

# Study on the purification effect of a pediatric isolation bed on the air in general hospital wards

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## Research article

**Keywords:** Pediatric isolation bed, purification effect, nosocomial infection, particulate, aerosol, bacteria

**Posted Date:** December 23rd, 2019

**DOI:** <https://doi.org/10.21203/rs.2.19522/v1>

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# Abstract

**Background:** Patients with acute infectious respiratory illness may emit bio-aerosols containing pathogens capable of infecting susceptible hosts, including other patients and healthcare workers. This study aimed to evaluate the purification effect of a pediatric isolation bed on aerosols and microorganisms in the air in experiment rooms and verify the purification efficiency in general wards.

**Methods:** Experiments were carried out in two settings: one with isolation bed and the other with regular bed. Using a dust particle counter to discriminate particles sizes in the air and using Anderson's six levels to discriminate *S. albicans*, the purification rate in the two rooms was evaluated. The concentration of cigarette particles (size 0.3–0.5  $\mu\text{m}$ , 0.5–1.0  $\mu\text{m}$ ) and *S. albicans* in the air was significantly decreased in the experimental room, indicating that the air was purified. Then detection the aerosol in the room to vilidaty the purification rate. Finally detection of aerosol and sedimentation bacteria in the air of general wards.

**Results:** Isolation beds in demonstration ward have a purifying effect on both aerosols and sedimentation bacteria.

**Conclusions:** Isolation bed can therefore be used in hospitals to reduce the risk of nosocomial infection and protect the health of doctors, patients, and visiting relatives.

## 1. Background

Nosocomial infections occur at high incidence each year and pose a considerable health threat. Infectious diseases that cause community infections can also spread via aerosols in hospitals. Examples of such infectious diseases include the severe acute respiratory syndrome (SARS) outbreaks in 2003, the Ebola virus disease outbreaks in West Africa in 2014–2015, and the Middle East respiratory syndrome (MERS) outbreaks in the Middle East and South Korea in 2014–2015 [1–3]. Nosocomial infections can lead to cross-infection between patients, families, and healthcare workers, and may even spread to the community via infected patients, resulting in increased community medical costs, longer hospital stays, and increased in-patient mortality [4, 5].

Studies have reported that respiratory bacteria can spread through the air as respiratory droplets or droplet nuclei (aerosols) [6, 7]. During the SARS epidemic, SARS virus spread through the air, causing a public health crisis [8–10]. Xiao investigated the transmission routes of MERS during the first nosocomial outbreak in the Republic of Korea in May 2015 using a multi-agent modelling framework, and suggested that MERS probably spread via the long-range airborne route [11]. In addition to those mentioned above, other respiratory and enteric viruses such as measles virus, varicella-zoster virus, influenza viruses, adenovirus, rhino/enterovirus, metapneumovirus, and respiratory syncytial virus, can also cause epidemics in hospitals through airborne transmission, which often leads to serious consequences [12–16]. It is therefore necessary to establish a wide range of systems and individual interventions to try to reduce aerosol transmission in medical settings.

Hospitals attempt to prevent and control nosocomial infections by a range of methods, including engineering solutions, strict hand hygiene, and wearing face masks [5, 17–19]. Infection control is particularly important in intensive care units (ICUs), where the focus is on environmental and air cleanliness to prevent colonization turning to pathogenesis and to enhance pathogen clearance. However, current methods are costly and have limited capacity in the event of an outbreak [6, 20]. Alternative strategies are therefore needed to protect critically ill patients from infestation with new pathogens or the exacerbation of existing infections. In this study, we propose a new strategy for the control of nosocomial infections in hospitals that involves a new type of pediatric isolation bed (isolation bed). The isolation bed is connected to a purification device that surrounds the child's head to prevent the spread of contaminants into the room. After the returned air has been purified, the air is blown into the room to control the local environment around the patient and reduce the risk of infection. Compared with directly controlling the air quality in the entire room, the isolation bed reduces energy consumption and has enormous potential for application. The purpose of this research was to study the purification effect of the isolation bed on airborne particulate matter and *Staphylococcus albicans*. The filtration and purification effects on particles of 0.3–0.5  $\mu\text{m}$ , 0.5–1.0  $\mu\text{m}$  and *S. albicans*, were evaluated in a experiment room. And we also verify the purification effects in Guangzhou chest hospital. The isolation bed could play an active role in the control of nosocomial infections, reducing the risk of respiratory infections among patients and healthcare workers.

## 2. Methods

### 2.1. Material and equipment

Sustained release *Staphylococcus albicans* was purchased from the Microbiology Institute of Guangdong (Guangdong, China). Cigarettes (brand: Hongtashan, Yunnan, China) were purchased from a local retailer. A Y09-301 laser dust particle counter and an Anderson six-level sampler were both purchased from Sujin (Jiangsu, China).

### 2.2. Pediatric Isolation bed

Pediatric Isolation bed (Angelbiosafety, Guangzhou, China) are supplied in three gears: high-gear (the wind speed of the negative pressure port: 0.8 m/s), middle-gear (0.5–0.6 m/s), and low-gear (0.3–0.4 m/s), and can be operated closed (0 m/s) as a control. The centrifugal fan works to generate negative pressure and any infectious microorganisms such as bacteria and viruses in the air exhaled by the patient are captured by the sterilization filter unit, and the resulting clean air passes through the air outlet from the bedside cabinet.

### 2.3. Test the purification effect of the isolate bed in the experiment room.

Two experiment rooms, containing no patients, were set up in the laboratory as the experimental group and the control group. Each room had the following dimensions: 3.63 × 4.26 × 2.8 m (length, width, and height; Fig 1). A pediatric isolation bed (left in Fig 1) was placed in the experimental group room, and a

standard hospital bed was placed in the control room. According to the five-point layout method[21], five sampling points (A,B,C,D,E) were selected that were arranged according to the positions shown in Fig 1A. The horizontal distances from the wall were greater than 1 m, and the vertical distance from the ground was about 140 cm. All tests were performed at 25°C–26°C, and the doors, windows, and air conditioners were all closed/off during the test.

