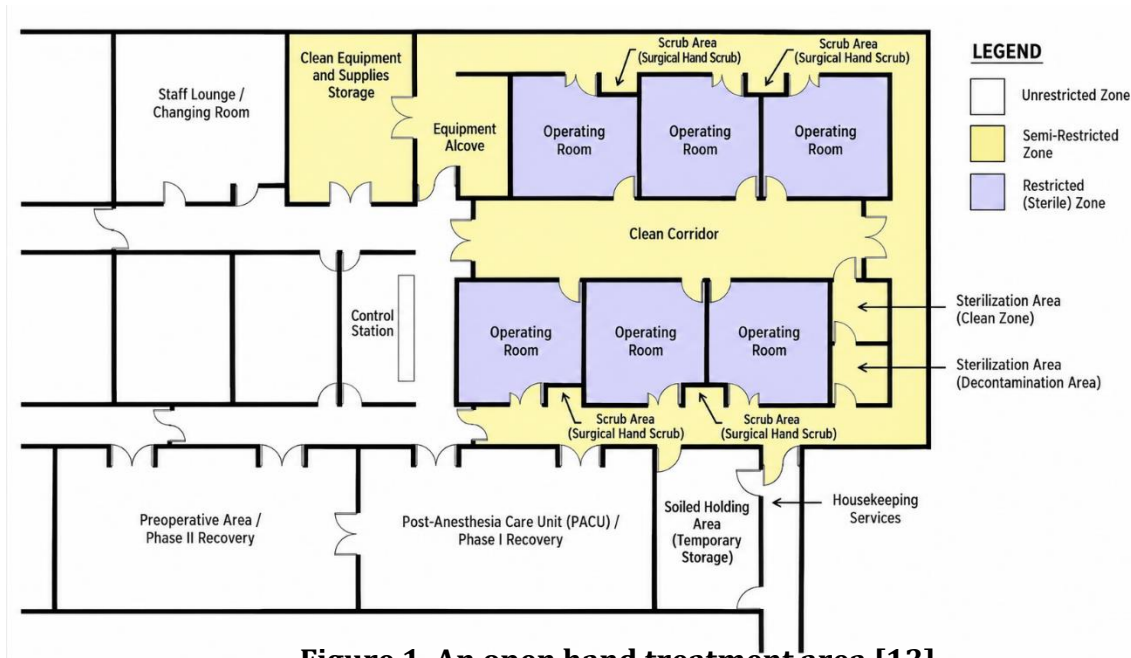


Figure 1. An open hand treatment area [13].

Research in the field of "evidence-based design" confirms that the internal organization of space directly affects the safety and effectiveness of treatment, and a well-designed architectural and planning structure reduces staff stress and the number of medical errors [9]. In the context of the above facts, a strict metric approach within the framework of national norms and regulations assumes a high level of risk of obsolescence and non-compliance with modern requirements of clinical practice, while the functional model of FGI provides flexibility and adaptability to technological development of processes (Table 1).

Organization of operational units in the context of isolation and optimization of processes

The differences are most evident when comparing approaches to the design of operating units, which are the most technologically complex and especially important areas of a medical facility from the point of view of increased security. The current sanitary and building regulations of the Republic of Kazakhstan preserve the ideology of strict spatial separation into "sterile" and "dirty" zones organized through separate corridors, stairs and elevators. This structural model goes back to the origins of the Soviet normative school of design of the 1960s and 1970s and assumes that infection safety is achieved primarily by architectural isolation of flows [10, 11]. To build a medical waste disposal system, it is necessary to provide separate "dirty" corridors and elevators; this approach leads to a complication of the planning structure of the operating unit and a significant increase in the total area of the building. Based on the results of the evaluation of design practice

and the analysis of implemented projects, these solutions can increase the construction volume of the facility by 15-20% [12], which significantly increases financial costs without proven improvement of clinical processes. On the other hand, the requirement to set up enclosed spaces for preoperative hand treatment by personnel [2, 3] leads to a quantitative increase in rooms and complicates the layout of the operating unit (Figure 2). According to FGI, it is recommended to design open niches for the treatment of staff hands, embedding them in the operating room space. This solution reduces long logistical routes for staff movement and opens up the possibility of constant monitoring of processes in the operating room (Figure 1).

According to international standards (FGI, JCI), the sterility of the operating unit is considered as a result of the interaction of architecture, engineering systems and operational protocols, where each element plays its key role in ensuring safety.

