Journal of Medical & Surgical Pathology

Shi et al., J Med Surg Pathol 2016, 1:4
DOI: 10.4172/2472-4971.1000138

Research Article Open Access

Evaluation of Purification Effect of Intelligent Air Purifier in the Pathology Department

Like Shi[1*], Yue Wang[1], Liang Xu[2], Yan Liu[1], Yuan Jia[1], Dongsheng Yao[2] and Xiuwu Li[1]

[1]*Infection Control Department, the Second Hospital of Hebei Medical University, Shijiazhuang 050000, China*

[2]*Hebei ENCANWELL Environment Science and Technology, China*

[*]**Corresponding author**: Like Shi, Infection Control Department, the Second Hospital of Hebei Medical University, Shijiazhuang 050000, China, Tel: +8615803210812; E-mail: shilike15911@sina.com

Received date: June 28, 2016; **Accepted date**: September 22, 2016; **Published date:** September 28, 2016

Abstract

Objective: Evaluate the application effect of the intelligent air purifier through the analysis of monitoring results before and after the pathology department air purification.

Method: Make 30 days of real time, dynamic monitoring to the air quality of the pathology department conventional technical support division before and after purification by "eagle eye" environment monitor, record 100 times of monitoring data of the work time and make analysis.

Result: The concentration of formaldehyde, TVOC, CO_2 and CO before purification are 1.21 ± 0.80 mg/m^3, 0.21 ± 0.46 mg/m^3, 0.06 ± 0.01%, 3.28 ± 1.49 mg/m^3, while after purification which respectively are 0.06 ± 0.01 mg/m^3, 0.00 ± 0.00 mg/m^3, 0.06 ± 0.01%, 0.71 ± 0.33 mg/m^3.

Conclusion: Through the real time monitoring to the air quality of the pathology department after using the intelligent air purifier, we find that the concentration of formaldehyde, TVOC,CO and PM 2.5, PM 10 are markedly reduced (P<0.05), those were in the safety level, it can make sure the staff health by using the air purifier.

Keywords: Pathology department indoor air quality; PHI purification; Real time monitor; Purification effect

Introduction

Air pollution generally means a phenomenon that certain substances caused by human activity or natural process get into the atmosphere, after reaching enough concentration and enough time, endanger the human comfort, health and welfare or the environment. It is mixture of all the solid and liquid in the air, which include physical particle, carbon monoxide, methane, nitrogen oxides, volatile organic compounds and metal powder [1], etc. At present, the harm of air pollution on human health has become one of the hot social attentions. Indoor air pollution, especially chemical and biological pollution, has great harm to human health. In the hospital due to technical needs, the content of formaldehyde, PM apparently exceeds the standard, which will cause and aggravate heart disease [2-5].

Indoor air pollution concentration measurement include physical particle diameter less than 10 μm (PM 10), formaldehyde and carbon dioxide (CO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), total volatile organic compounds (TVOC), benzene, toluene, ethyl benzene, xylene, styrene, bacteria and fungi of aerosol [6].

"Indoor air quality standard GB/T18883-2002" [7] formulated the related national standards about the indoor temperature, humidity, PM, harmful gas concentration. So the indoor air quality monitoring and management is imperative. The way to improve air quality can be divided into source control, ventilation, air purification, etc. At present according to the air purifier for particle removal techniques in the air, there are mainly machinery, static in a mesh type, mesh type high voltage electrostatic dust collection, anion and plasma method, etc. But the product is uneven, some irritating, and some purification efficiency is low, it is difficult to meet the requirements of continuous purification. In this article, we made a real time monitoring to the air quality purification effect of the intelligent air purifier, results are reported as below.

Materials and Methods

Air quality monitoring equipment

Eagle eye environment monitor was used for the measurement of air quality. Transducers used are formaldehyde (HCHO) transducer which adopted electrochemical principle, whose range is 0-12 mg/m^3, resolution ratio is 0.005 mg/m^3; carbon dioxide (CO_2) transducer adopted infrared optics principle, whose range is 0-3598 mg/m^3, resolution ratio is 147 mg/m^3; PM 2.5 and PM 10 transducer adopted laser principle, whose range is 1-10 μm, resolution ratio is 1 μm; total volatile organic compound (TVOC) adopted PID principle, whose range is 0-20 mg/m^3, resolution ratio is 0.004 mg/m^3.

Air purification equipment

The purifier adopts filter, activated carbon adsorption, plasma combined purification mode. Efficient filter and activated carbon filter layer filter the dust particles, adsorb formaldehyde, toluene and other harmful gas, plasma sterilization purifier release purification factor,

active settlement PM 10 and PM 2.5 particles, purify the harmful gas such as formaldehyde, toluene, kill pathogenic microorganisms.

Statistical method

SPSS18.0 was used to make data statistical analysis, using Student-Newman-Keuls (SNK)to check the difference of groups of two and compare, inspection level is 0.05.