#### **2.4. Verification the purification effect of the isolation bed in hospital.**

Two general wards were set up in the pediatric ward of Guangzhou Chest Hospital as the model and control wards. The Guangzhou Chest Hospital ward had the following dimensions: 5.7 × 3.3 × 2.8 m (length, width and height; Fig 2). Three pediatric isolation beds (shown in Fig 1B) were placed in the model ward, and three standard hospital beds were placed in the control ward. According to the five-point layout method[21], five sampling points(A,B,C,D,E) were selected, the positions of which are shown in Fig 2A. The horizontal distances from the wall were greater than 1 m, and the vertical distance from the ground was about 140 cm. The size, area, layout, and orientation of the control ward and the model ward were identical.

All tests were performed at 25°C–26°C, and the doors, windows, and air conditioners were all closed/off during the test.

#### **2.5. Particle purification effect**

(1) A cigarette was lit at point C in Fig 1A and left to burn for 15 min. After sufficient inhalable particles had been produced, the cigarette was extinguished. The electric fan was then turned on, adjusted to low wind speed, and left for 2 min to evenly distribute the inhalable particles throughout the room. The fan was then stopped and after a 3-min rest, samples were taken from the five sampling points indicated in Fig 1A. The Y09-301 laser dust particle counter was used at 2.83 L/min according to the "Test Method for Suspended Particles in the Cleanroom (Zone) of the Pharmaceutical Industry" GB/T16292-1996 standard. The flow rate was measured for the number of particles according to the six size ranges in the air in the room, pumping for 20 s at a time, and each point was continuously sampled three times and the average value was taken. Data were recorded every 10 min for 1 h. The total number of particles with a diameter of 0.3- 0.5 μm and 0.5–1.0 μm equated to the number of dust particles of this size. The above-mentioned experiment was carried out in a closed state (as the control), and at high-gear, mid-gear, and low-gear, and data were recorded for each gear position. Using these data, curves of particle size (0.3–0.5 μm and 0.5–1.0 μm) against time were plotted. The particle (0.3–0.5 μm and 0.5–1.0 μm) purification rate for each sampling point for each gear position was calculated separately.

(2)The doors and windows of the room were opened for 24 h to allow for air flow into the room and the concentration of particulate matter in the ward stabilized. Then, the doors and windows were closed and the isolation bed run with low gear, at the same time,using the dust particle counter to sample the air at five sampling points with a flow rate of 2.83 L/min and a sampling time of 20 s. The average concentration of particulate matter at each point was based on three consecutive sampling times, and

one round of sampling was undertaken every 10 min for 2 h of continuous sampling to observe changes in the distribution and concentration of particulate matter of different particle sizes in the room.

## **2.6. Purification effect following the sustained release of *Staphylococcus albicans***

(1) Experimental preparation: *S. albicans* was inoculated into an enriched culture medium and was cultured in an incubator at 37°C for 24 h to enrich the bacteria. PBS was used for the preparation and dilution of bacteria, and *S. albicans* bacterial suspensions of known concentration were prepared using a spectrophotometer.

(2) Experimental group: the prepared bacterial suspension was added to the microbial aerosol generator and placed in the center of the ward to be opened for 15 min. The fan was turned on for 3 min, dispersing indoor microbial aerosols. The fan was then turned off and after a 2-min rest to allow for stabilization of the microbial concentration across the room, samples were taken from five sampling points set in the diagonal corners and the center of the room (>0.5 m from the wall, and ~1.4 m from the floor). The Anderson six-level sampler was used to collect and determine the initial concentration of microorganisms in the room at a flow rate of 28.3 L/min for 1 min. Samples were taken from room with the isolation gives 3 different gear (high-gear, medium-gear, and low-gear) after opening for 30 and 60 min. The sample plate was placed in an incubator at 37°C for 24 h to count the colonies and calculate the concentration of microorganisms in the air.

(3) Control group experiment: The method is similar to the Experimental group, but with an ordinary hospital bed.

(4) Data calculation

The microbial/particulate purification rate of the open isolation bed was calculated according to the equation:

[Due to technical limitations, the formula could not be displayed here. Please see the supplementary files section to access the formula.]

where,  $K$  is the purification rate,  $C_0$  is the initial air microbial/particulate concentration, and  $C_t$  is the air microbial/particulate concentration after opening the isolation bed for min.

## **2.7. Verify the purification efficiency in general wards.**

(1) Experimental preparation: Prepare two wards which gives the same size, layout and orientation, one for demonstration ward and the other for control ward. Five sampling points were set up at the diagonal points in the ward and the center of the ward, which were more than 0.5 m from the wall horizontally, and about 1.4 m from the floor vertically. The indoor temperature and humidity were monitored and maintained at a constant level.

(2) Demonstration ward: There are 3 isolation bed in the demonstration ward. The isolation bed runs uninterrupted with a low gear. A child with a respiratory illness lives on each isolation bed, and each child has an adult caregiver. So there are 3 child patients and 3 adult caregivers in the demonstration ward. The doors and windows of the ward were closed for 2 h before test to allow the stability of the sampling. Samples were taken from five sampling points set in the diagonal corners and the center of the room (>0.5 m from the wall, and ~1.4 m from the floor) (fig 1B). The dust particle counter were used to sample the air at five sampling points with a flow rate of 2.83 L/min and a sampling time of 20 s. The average concentration of particulate matter at each point was based on three consecutive sampling times.

