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Indoor Air Quality Real-Time Monitoring Results of Pathology Department

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Abstract

In this work, the objectives were to provide a scientific basis for environmental governance and to ensure staff health by real-time monitoring of indoor air quality of the pathology department. Using eagle eye environment monitor to make a real-time dynamic monitoring of the air quality of the pathological technical room for 30 days, the paper records the monitoring data of PM 2.5, PM 10, formaldehyde, CO_2, total volatile organic compounds (TVOC) every day at Beijing time 3 a.m, 10 am, 1 pm, 4 pm, and 10 pm, and makes a summarization and analysis. The average value of CO_2 concentration of the 5 time points is (0.05 ± 0.01)%, and each time point concentration are different ($P < 0.05$), of which the concentration at 10 am, 4 pm are significantly higher than other time points ($P < 0.05$), especially the 1 pm, which is different with every other time points ($P < 0.05$); the average value of formaldehyde concentration of the 5 time points is (1.32 ± 0.86) mg/m^3, and each time point concentration is different ($P < 0.05$), of which the concentration at 10 am, 1 pm are significantly lower than other time points ($P < 0.05$). There is no significant difference between the concentration at 10 am and 1 pm; the average value of PM 10 concentration of the 5 time points is (40.72 ± 41.76) mg/m^3, and each time point concentration is different ($P < 0.05$), of which the concentration at 10 am, 4 pm are significantly higher than other time points ($P < 0.05$), and the concentration at 1 pm is different with every other time point, while the differences are with statistical significance ($P < 0.05$); the average CO concentration of the 5 time points is (3.25 ± 1.44) mg/m^3, and there is no obvious difference between each other ($P > 0.05$); the average TVOC concentration of the 5 time points is (0.08 + 0.31) mg/m^3. They are all different between the concentration at each time point ($P < 0.05$), of which that of 4 pm is significantly higher than other time points ($P < 0.05$); SO_2 and NO are not checked out. Through the real-time online monitoring of the pathology room, we find that the formaldehyde concentration of different time periods is far more than the safety value standard, and the concentration of formaldehyde, CO_2, PM 2.5, PM 10 and total volatile organic compound (TVOC) is different at different time periods, and the concentrations at working time are higher than the non-working time. We must take effective measures to control the concentration of harmful gases in order to ensure the staff's health.

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Keywords

Pathology Department, Indoor Pollution, Real-Time Monitoring, Influence Factors

1. Introduction

Air pollutants are complex mixtures which are caused by many natural and man-made reasons, including particulate matter (PM), ozone, carbon monoxide, sulfur oxides, nitrogen oxides, methane and other gases, volatile organic compounds (for example, benzene, toluene and xylene) and metals (for example, lead, manganese, vanadium, iron) [1]. Air pollution is harmful to human health, and may well be associated with the heart, lungs death which account for 1.4% and 2% of the global total mortality rate. It has been proved that particulate matter, nitrogen dioxide (NO_2), ozone (O_3) and carbon monoxide (CO), and other gases in the environment can increase the morbidity and mortality rate of cardiovascular and respiratory (mainly lung cancer and chronic obstructive pulmonary disease) [2]. Indoor air pollutants concentration measurement includes PM diameter less than 10 μm (PM 10), formaldehyde, 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 [3]. The "indoor air quality standard GB/T18883-2002" [4] has formulated relevant national standards for the indoor environment temperature, humidity, particulate matter and the concentration of harmful gases, so the indoor air quality monitoring and management is imperative. We have made a real-time monitoring for the pathology department indoor air quality for 1 month. The results are as follows.

2. Materials and Methods

We measure the air quality with eagle eye environment monitor and sensor, including the formaldehyde (HCHO) sensors which adopt electrochemical principle, and the range is 0 to 12 mg/m^3, resolution ratio is 0.005 mg/m^3; carbon dioxide (CO_2) sensors adopting infrared optical principle, the range is 0 to 3598 mg/m^3, resolution ratio is 147 mg/m^3; PM 2.5 and PM 10 sensors adopting laser principle, range is 1 to 10 μm, the resolution ratio is 1 μm; total volatile organic compounds (TVOC) sensors adopting PID principle, range is 0 to 20 mg/m^3, the resolution ratio is 0.004 mg/m^3. The acquisition program implementation monitoring data uploaded to the "gateway", the gateway backend server via 3G signal connection, then sent the data to the server.