Result

Pathology department indoor chemical gas purification effect

After 100 times of measurement, by using the intelligent air purifier, the indoor CO_2 concentration before and after purification are all 0.06 ± 0.01(%), with no obvious difference. Concentration of formaldehyde, CO, TVOC have significant difference (P<0.05), and the formaldehyde concentration is lower than the national standard of 0.10 mg/m^3, as shown in Table 1.

monitoring index	N	Before (mg/m^3)		After (mg/m^3)		P value
		x ± S	95% CI	x ± S	95% CI	
HCHO	100	1.21 ± 0.80	(1.05, 1.37)	0.06 ± 0.01	(0.06, 0.07)	0
CO	100	3.28 ± 1.49	(2.98, 3.57)	0.71 ± 0.33	(0.64, 0.77)	0
TVOC	100	0.21 ± 0.46	(0.12, 0.30)	0.00 ± 0.00	(0.00, 0.00)	0

Table 1: Pathology department indoor chemical gas purification effect.

Pathology department indoor particulate matter purification effect

After 100 times of measurement, by using the intelligent air purifier, the indoor PM 2.5 and PM 10 concentration decrease have significant difference (P<0.05) (Table 2).

monitoring index	N	Before (mg/m^3)		After (mg/m^3)		P value
		x ± S	95% CI	x ± S	95% CI	
PM 2.5	100	0.18 ± 0.03	(0.17, 0.18)	0.06 ± 0.01	(0.06, 0.07)	0
PM 10	100	0.32 ± 0.11	(0.30, 0.34)	0.11 ± 0.02	(0.11, 0.11)	0

Table 2: Pathology department indoor particulate matter purification effect.

Discussion

The harm of formaldehyde

Formaldehyde is a kind of chemical raw materials, also be used as a preservative, disinfectant and insecticide, etc. in many industrial process. In pathological science laboratory, which is widely used in fixing and preservation of specimens? Formaldehyde is great harm to human body, which can be absorbed through respiratory tract, digestive tract and skin. The acute harm of formaldehyde mainly is irritation and sensitization to the respiratory tract mucous membrane, eye conjunctiva and skin. Chronic harm of formaldehyde is the damage to the liver, skin and immune system, carcinogenesis, etc. Long-term inhaled formaldehyde concentration higher than 0.45 mg/m^3 can significantly increase the incidence of chronic respiratory disease. Inhalation of high concentration (>60 mg/m^3) formaldehyde can cause pneumonia, throat and pulmonary edema, bronchospasm, and even respiratory failure. Formaldehyde also has the neurotoxicity and reproductive toxicity. Formaldehyde is determined to be suspicious of cancer teratogenic substances [8] by the world health organization (WHO).

The harm of particulate matter

The harm of particulate matter (PM) on human is related with the size of the particle diameter. The smaller the diameter, the deeper into the respiratory tract. Particles of 10 mm in diameter are deposited in the upper respiratory tract, particles of 5 mm are deep into the respiratory tract, and particles less than 2 mm can all go deep into the bronchi and alveoli. A large number of domestic and foreign literature reported that PM 10 can significantly affect the human health, can cause extensive damage of the body's respiratory system, heart and blood system, immune system and endocrine system etc. [9,10]. Pope and other people [11], found that the particulate matter concentration in the air is highly correlated with sample total mortality, cor pulmonale mortality, lung cancer mortality, PM 10 increase per 10 μg/m3, the risk of cor pulmonale mortality and lung cancer mortality rate is increased by 6% and 8% respectively, relative risk in serious pollution areas could be higher. In addition, studies have shown that children are more sensitive to the damage caused by inhalable particles [12].

The purpose of air purification is to reduce or eliminate various kinds of pollutants in the air by purifying effect, make it reach a certain health standards. The traditional air purification equipment is mainly through the filter of dust particles to reach the purpose of purification, but the harmful gas such as formaldehyde, toluene, etc. cannot be removed.

Intelligent air purifier adopts air filtration and plasma cleaning principle, plasma contains a large number of electrons and positive and negative ions adsorb tiny dust through the charge effect, which makes the plasma effectively reduce particulate matter in the air and purify the air safely and effectively in some environment with human. According to the variation of indoor air environment, the automatic control system can automatically regulate the running state of purifier. The studies of Grinspun etc. [13] to plasma purifier show that the particle removal efficiency after 30 min is 80%, and 100% after 1.5 h

Zygmunt [14] research shows that plasma purifier used indoor to purify smoke, particle of 0.1 to 0.75 μm diameter purification rate is 29% per hour, for 0.75-1.5 μm of particles per hour purification rate is 23%; two plasma purifier application in an airtight experiments cabin, purify 0.12-0.17 μm diameter of particle, particle purification rate reached 99% after 2 hours.

Plasma technology degradation of volatile organic compounds is result of the collision decomposition reaction between high energy electron, active free radicals produced by discharge and pollutant decomposition reaction, so by destroying the molecular structure of the harmful gas such as formaldehyde, to decompose them. Existing studies have shown that plasma have certain effect for purification of volatile organic compounds, especially when used in combination with other technologies (photocatalytic technology, catalytic technology, photolysis technology, etc.) volatile organic matter degradation efficiency increased significantly [15,16]. Plasma sterilization purifier release purification factor, purify the harmful gas such as formaldehyde, toluene, kill the pathogenic microorganisms, can also through the efficient filter and activated carbon filter layer to filter tiny particles of dust, adsorb the harmful gas such as formaldehyde, toluene.

Research results show that after purification the Department of pathology indoor chemical gas and particulate matter levels were significantly lower, formaldehyde concentration decreased to (0.06 ± 0.01) mg/m^3, lower than the national standard range of 0.1 mg/m^3, which shows that the purifier can purify the chemical gas and particles in the environment with human, can meet the national safety standards, has a good purification effect.

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