The Anderson six-level sampler was used to collect and determine the initial concentration of settlement bacteria in the room at a flow rate of 28.3 L/min for 40 min. Repeat three times for each sample. Samples were taken from ward with the isolation gives low-gear. The sample plate was placed in an incubator at 37°C for 24 h to count the colonies and calculate the concentration of settlement bacteria in the air.

(3) Control experiment: The method is similar to the Experimental group, but with an ordinary hospital bed.

(4) Data calculation

This followed the same procedure as section 2.6.

## 2.8. Statistical analysis

Statistical analysis of the result was performed using Prism 7 software (GraphPad). Statistics analyses for other experiments were performed using t-test. P values (P) less than 0.05 were considered statistically significant.

# 3. Results

## 3.1. Purification effect on Cigarette particles

The results of the experiments to determine the purification effect of the pediatric isolation bed on cigarette particles are shown in Fig 2 and Table 1. The time-dependent curves for both particle sizes, 0.3–0.5  $\mu\text{m}$  and 0.5–1.0  $\mu\text{m}$ , are shown in fig 2. The results are the average of the data from sampling points A–E. Compared with the curve for the control group, the results from the experimental group indicated that the isolation bed had the effect of reducing the number of dust particles in the air. After 15 min, the purification effect was evident. Purification effect enhances over time.

The purification rate of the isolation bed for particulate matter of 0.3–0.5  $\mu\text{m}$  at each sampling point over 1 h was calculated for the experimental and control groups, as shown in Table 1. From the table, it shows that the purification rate of the control group gives the low result, almost from 36–38%. But when the isolation bed run, the rate increase very fastly, the low gears gives about 91–92%. The middle gears and

the high gears gives above 95%. however, no significant differences were detected between the sampling points in the high- and mid-range.

### **3.2. Purification effect on *Staphylococcus albicans***

The concentration changes in *S. albicans* within 60 min were compared between the experimental and control groups and revealed that the isolation bed had a purification effect on *S. albicans* in the air (Fig 3). The data represent the average of sampling points A–E. After 30 min, the pediatric isolation bed had reduced the concentration of *S. albicans* in the air, and after 60 min, the purification effect in the demonstration room was above 99%.

### **3.3. Purification effect of the isolation bed on particulate matter in the Experiment room.**

The results of the experiments to determine the purification effect of the pediatric isolation bed in the room are presented in Fig 4 and Table 2.

The time-dependent curves for both particle sizes, 0.3–0.5  $\mu\text{m}$  and 0.5–1.0  $\mu\text{m}$ , the low gear data are shown in fig 4. After 10 min, the number of the particulate matter are decrease. After 30 minutes, the number of dust particles reached a minimum, after which the number of dust particles in the indoor air remained at this number until 2 hours.

As shown in Table 2. From the table, it shows that the purification rate of the control group gives the low result, almost from 9-10%. But when the isolation bed run, the rate increase very fastly, the low gears gives about 72-79%, the middle gears gives about 86-89%, and the high gears gives above 90-92%. For the three gear and control group, significant differences were detected between the sampling points. For the mid- and low- gear, significant differences were detected. For the high- and low- gear, significant differences were detected. For the high- and mid- gear, no significant difference was detected.

### **3.4. Purification effect of the isolation bed on the particulate matter and the settlement bacteria in the air of a ward in Guangzhou Chest Hospital**

The result of the experiments to determine the purification effects of the pediatric isolation bed in Guangzhou Chest Hospital are shown in Fig 5. We analyzed the particulate matter in both the demonstration ward and the control ward. Each ward had three beds and three patients, along with three members of the patients' families, in total six people. Compared with the curve for the control group, the data for the low-gear pediatric isolation bed showed a reduction in the number of dust particles and bacteria in the air. For the low gear and control group, significant differences were detected between the sampling points. No significant difference was detected in each point.

The result of the purification effect on the settlement bacteria are shown in fig 6. We analyzed the concentration of settlement bacteria in both the demonstration ward and the control ward. For the low gear and control group, significant differences were detected between the sampling points.

## 4. Discussion

In this study, we artificially released cigarette particles and *S. albicans* in the experimental room, while opening the isolation bed to collect the purification effect over time. The results show that the purification effect increases with time, indicating that the isolation bed has a good purification effect under the exposure of high concentration of pollutants. In order to further verify the purification effect, we tested the air purification rate of the isolation bed to the room. The results showed that after the isolation bed was opened for 10 minutes, the room air began to purify, and the purification effect was best in 30 minutes. The purification effect continues over time. So how is the isolation of the bed to the air in the hospital ward? We set up a demonstration ward in the Guangzhou Chest Hospital, which houses 3 isolation beds and children who are randomly infected with respiratory infections. Air aerosol particles and settlement bacteria in the ward were significantly reduced, which proved that the isolation bed have good purification efficiency and can effectively reduce the risk of infection through aerosol transmission in hospitals.

Regarding particle size, droplets traditionally have been defined as being  $>5\ \mu\text{m}$  in size. Droplet nuclei, which are particles arising from the desiccation of suspended droplets, have been associated with airborne transmission and are defined as being  $\geq 5\ \mu\text{m}$  in size. Such particles are relevant to the pathogenesis of pulmonary tuberculosis but are not generally applicable to other organisms [13, 22]. Observations of particle dynamics have demonstrated that a range of droplet sizes, including those with diameters of  $30\ \mu\text{m}$  or greater, can remain suspended in the air. The behavior of droplets and droplet nuclei is important in preventing transmission [2]. Here, we studied particle sizes of  $0.3\text{--}0.5\ \mu\text{m}$  and  $0.5\text{--}1.0\ \mu\text{m}$ , and the results showed that the pediatric isolation bed had a high purification effect on the presence of particles of these sizes in the air. We also studied particle sizes of  $1.0\text{--}3.0\ \mu\text{m}$  and  $3.0\text{--}5.0\ \mu\text{m}$ ,  $5.0\text{--}10\ \mu\text{m}$  and  $\geq 10\ \mu\text{m}$ , all of which conferred a high purification effect (data not shown). In future studies, the next step would be to study the isolation effect of the pediatric bed on particular sized particles.