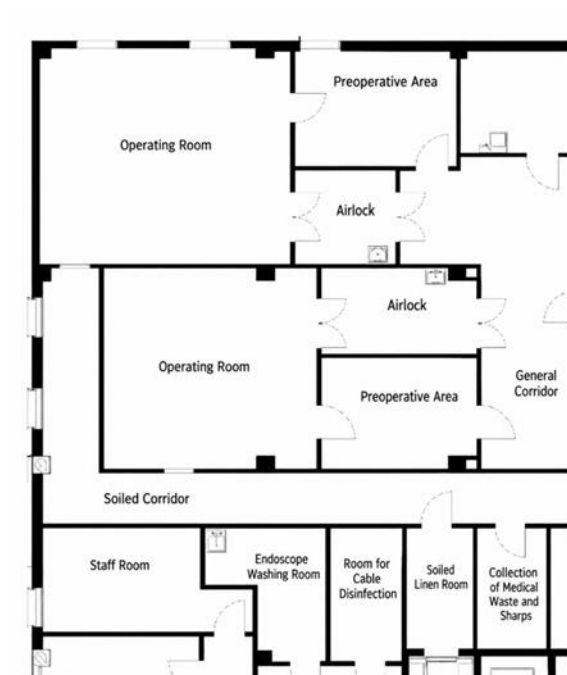


Figure 2. Two-corridor solution of the operating unit (design materials of the author).

In modern Western medical institutions, this issue is solved through a system of closed containers, vacuum or pneumatic transportation, as well as hermetically sealed trolleys with clearly delineated routes and operating regulations. As a result of this approach, the transportation of "dirty" materials is allowed along common corridors without the risk of cross-infection, since safety is ensured not by walls, but by packaging technology, transportation, and operational requirements. Scientific research [9] proves that the key factor in preventing cross-contamination is not the presence of a separate dirty corridor, but the frequency of door openings and the organization of staff movement. With a single-corridor planning structure, when medical waste is packed inside the operating room, the number of exits to the corridor is reduced. This makes such a system safer compared to a two-corridor system, where staff movement is more chaotic.

Building life cycle cost analysis: capital and operating costs

One of the key differences between the domestic and international regulatory frameworks is the approach to financial and economic assessment of design solutions throughout the entire life

cycle of a building. In Kazakhstan's design practice, priority is traditionally given to minimizing CapEx (Capital Expenditure) - capital expenditures during the construction phase. This is manifested in strict control over not exceeding the cost per square meter [14], optimization of architectural, planning and design solutions, rejection of complex facade systems, as well as the choice of budget finishing materials and engineering equipment. When designing hospitals on a government order, the customer, limited by tight budget limits and procurement procedures at the lowest price, is forced to give priority to reducing initial costs. This systematically leads to a balancing act between the choice of engineering equipment, high-quality building materials and architectural solutions, which further negatively affects the operational reliability and durability of healthcare facilities. Energy efficiency of a building is often considered as a technical task implemented at the final stages of design by selecting equipment, and the architectural shape of the building, the orientation of the facades and the planning structure are rarely analyzed in terms of energy consumption and adaptation to climatic conditions.

Parameter	National standards	JCI/FGI
Priority	CapEx (capital expenditures)	OpEx (operating costs)
Share of operating costs	It is not taken into account in the design	70-80% of the cost for 30-40 years
The cost approach	Minimizing the cost of m2	Life Cycle Cost (LCC)
Energy efficiency	An engineering challenge in the late stages	Integrated into the architecture from the early stages
Energy saving	Conditionally regulated	Up to 40-50% compared to the baseline
Selection of materials	Minimum cost, frequent repairs (3-5 years)	High wear resistance, durability (15-25 years)
Climate adaptation	The initial condition for calculations	The formative factor
Design Philosophy	Compliance with formal standards	Long-term cost optimization
Planning horizon	1-5 years	30-40 years

Table 2. Comparative analysis of economic approaches

The choice of materials is focused on compliance with sanitary requirements and minimum

cost, which often leads to the need for frequent cosmetic repairs every 3-5 years, increasing operating costs and disrupting the work of medical institutions, creating inconvenience for patients and staff.

International design standards, on the contrary, are based on the concept of Life Cycle Cost (LLC, life cycle cost) and focus on optimizing OpEx (Operating Expense) - operating expenses during the operation of the facility. Research by the Whole Building Design Guide [15] and Life Cycle Cost Analysis (LCC) [16] proves that operating costs (OpEx) exceed 3.6 times the initial investment in design and construction for modern buildings with an estimated service life of 60 years. Taking this approach into account, the architect acts not only as the author of a spatial planning solution, but also as a strategist who calculates the long-term economic efficiency of each decision. Higher initial investments in energy-efficient facade systems, high-quality engineering equipment and durable materials pay off with significant reductions in operating costs and increased comfort for patients and staff (Table 2).