We make a 24 hours real-time monitoring for pathology department technical room during July 1st, 2014 to July 30th, 2014, and locate the eagle eye environment monitor at 1.5 m high from the indoor ground, record the data everyday at (Beijing Time) 3 am, 10 am, 1 pm, 4 pm, 10 pm (8 am - 12 am and 2 pm - 6 pm are working hours).

The alert value of formaldehyde, CO_2, PM2.5, PM10, TVOC, NO_2 and SO_2 were 0.10 mg/m^3, 0.10%,75 μg/m^3, 150 μg/m^3, 0.60 mg/m^3, 0.24 mg/m^3 and 0.50 mg/m^3, respectively, according to Indoor air quality standard [4].

Statistical analyses were performed using SPSS18.0, using single factor ANONA to analyze the differences between the concentration comparison of each material at different time points, using Student-Newman-Keuls (SNK) to check the differences between groups and make pairwise comparison, and inspection level is 0.05.

3. Results

The average concentration of CO_2 at 3 am, 10 am, 1 pm, 4 pm, 10 pm (Beijing time) was (0.05 ± 0.01)%, CO_2 concentration at each time point as shown in **Figure 1**. The concentration are different at each time point, which is proved to be with statistical significance by variance analysis ($F = 17.10$, $P < 0.05$); among which the concentration at 10 am and 4 pm are significantly higher than that of other time point, the difference is with statistical significance ($P < 0.05$); the concentration at 1pm is different with any other time points, and the difference is with statistical significance ($P < 0.05$).

The average concentration of formaldehyde at 3 am, 10 am, 1 pm, 4 pm, 10 pm (Beijing time) was (1.32 ± 0.86) mg/m^3, the formaldehyde concentration at each time point are different (**Figure 2**), which is proved to be with statistical significance by variance analysis ($F = 6.68$, $P < 0.05$); among which the concentration at 10 am

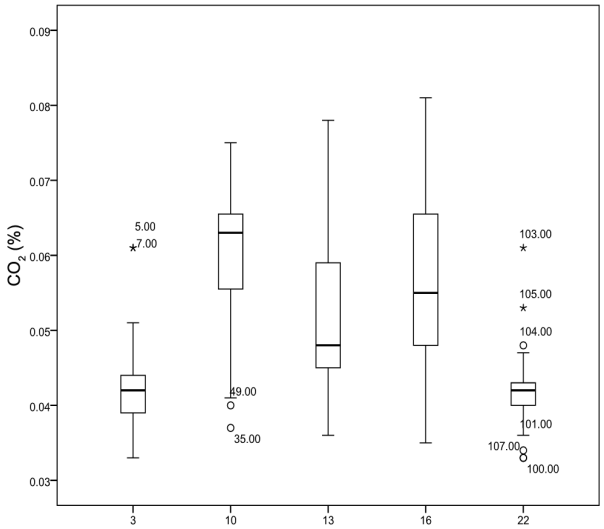

Figure 1. CO_2 concentration at different time points.

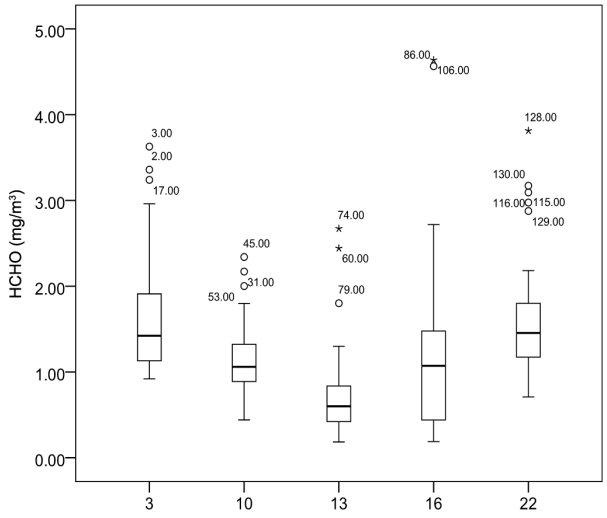

Figure 2. Formaldehyde concentration at different time points.

and 1 pm are significantly lower than that of other time points ($P < 0.05$), and there is no obvious difference between the two concentration ($P > 0.05$).