There are 3 gear for the isolation bed. From the result of table 2, we find that the purification rate of 3 gears give the different result. Purification effect increases as wind speed increases. But high wind speed accompanied by high noise decibels. In this study, we used the low gear to do the analysis. The mid- and high- gear give the high purification rate (data are not shown).

Air filtration systems are another common purification technique, which allow the air to pass through a series of filters of decreasing pore size through positive pressure ventilation [23]. Our study proposed a new concept of effectively isolating a single patient and killing the aerosolized pathogens from that patient immediately. This concept covers the three principles of infectious disease prevention and control: “isolating infectious sources”, “cutting off transmission channels”, and “protecting susceptible people”, and represents a major theoretical and conceptual innovation in the field of nosocomial infection protection.

## 5. Conclusion

Isolation beds in demonstration ward have a purifying effect on both aerosols and sedimentation bacteria. Isolation bed can therefore be used in hospitals to reduce the risk of nosocomial infection and protect the health of doctors, patients, and visiting relatives. This new aerosol isolation and elimination product effectively isolates the patient on site, thereby reducing the possibility of pathogen spread during the transportation process. The advantages of this system are low-cost single equipment and mobile deployment. In addition, new indicators, such as evolutionary efficiency, are being applied to the product design and evaluation procedures to ensure the complete isolation of pathogens from patients' exhaled air, thereby avoiding the circulation of polluted air and expansion of the infected area. In future studies, the next step will be to study the isolation effects with respect to distance and the transmission risk, and the effectiveness of this new technology in preventing infections in hospitals.

## Abbreviations

SARS: severe acute respiratory syndrome; MERS: the Middle East respiratory syndrome; ICUs: intensive care units; Isolation bed: pediatric isolation bed. *S. albicans*: *Staphylococcus albicans*.

## Declarations

### Conflicts of interest:

The authors declare that they have no conflicts of interest.

### Declarations:

### Ethics approval and consent to participate:

Ethics approval was not required as testing the air of the hospital. As our study did not involve interventions or additional clinical samples to be collected, no consent to participate was required.

### Consent for publication:

The data used to support the findings of this study are available from the corresponding author upon request.

### Availability of data and material:

Not applicable. Our manuscript does not contain any individual person's data in any form, including any individual details, images or videos.

### Competing interests:

The authors declare that they have no competing interests.

### Funding:

This study was supported by grants from National Key Research and Development Program of China (2018YFC1200100), Guangdong Medical Science and Technology Research Center Project (A2019460), Entrepreneurship Leadership Project in Guangzhou Development Zone of China (CY2018-003), Guangzhou science and technology project (201704020225).

### **Authors' contributions:**

Tiantian Liu: Write the paper and do the experiment. Xiaotang Hao, Mei Wang and Yubing Guo: do the experiment. Rong Zhou: design the experiment.

### **Acknowledgements:**

We thank Prof. Zhengshi Lin for providing advice about our manuscript and editing the English text of a draft of this manuscript. We thank for Guangzhou chest hospital to provide the hospital ward.

## **Reference**

1. Ho PL, Tang XP, Seto WH: *SARS: hospital infection control and admission strategies. Respirology* 2003, 8 Suppl:S41–45.
2. Ansumana R, Keitell S, Roberts GM, Ntoumi F, Petersen E, Ippolito G, Zumla A: *Impact of infectious disease epidemics on tuberculosis diagnostic, management, and prevention services: experiences and lessons from the 2014–2015 Ebola virus disease outbreak in West Africa. Int J Infect Dis* 2017, 56:101–104.
3. Ki M: *2015 MERS outbreak in Korea: hospital-to-hospital transmission. Epidemiol Health* 2015, 37:e2015033.
4. Giraldi G, Montesano M, Sandorfi F, Iachini M, Orsi GB: *Excess length of hospital stay due to healthcare acquired infections: methodologies evaluation. Ann Ig* 2019, 31(5):507–516.
5. Suleyman G, Alangaden GJ: *Nosocomial Fungal Infections: Epidemiology, Infection Control, and Prevention. Infectious disease clinics of North America* 2016, 30(4):1023–1052.
6. Su LX, Wang XT, Pan P, Chai WZ, Liu DW, China Critical I, Infection Control A: *Infection management strategy based on prevention and control of nosocomial infections in intensive care units. Chinese medical journal* 2019, 132(1):115–119.
7. Lopez-Garcia M, King MF, Noakes CJ: *A Multicompartment SIS Stochastic Model with Zonal Ventilation for the Spread of Nosocomial Infections: Detection, Outbreak Management, and Infection Control. Risk Anal* 2019, 39(8):1825–1842.
8. Tong TR, Liang C: *Evidence of airborne transmission of SARS. N Engl J Med* 2004, 351(6):609–611; author reply 609–611.

