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The Status of Research on Clean Air Conditioning System in Hospital Operation Room

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Abstract

With the gradual improvement of medical level, the influence of the operating room environment on surgical results is becoming more and more obvious. This paper reviews the current situation and significance of clean air conditioning systems in different operating rooms of hospitals, and explores the application of environmental control technology in the operating room, such as the form of airflow in the operating room, the selection of air-conditioning system and equipment, indoor heat and humid air treatment process, control of pollutant concentration, and so on, which reveals the important impact of the operating room airflow environment on surgery and forecasts the application of clean air-conditioning system in the hospital operating room.

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Keywords: Operating room; Clean air conditioning; Airflow organization; Pollutant concentration

1. Introduction

With the rapid development of China's economy in recent years, people's living standard has been greatly enhanced, and higher demands for medical treatment have been pursued, which will further push forward the improvement for the construction level of medical facilities. Therefore, clean operation room, especially senior clean operation room, will give full play to a more and more important role. It is known to us that the cleanness of an operation room is a key link in controlling infection, which will directly influence the infection rate after the operation. Therefore, the requirement for clean air conditioning technology is gradually increasing[1].

In GB50333-2002 Specifications for the Construction Technology of Clean Hospital Operation Rooms published and implemented in 2002[2], operation rooms were divided into four levels, including especially clean operation rooms, standard clean operation rooms, generally clean operation rooms, and to-be clean operation rooms. Their leveling standards and indicators are shown in Table 1.

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Table1. Standard of clean operation room

Level	Classification of the operating room			The largest average		The maximum density of surface forms pollution	Air cleanliness level	
				concentration			Operating zone	surrounding zone
I	special room	clean	operating	0.2(5/m ³)	0.4(10/m ³)	5/m ³	100	1000
II	standard room	clean	operating	0.75(25/m ³)	1.5(50/m ³)	5/m ³	1000	10000
III	general room	clean	operating	2(75/m ³)	4(150/m ³)	5/m ³	10000	100000
IV	quasi clean		operating room	5(175/m ³)		5/m ³	300000	

2. Clean operating room air-conditioning system features *Air distribution mode*

2.1. *Air distribution mode*

The airflow state in a clean operation room plays a vital role in controlling the pollutants in a clean room, which can be divided into non-unidirectional airflow and unidirectional airflow in line with the level of the clean room, as well as the requirements of the design. Unidirectional airflow gradually squeezes the dirty air and discharges it to the return air outlet by means of piston displacement, to achieve certain dynamic balance, thus cleaning the air. On the other hand, the principle of non-unidirectional airflow is to dilute the concentration of indoor pollutants by mixing the clean airflow sent to the room and the indoor air.

Recently, foreign researchers have studied on the air distribution in clean operation rooms by making use of CFD (Computational Fluid Dynamics) simulation technology, hoping to get more reasonable air distribution mode. American scholar Farhad Memarzadeh[3,4] simulated the air distribution of different systematic modes by applying CFD, and evaluated the distribution of all kinds of particles during the operation process through mathematical models, to seek out the optimal systematic mode. Yan et al. [5] simulated the designed air quantity of operating rooms by making use of CFD technology, verified the indoor cleanliness, and simulated personnel's influence on the cleanliness of operating rooms. As a result, they obtained the conclusion that with the air supply velocity of 0.48m/s, it could meet the requirement of the velocity in cross section of operating rooms in the Standards, namely 0.25-0.30m/s. What's more, the dust concentration and bacterial colony number obtained from work can completely meet the cleanliness requirement of 100-level clean operation room. Taking Level III operating rooms as the research object, Deng [6] et al. studied the airflow mode in operating rooms by combining CFD value simulation, the result of which shows that the vortex area of clean operation rooms may be increased with the decreasing size of air supply outlet. Meanwhile, the blowing-in speed of air may be increased, but it is not favorable for the running of clean operating rooms. Liang, et al. [7] from Nanjing Tech University have studied the effect of air curtain device on the air distribution in operating room, and found that the air curtain not only has buffer function, but also has strong resistance to external disturbance when it reaches to breaking wind speed, which can effectively protect the operating area from being distracted by external environment. Wei, et al. [8] from Harbin Institute of Technology have studied the characteristics of concentrated air supply and return air on both sides in unstable triangle eddy in unidirectional-flow clean room. The results show that the height of the air outlet has a close relation to the width of the triangle eddy. Upon the requirements, the width of the clean room shall be reduced as much as possible.

2.2. *Air conditioning system and cold and heat sources*

Design concept of an air conditioning system in the hospital clean operating room is different from the general industrial clean room. Key parts shall be especially protected and bacteria control measures are required to ensure a set of sterile protection system to ensure a smooth and effective operation. At present, clean air conditioning system is divided into stand-alone system and multi-machine system. Stand-alone systems are served for one operating room or 2 to 3 operating rooms [9]. Standards states that clean air conditioning system shall ensure the overall

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