The average concentration of PM 2.5 at 3 am, 10 am, 1 pm, 4 pm, 10 pm (Beijing time) was (10.34 ± 11.62) μg/m^3, **Figure 3** illustrate the concentrations at each time point are different ($F = 15.12$, $P < 0.05$), among which the concentrations at 10 am and 4 pm are significantly higher than that of other time points ($P < 0.05$), and there is no obvious difference between the two concentration ($P > 0.05$).

The average concentration of PM 10 at 3 am, 10 am, 1 pm, 4 pm, 10 pm (Beijing time) was (40.72 ± 41.76) μg/m^3, the formaldehyde concentrations at each time point are different (see **Figure 4**), which is proved to be with statistical significance by variance analysis ($F = 19.98$, $P < 0.05$); among which the concentration at 10am and 4 pm are significantly higher than that of other time points, the difference is with statistical significance ($P < 0.05$), the concentration at 1pm is different with any other time point, and with statistical significance ($P < 0.05$).

The average CO concentration at 3 am, 10 am, 1 pm, 4 pm, 10 pm (Beijing time) was (3.25 ± 1.44) mg/m^3, and the CO concentration at each time point have no statistical difference ($F = 0.75$, $P > 0.05$), see **Figure 5**.

The average concentration of TVOC at 3 am, 10 am, 1 pm, 4 pm, 10 pm (Beijing time) was (0.08 ± 0.31) mg/ m^3, the concentrations at each time point are different ($P < 0.05$), among which the concentrations at 4 pm is significantly higher than that of other time points, and the difference is with statistical significance ($P < 0.05$), see **Figure 6**.

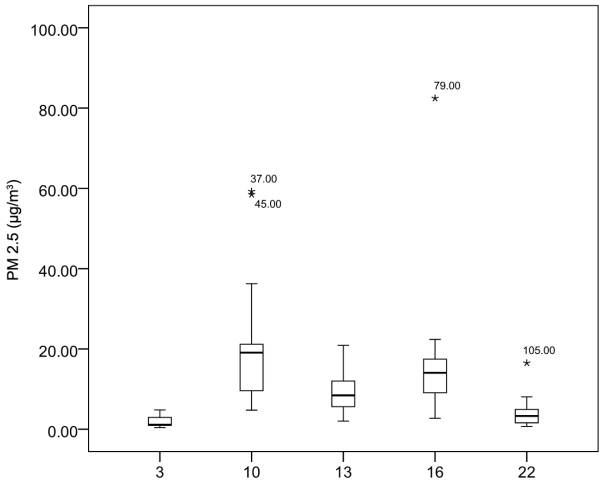

Figure 3. PM 2.5 concentration at different time points.

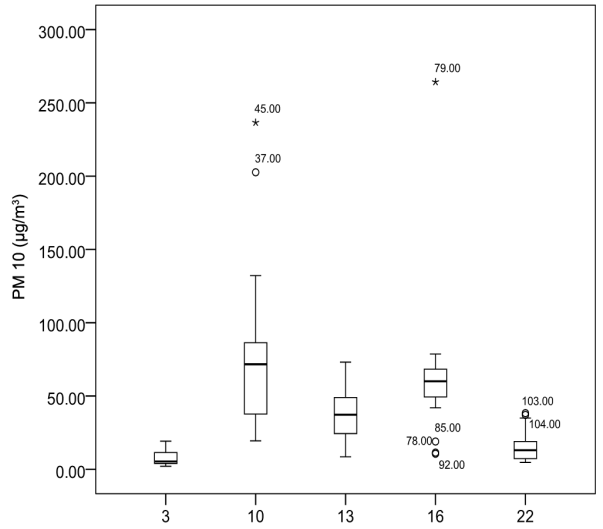

Figure 4. PM 10 concentration at different time point.