9. Yu IT, Li Y, Wong TW, Tam W, Chan AT, Lee JH, Leung DY, Ho T: *Evidence of airborne transmission of the severe acute respiratory syndrome virus. N Engl J Med* 2004, 350(17):1731–1739.
10. Christian MD, Loutfy M, McDonald LC, Martinez KF, Ofner M, Wong T, Wallington T, Gold WL, Mederski B, Green K *et al*: *Possible SARS coronavirus transmission during cardiopulmonary resuscitation. Emerging infectious diseases* 2004, 10(2):287–293.
11. Xiao S, Li Y, Sung M, Wei J, Yang Z: *A study of the probable transmission routes of MERS-CoV during the first hospital outbreak in the Republic of Korea. Indoor Air* 2018, 28(1):51–63.
12. Chen H, Liu S, Liu J, Chai C, Mao H, Yu Z, Tang Y, Zhu G, Chen HX, Zhu C *et al*: *Nosocomial Co-Transmission of Avian Influenza A(H7N9) and A(H1N1)pdm09 Viruses between 2 Patients with Hematologic Disorders. Emerging infectious diseases* 2016, 22(4):598–607.
13. La Rosa G, Fratini M, Della Libera S, Iaconelli M, Muscillo M: *Viral infections acquired indoors through airborne, droplet or contact transmission. Annali dell'Istituto superiore di sanita* 2013, 49(2):124–132.
14. Chow EJ, Mermel LA: *Hospital-Acquired Respiratory Viral Infections: Incidence, Morbidity, and Mortality in Pediatric and Adult Patients. Open forum infectious diseases* 2017, 4(1):ofx006.
15. Yang Z, Suzuki A, Watanabe O, Okamoto M, Ohmi A, Huang W, Nishimura H: *Outbreak of human metapneumovirus infection in a severe motor-and-intellectual disabilities ward in Japan. Japanese journal of infectious diseases* 2014, 67(4):318–321.
16. Herfst S, Bohringer M, Karo B, Lawrence P, Lewis NS, Mina MJ, Russell CJ, Steel J, de Swart RL, Mence C: *Drivers of airborne human-to-human pathogen transmission. Current opinion in virology* 2017, 22:22–29.
17. Liang Q, Yan C, Xu Z, Huang M: *Preemptive isolation and active surveillance in the prevention and control of nosocomial infection reduce the incidence of carbapenem-resistant Enterobacteriaceae. Infectious diseases* 2019, 51(5):377–379.
18. Kang Y, Zhu SC: *[Prevention of severe infection with the help of nosocomial infection control in intensive care units]. Zhonghua nei ke za zhi* 2017, 56(5):335–336.
19. O'Hara LM, Thom KA, Preas MA: *Update to the Centers for Disease Control and Prevention and the Healthcare Infection Control Practices Advisory Committee Guideline for the Prevention of Surgical Site Infection (2017): A summary, review, and strategies for implementation. American journal of infection control* 2018, 46(6):602–609.
20. Segreti J, Parvizi J, Berbari E, Ricks P, Berrios-Torres SI: *Introduction to the Centers for Disease Control and Prevention and Healthcare Infection Control Practices Advisory Committee Guideline for Prevention of Surgical Site Infection: Prosthetic Joint Arthroplasty Section. Surgical infections* 2017, 18(4):394–400.

21.Rao NG, Kumar A, Wong JS, Shridhar R, Goswami DY: *Effect of a Novel Photoelectrochemical Oxidation Air Purifier on Nasal and Ocular Allergy Symptoms. Allergy & rhinology* 2018, 9:2152656718781609.

22.Siegel JD, Rhinehart E, Jackson M, Chiarello L, Health Care Infection Control Practices Advisory C: *2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Health Care Settings. American journal of infection control* 2007, 35(10 Suppl 2):S65–164.

23.Alonso C, Raynor PC, Davies PR, Morrison RB, Torremorell M: *Evaluation of an electrostatic particle ionization technology for decreasing airborne pathogens in pigs. Aerobiologia* 2016, 32(3):405–419.

## Tables

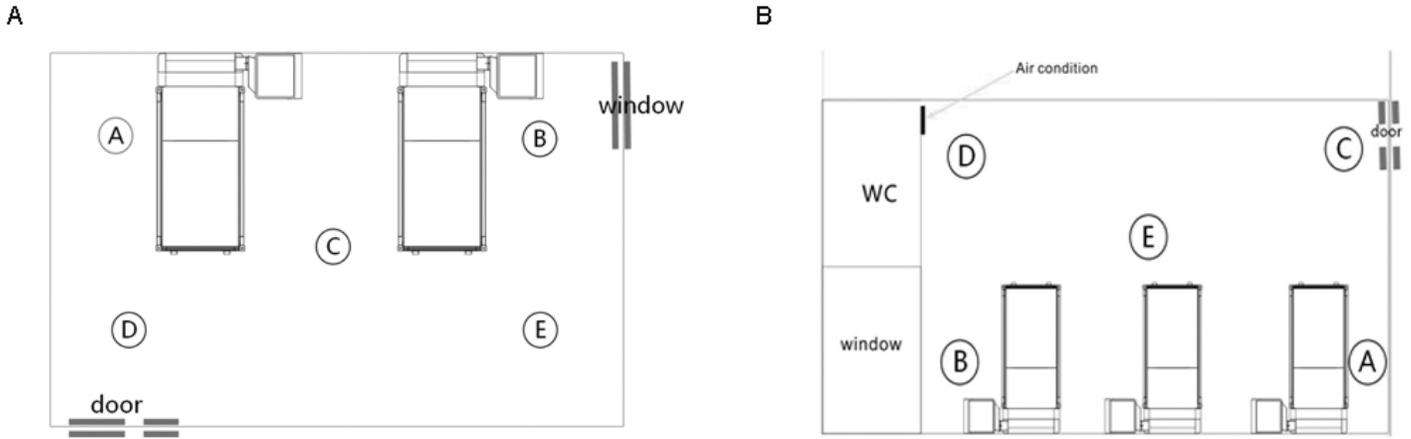
Table 1. Purification rate (%) of 0.3–0.5 µm particles at each sampling point within 1 h for the pediatric isolation bed. Each experiment was repeated independently three times, and the mean values and standard deviations are shown.