Energy efficiency is integrated into architectural design from an early stage. Climate is considered as a formative factor determining architectural typology, and not only as a starting condition for engineering calculations. It is recommended to use materials with high wear resistance and long service life (for example, HPL panels with a 15-20-year warranty, homogeneous floor coverings with a service life of up to 25 years), which retain functional and aesthetic characteristics for decades and reduce total costs during the life cycle of a building by 30-40% compared to budget counterparts. requiring frequent replacement.

Thus, the difference between regulatory systems lies not only in specific numerical parameters and requirements, but also in the fundamental design philosophy that defines the role of the architect, the planning horizon and criteria for making design decisions.

Functional planning solutions and operational efficiency

A comparative analysis revealed significant differences in the approach to the organization of functional relationships within medical institutions, and these decisions directly affect the effectiveness of staff and the quality of medical care provided. National standards focus on compliance with areas and the isolation of functional planning areas, while analyzing the internal logistics of personnel, optimizing work processes and ergonomics of medical activities often remain outside the regulatory framework. This leads to the formation of long corridors, remote placement of office premises and inefficient organization of work areas, and this results in increased physical strain on staff and response time to patient requests (Table 3).

International design standards actively use the concept of evidence-based design, which examines real-world scenarios of building operation using timekeeping, video surveillance, and staff surveys. One of the main parameters is the "nurse's path" - the distance that medical personnel travel during a shift between wards, posts, auxiliary rooms and storage areas. Studies show that in traditionally designed departments, a nurse can walk up to 4-6 km per shift, and as a result, increased physical fatigue and a decrease in the quality of medical care for patients at the end of a work shift [17].

Reducing the distances between key functional points increases staff efficiency, reduces fatigue and the likelihood of errors by up to 20% [17]. From an architectural point of view, this is achieved through compact planning schemes (for example, radial or group configurations instead of corridor ones), the rational placement of nursing posts in the geometric center of the department with the possibility of visual monitoring of all wards, the decentralized placement of storage and preparation areas for medicines, as well as the rejection of excessively long corridors.

As a result, the difference between standards lies not only in numerical indicators of areas and

distances, but also in the project philosophy, which defines the role of the architect in the decision-making process - from the author of the interpretation of regulatory requirements to the designer of high-tech workflows and an active participant in the formation of a model of medical care.

Aspect	National standards	JCI/FGI
The concept of sterility	Architectural isolation	Managed process (engineering+protocols)
Waste disposal	Separate "dirty" corridors and elevators	Closed containers, pneumatic transport, common corridors
Increase in construction volume	+15-20% due to duplication of communications	Optimization through technology
Preoperative hand treatment	Closed boxes	Open areas with controlled ventilation
Ensuring sterility	Spatial separation	Laminar flows, pressure monitoring, monitoring
Flexibility of layout	Rigid structure	High (compact, adaptable)
Evidence base of effectiveness	Tradition, historical experience	Clinical trials

Table 3. Comparative analysis of approaches to the design of operational units

Conclusion

At the state level, Kazakhstan recognizes the need for a transition to international standards and the unification of national standards with the requirements of JCI and FGI. The "Concept for the development of healthcare infrastructure for 2024-2030" notes that JCI requirements should be taken into account already at the design stage, since it is the requirements that contribute to ensuring the systemic quality and safety of medical services [1]. This indicates the importance not only of the architectural form, but also of the technological process and the recognition of the need to synthesize the principles of functional design and patient safety into national standards. In turn, in practice, this transition may face a number of barriers: lack of methodology for implementing international standards into the national regulatory framework, insufficient training of designers in the field of evidence-based design, resistance from expert organizations using more traditional

approaches in their work, as well as economic constraints associated with higher initial investments in the application of international standards.

Based on the results of the comparative analysis, it is confirmed that the differences between JV/CH RK and JCI/FGI standards are systemic in nature and cover all aspects of design - from conceptual foundations to the application of specific technical solutions. International practice considers architecture as a risk management tool and support for the medical process, while the domestic regulatory framework is still focused on limiting construction parameters and formal compliance with requirements. The transition from a space-oriented to a process-oriented approach to design requires not only updating the regulatory framework, but also changes in the professional qualifications and methodology of architectural design in the field of healthcare, including the introduction of an integrated approach involving medical practitioners and consultants at all stages of design. The integration of the principles of functional and spatial design, evidence-based design and the concept of Life Cycle Cost into national standards is a key condition for improving the quality of design and efficiency of healthcare facilities in Kazakhstan, as well as a necessary step to achieve an international level of quality of medical care and patient safety.

Contribution of the authors:

Yugay M.S. - research concept, collection and processing of materials, data analysis and writing of the text of the article.

Semenyuk O.N. - scientific guidance, critical revision of the content and approval of the final version of the manuscript.

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