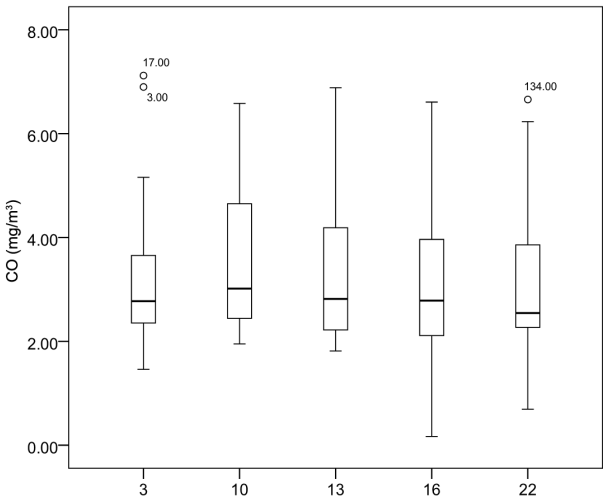

Figure 5. CO concentration at different time point.

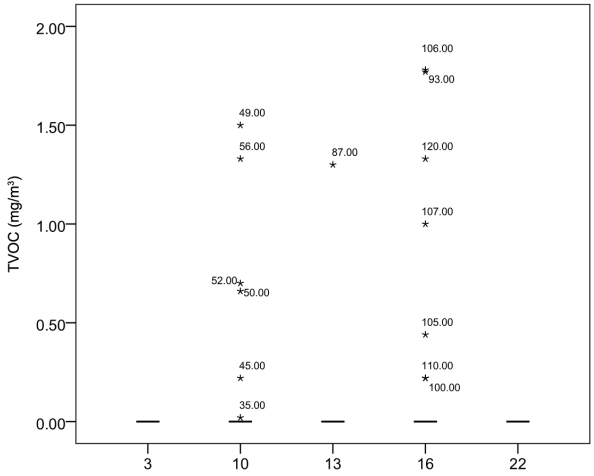

Figure 6. TVOC concentration at different time point.

NO_2 and SO_2 were not checked out.

4. Discussion

Air quality has become an important issue in the work of medical workers [5]. Studies have found that when human are exposed to workplace with air of low concentration formaldehyde, the incidence of nasopharyngeal carcinoma (NPC) will increase [6]. Some epidemiological studies have reported that formaldehyde exposure is associated with the increasing of leukemia mortality [7] [8]. From monitoring, we find that the formaldehyde concentration of every day and each time point is all far more than the standard value (0.1 mg/m^3) and that concentration at 10 am and 1 pm is lower than other time points ($P < 0.05$), even no work at night, because the fume hood also stops working, the formaldehyde concentration is still high at night and workers have great health hazards working in such environment for long time. The 10 μg/m^3 increase of PM 10, PM 2.5, SO_2, NO_2 and CO concentration is associated with the 0.49%, 0.68%, 0.88%, 1.60% and 0.08% increase of coronary heart disease mortality rate of people who are not in hospital [9]. For short-term exposure to PM2.5, PM increases 10 μg/m^3 and relevant mortality rate will increase 2.8% (95% confidence interval [CI] = 2.0 - 3.5). Long-term exposure to PM 2.5, PM increases 10 μg/m^3 and disease associated with particulate matter odds ratio is 1.6 (CI = 1.5 - 1.8) [10]. PM 2.5 increases 10 μg/m^3, the 23 all which causes mortalities will increase 1.04% (95% CI 0.52% to 1.56%) risk of death. Different areas around the world change a lot (0.25% - 2.08%) [11]. The monitoring results of PM 2.5 and PM 10 concentration do not exceed standard value. It means that there is less haze weather in July Shijiazhuang and that the indoor air quality is acceptable. The PM 2.5, PM 10, and CO_2 concentration at 10 am, 4 pm Beijing time (working hours) is higher than other non-working times ($P < 0.05$) which shows that human activities have an effect on particulate matter. People breathe out CO_2, so during indoor working time CO_2 concentration is higher than that of non-working time; each time point, TVOC concentrations are difference and below the alert value (0.6 mg/m^3). The concentration of TVOC at 4 pm is significantly higher than other time points ($P < 0.05$); the CO concentration is lower than 10 mg/m^3 the alert value, and each time period it has no significant difference; NO_2 and SO_2 are not checked out. By monitoring, we find that the pathology department indoor PM 2.5, PM 10 and CO_2 concentration on the whole is within the alert value, that concentration during working time is higher than that of non-working time and that concentration of formaldehyde exceeds standard value seriously. Effective measures should be taken to reduce indoor formaldehyde concentration, and ensure the safety of our working staff.

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