	A	B	C	D	E
High-gear	95.71	95.84	95.21	94.75	95.30
Middle-gear	96.91	96.82	96.78	97.25	97.52
Low-gear	91.37	91.32	91.13	92.04	91.40
Control	36.48	36.33	37.24	37.69	37.96

Table 2. Purification rate (%) of 0.3–0.5 µm particles at each sampling point within 2 h with the pediatric isolation bed. Each experiment was repeated independently three times, and the mean values and standard deviations are shown.

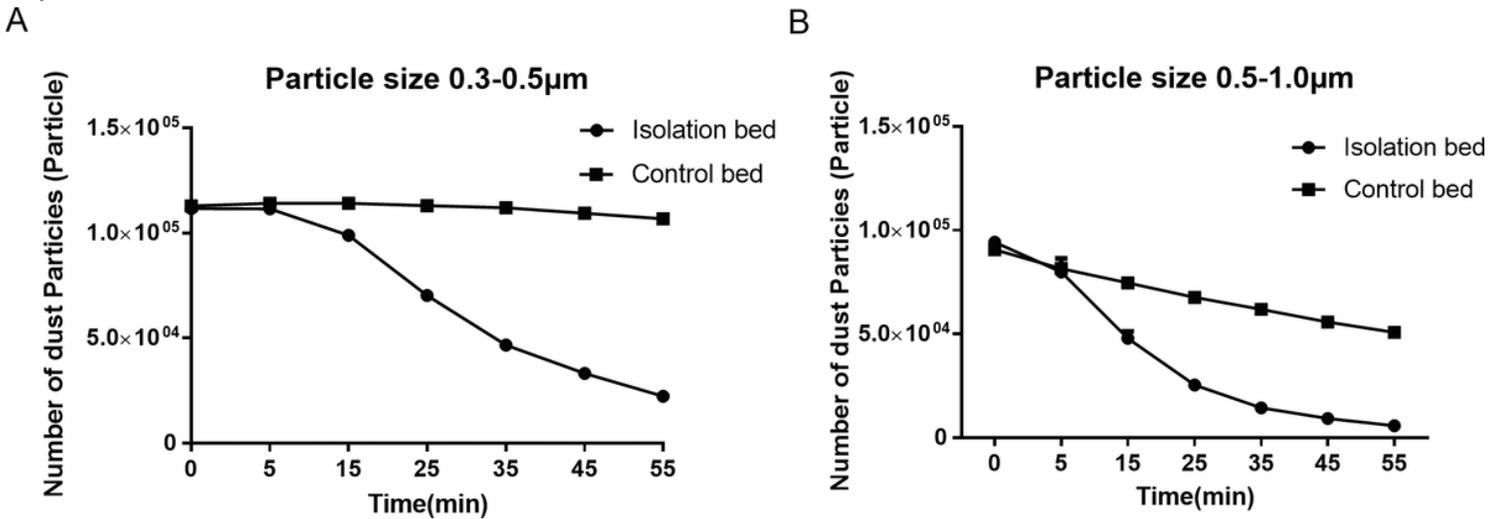
	A	B	C	D	E
High-gear	91.91	90.29	90.83	90.81	90.65
Middle-gear	87.80	88.26	87.89	86.82	86.50
Low-gear	78.90	77.89	78.54	78.19	72.14
control	9.89	10.73	10.33	10.80	9.30

## Figures



**Figure 1**

Schematic diagram of the pediatric isolation bed showing the positions of the sampling points: A: experiment room. B: General ward.



**Figure 2**

Purification effect of the low-gear pediatric isolation bed in the laboratory Curve of the number of 0.3–0.5 μm particles over time. (B) Curve of the number of 0.5–1.0 μm particles over time. Each experiment was repeated independently three times, and the mean values and standard deviations are shown.

