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FUNDAMENTALS OF RAPID ASSESSMENT OF INDOOR AIR CLEANLINESS

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Abstract: Maintaining indoor air cleanliness is essential for ensuring human health, comfort, and overall hygienic conditions, particularly in healthcare facilities, educational institutions, workplaces, and residential environments. Rapid assessment methods play a crucial role in evaluating air quality directly on-site, providing immediate and reliable results without the need for complex laboratory analyses. These methods allow for the prompt identification of key indicators such as carbon dioxide (CO_2) concentration, temperature, humidity, airflow velocity, dust and aerosol levels, as well as indirect signs of microbial contamination.

This article discusses the fundamental principles of rapid indoor air quality assessment, highlights the most widely used techniques and instruments, and outlines the hygienic standards for optimal indoor environmental conditions. The application of these methods helps to detect ventilation inefficiencies, prevent the spread of airborne infections, and improve the overall quality of life and workplace safety.

Keywords: indoor air quality, rapid assessment, CO_2 concentration, ventilation, aerosols, hygiene standards, air cleanliness.

INTRODUCTION

Indoor air quality plays a critical role in maintaining public health, comfort, and overall well-being. People spend up to 80–90% of their time indoors, whether at home, in workplaces, educational institutions, or healthcare facilities. Poor indoor air quality can negatively affect human health, leading to decreased productivity, respiratory diseases, allergic reactions, and even the spread of infectious diseases. Therefore, monitoring and maintaining optimal indoor air cleanliness has become a priority in modern environmental and public health practices.

Traditional laboratory-based methods of assessing indoor air quality, while accurate, are often time-consuming, costly, and require specialized equipment and personnel. In many cases, rapid on-site assessment is necessary to make immediate decisions, particularly in settings such as hospitals, classrooms, or industrial facilities where air cleanliness directly impacts health and safety.

Rapid assessment methods provide a practical solution by allowing quick, reliable, and cost-effective evaluation of indoor air without complex laboratory procedures. These techniques focus on key indicators such as carbon dioxide (CO_2) concentration, relative humidity, temperature, airflow velocity, dust and aerosol levels, and indirect signs of microbial contamination. By promptly identifying deviations from hygienic norms, these methods support timely interventions to improve ventilation systems and prevent potential health risks.

This article aims to review the fundamental principles of rapid assessment of indoor air cleanliness, discuss commonly used tools and techniques, and emphasize their significance for maintaining safe and healthy indoor environments.

METHODS

Providing children's and medical institutions with fresh air is one of the most basic hygienic requirements. Various ventilation networks are used to replace polluted air in rooms, wards and other buildings with fresh air. The following types of providing buildings with fresh air are distinguished:

1. Ventilation of rooms through windows, transoms and doors.
2. Air exchange by natural and mechanical means, but without recycling the incoming air.
3. Air exchange by means of air heating networks and air conditioning, which provide air exchange. An effectively designed and constructed ventilation network creates the most comfortable microclimate in hospitals and children's institutions.

Air exchange is mainly carried out in two ways:

1. Natural ventilation
2. Artificial (mechanical) ventilation.

One of the most convenient types of air exchange is natural air exchange, and this method is currently widely used in DPMs. The most effective method is air exchange by simultaneously opening windows, windowsills, transoms and doors (elvizak). With this method of air exchange, the room air temperature decreases by 1.5-2.9 C within 10-15 minutes. With the elvizak method, air exchange occurs quickly, creating a favorable microclimate in the summer. The order of air exchange is carried out depending on the season, including in the cold season, when airing windows, windows, transoms is half-opened for a long time, and in the cold season, it is preferable to open them for a short time. As a result of the cold entering through an open window or window for a long time, the walls of the wards cool down at the same time as the air, which causes a feeling of freezing cold "chilling" in patients. Therefore, in order to reduce the impact of cold air on patients, transoms are used in Treatment Prevention Institutions instead of windows.

RESULTS

Artificial ventilation. Natural ventilation is not always practical. Because it is not always possible to regulate the amount of air flowing into the wards. Taking this into account, artificial ventilation networks are increasingly used in hospitals.

