ENGINEERING CHALLENGES OF VENTILATION AND AIR EXCHANGE IN THE HOSPITALS DURING COVID-19

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Abstract: *features of ventilation and air conditioning of various types of hospitals. The pandemic has revealed problems in engineering systems of air exchange during the transformation of ordinary hospitals into facilities for the treatment of contagious infectious diseases. New engineering solutions are required for possible future pandemics.*
Keywords: *air conditioning, air exchange, ventilation, Covid-19, hospital engineering.*

ОБЕСПЕЧЕНИЕ ВОЗДУХООБМЕНА В БОЛЬНИЧНЫХ УЧРЕЖДЕНИЯХ И ОСОБЕННОСТИ В ПЕРИОД КОВИД-19

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Аннотация: *особенности вентиляции и кондиционирования воздуха различных типов больничных учреждений. Пандемия Ковид-19 выявила проблемы в решении инженерных вопросов, связанных с воздухообменом помещений при перепрофилировании обычных больничных подразделений в инфекционные. Требуются новые инженерные разработки с учетом возможных будущих пандемий и других непредвиденных ситуаций.*
Ключевые слова: *кондиционирование, вентиляция, воздухообмен, Ковид-19, больницы, инжиниринг.*

The current Covid-19 situation requires special approaches in operating various health facilities. New approaches are needed to solve the challenges of hospital engineering and the training of technical personnel at specific healthcare facilities. The epidemiological situation in different countries can vary but the technical problems are similar. We must always be prepared for new pandemics and other challenges.

The complexity of the healthcare system is defined by a wide variety of different types of medical facilities. Each of these types of healthcare institutions is distinguished by its originality in the organization of the work of engineering support, and technologies related to medical, sanitary, fire, environmental, and other requirements.

Higher operational requirements appear at specific facilities, and also at some strategic structural units, often located in the same building along with the usual non-specific facilities and services. For example, a surgery block or X-ray rooms, their technologies cannot even be compared. Approaches to engineering maintenance and use of premises are so different in all respects that poorly trained or insufficiently trained technical personnel can inadvertently establish the incorrect setting operation of a specific facility, which can cause the spread of infectious agents and affect people's health.

In the case of indoor air exchange which is calculated by the engineers and included in the design documentation, then the adjusters of the ventilation and air conditioning systems bring the parameters to the design mode. And during the operation of the facility, not knowing the specific features and technological issues, the technical staff may neglect the order of operation of the engineering equipment. In many hospitals, there are cases where there are no instructions for operating equipment in specific areas.

The instruction on the operation of engineering systems as a whole should be with the engineering service, but when working with specific or non-standard cases and technologies, such documents are often absent. Therefore, you have to rely only on the high professionalism and knowledge of the service personnel. And there should be a system of measures and personnel training in order not to miss important points in the operation of engineering systems.

When the exhaust ventilation system in operating rooms is activated before work, then air is sucked in from external rooms or systems with hidden defects, and then the “clean zone” of the operating room can be contaminated since bacteria and microorganisms come from conditionally “dirty areas". This may adversely affect the success of the operation. It is required to supply fresh air to the operating rooms 10-15 minutes before the start of work, its amount is determined by calculation, and only after the supply air has been created, the exhaust ventilation system can be turned on, thus eliminating the suction of “dirty air” into sterile operating rooms. Now air exchange systems are mostly automated. But during periods of failure or switching systems to different modes, personnel must be in control of the process technology that maintains the stable operation of the operating unit. To do this, the engineering service needs to have instructions for various options that may arise in the process of the system's

operation in order to minimize the consequences for patients in the operating room, due to the possible entry of "dirty air" into "clean areas".

In a different situation in the maintenance of X-ray rooms, the approach to solving the air exchange in the premises is distinctive. Since such cabinets work with radioactive radiation, other requirements become crucial. In this article, we will consider only air exchange, without touching on other aspects of the X-ray service technology. In x-ray rooms, it is advisable to provide an exhaust air system not only from the upper zone of the room, but also from the lower zone. At the same time, it is necessary to remove air from the room in larger volumes from the lower zone than from the upper level while the volumes of air removed are calculated according to the norms depending on the volume of the room, type of equipment, number of patients, etc. In X-ray rooms, exhaust ventilation systems are first turned on to remove air from the lower and upper zones. At the same time, the air removal system should not be used in other rooms not associated with X-ray rooms. This is done to ensure that micro radioactive elements do not get into other rooms, but are taken to safe areas. If you first turn on the supply air supply systems in X-ray rooms at the beginning of work, then the radioactive elements will be squeezed out into the adjacent rooms by air pressure. This is a simple example of the features of the disease.

The issues of hospital operation during the Covid-19 pandemic have clearly shown that approaches to hospital engineering need to be changed and adjusted taking into account new situations with the emergence of possible infections, and environmental and other problems.

During the pandemic, hospitals were able to quickly transform ordinary rooms into rooms for Covid-19 patients. This helped to save lives. But at the same time, the engineering systems of hospitals did not have adjustments.

For example, one large ventilation system can serve many rooms on different floors. And, if patients with Covid-19 are temporarily placed there on one level, and all other patients are on the other level then if they are supplied by the same ventilation system and there is the probability that viruses with air will enter areas with non-infectious patients. This is especially possible when the ventilation equipment is turned off for resetting or does not turn on at all. Then the free flow of air from one room to another due to the difference in temperature, air density, and other factors in the rooms, allows spontaneous air gas exchange. Viruses would move along with the air, and most of them settle in place, but theoretically, also could also transfer to other facilities.

Hospital laboratories that work with the biomaterial of infected patients should have more stringent engineering support during pandemics. As It turned out the engineering solutions of hospitals during the pandemic were not always safe from the spontaneous spread of viruses. There are no statistics on this, but there were cases reported. In the future, this problem should be taken into account when designing hospitals.

The new challenges of the Covid-19 pandemic required a sufficient number of facilities specially designed for this, with sophisticated technology and high requirements for engineering support with clear regulations for their work. Such facilities should include "clean room" technology, which requires a specific engineering strategy. This is important to prevent accidental contamination by viruses and bacteria from other facilities.

Given the new epidemiological reality, to minimize the risks, it is necessary to have more flexible and refined engineering solutions as well as specialized training programs for engineering personnel.

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