# Staphylococcus albicans

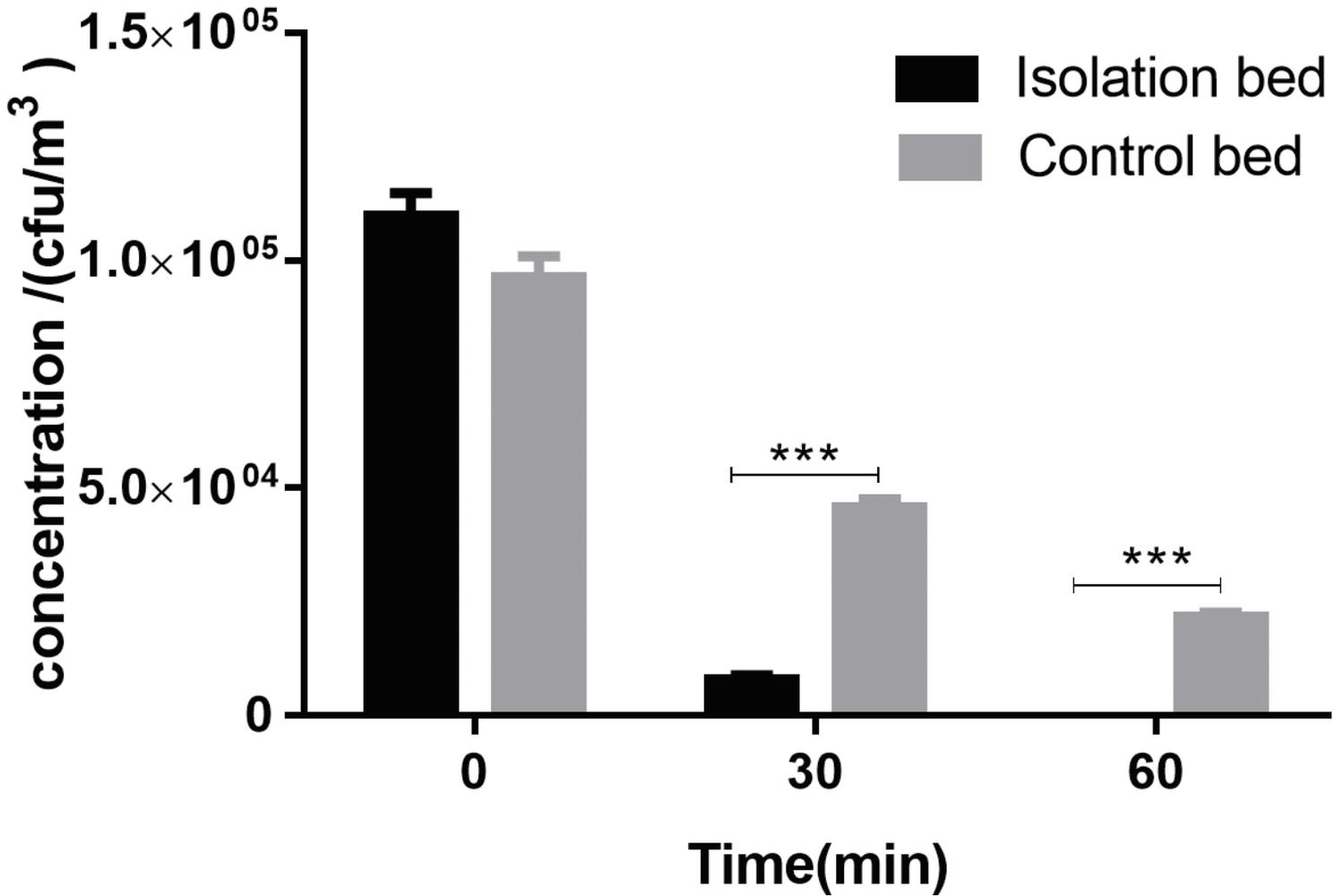
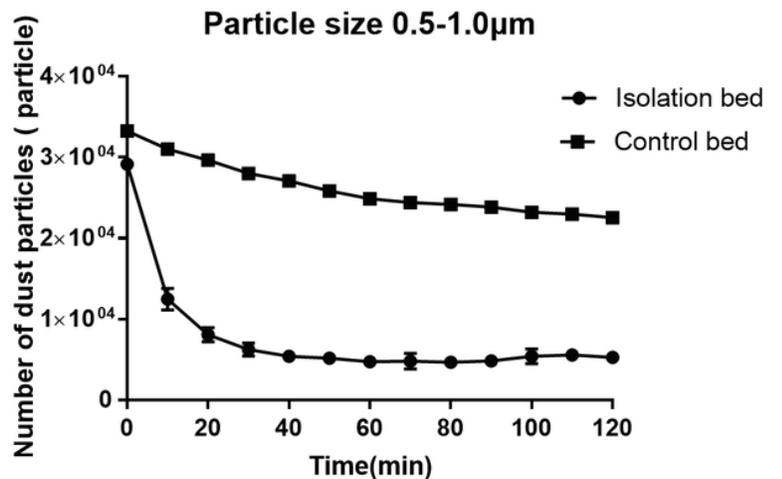
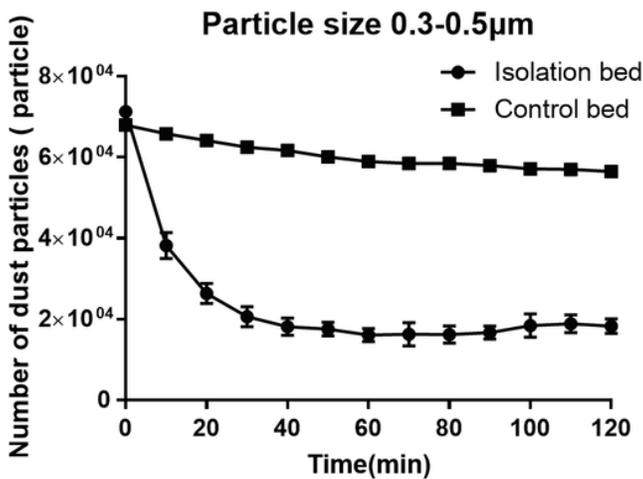


Figure 3

Changes in the *Staphylococcus albicans* concentration over 60 min with the low-gear isolation bed. Values are expressed as mean ± SE of three replicates. \*\*\*, P < 0.01.