The following types of artificial ventilation networks are distinguished:

1. Extraction networks that remove polluted air from the rooms.
2. Supply networks that heat the air needed by the rooms in the winter.
3. Supply-extraction networks that bring fresh air needed by the rooms and extract polluted air.

The network that brings the extraction network to the exhaust air outlet is of “local”, “general”, “combined” (combined) types, depending on the place of supply of fresh air from the outside in the rooms. In non-entrance wards of hospitals, there are usually supply-exhaust ventilation networks, in wards with entrances there are two options:

1. Supply-exhaust ventilation networks with suction from sanitary networks through the entrance.
2. Only supply and suction networks with suction from sanitary networks through the entrance are used.

Surgical blocks, boxes and semi-boxes should have a separate supply-exhaust ventilation network that does not connect to other networks.

In most hospitals, the volume of air per patient per hour is 80 m3, this indicator may vary depending on the hospital departments and the age of the patients. In infectious diseases and purulent surgery departments, the suction network should be stronger than the supply network. In a number of rooms, including delivery rooms and operating rooms, the supply network should be stronger than the exhaust network.

DISCUSSION

The rapid assessment of indoor air cleanliness has become increasingly important due to the growing awareness of the effects of indoor air quality on human health and productivity. The findings of this study emphasize that rapid evaluation methods are essential for identifying air quality issues promptly and implementing timely corrective measures. Unlike conventional laboratory-based techniques, which often require complex sampling procedures and significant time to obtain results, rapid assessment tools offer immediate and reliable data, making them suitable for practical use in healthcare, education, and industrial settings.

One of the primary indicators used in rapid assessment is carbon dioxide (CO_2) concentration, which reflects the adequacy of ventilation. Elevated CO_2 levels, typically above 700 ppm, indicate insufficient air exchange and the accumulation of exhaled air. This condition is associated with symptoms such as headaches, fatigue, and decreased cognitive performance. In environments such as classrooms, offices, and hospitals, continuous monitoring of CO_2 is particularly important to ensure optimal ventilation and reduce the risk of airborne disease transmission. Portable CO_2 meters and chemical indicator tubes, such as Dräger tubes, have proven effective for quick and accurate measurements in these settings.

In addition to CO_2 monitoring, temperature and relative humidity are critical factors influencing comfort and microbial growth. Rapid assessment using portable thermometers and hygrometers provides valuable information about the microclimate of a room. Maintaining a temperature between 18–22°C and relative humidity between 40–60% not only enhances comfort but also reduces the survival rate of pathogens, especially in healthcare environments where infection control is paramount.

Dust and aerosol concentration serve as another key parameter in air cleanliness evaluation. High particulate matter levels can exacerbate respiratory conditions such as asthma and chronic obstructive pulmonary disease. Rapid assessment devices, including portable dust meters and light-scattering instruments, enable quick estimation of particulate matter levels. In resource-limited settings, simple visual methods, such as dust accumulation plates, can provide a preliminary indication of air pollution.

Moreover, the integration of rapid assessment data into ventilation management systems enhances overall building performance. When deviations from hygienic norms are detected, immediate actions can be taken, such as increasing natural ventilation, adjusting mechanical ventilation rates, or installing air purification systems. This proactive approach not only prevents health issues but also supports sustainable building management practices.

However, rapid assessment methods have certain limitations. While they provide fast and practical results, they may lack the precision of comprehensive laboratory analyses. For instance, while CO_2 serves as a good indirect indicator of ventilation efficiency, it does not measure specific pollutants such as volatile organic compounds or biological contaminants directly. Therefore, in cases of severe or unexplained air quality issues, detailed laboratory investigations remain necessary to complement rapid assessments.

Overall, the discussion highlights that rapid assessment methods are indispensable tools for maintaining indoor air cleanliness. Their application enables real-time monitoring, quick decision-making, and preventive interventions, which are crucial for reducing the spread of airborne diseases and ensuring a safe and comfortable indoor environment. Future developments in sensor technology and data integration are expected to further improve the accuracy and usability of these methods, making them even more effective in promoting public health and environmental sustainability.

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