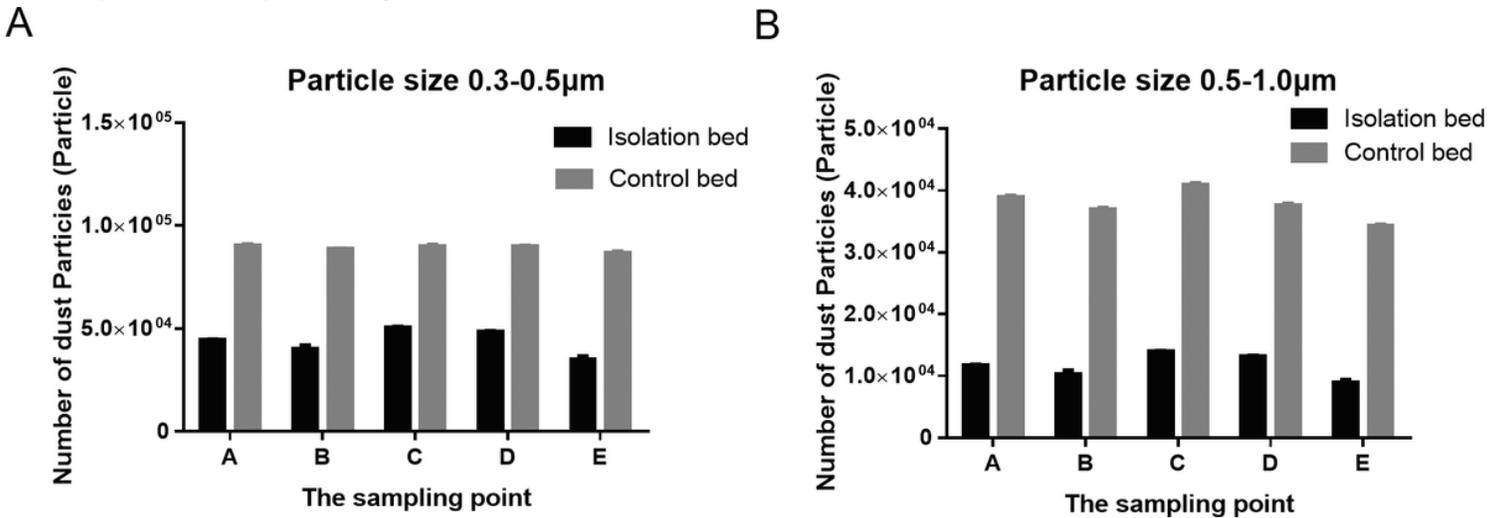
A

B



**Figure 4**

Purification effect of the low-gear pediatric isolation bed in the laboratory (A) Curve of the number of 0.3–0.5  $\mu\text{m}$  particles over time. (B) Curve of the number of 0.5–1.0  $\mu\text{m}$  particles over time. Each experiment was repeated independently three times, and the mean values and standard deviations are shown.



**Figure 5**

Purification effect of the low-gear pediatric isolation bed in Guangzhou Chest Hospital. (A) Curve of the number of 0.3–0.5  $\mu\text{m}$  particles over time. (B) Curve of the number of 0.5–1.0  $\mu\text{m}$  particles over time. Each experiment was repeated independently three times, and the mean values and standard deviations are shown.

# Purification the settlement bacteria

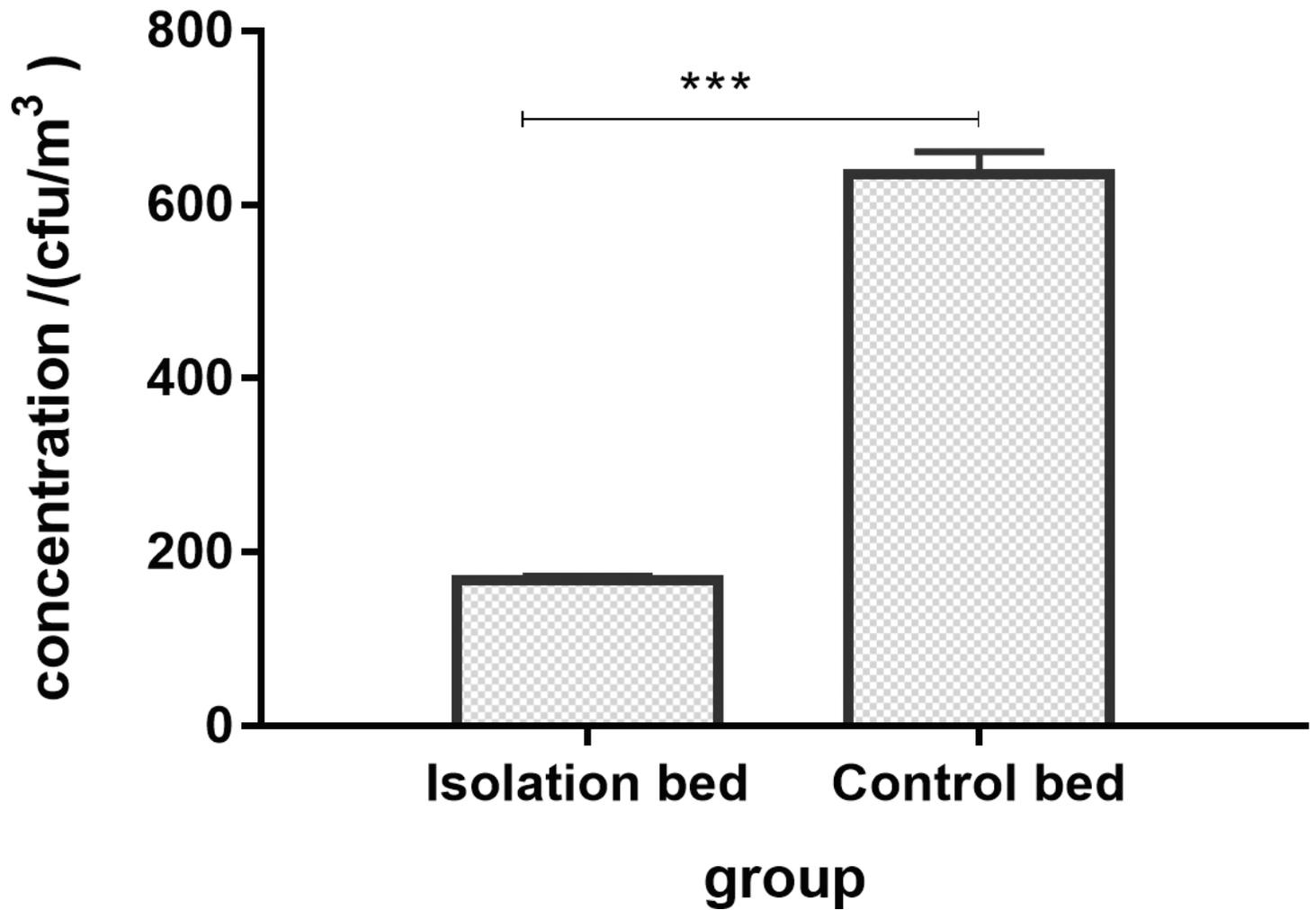


Figure 6

Purification effect on the deposition of bacteria. \*\*\* P<0.001

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Formula.docx](#)