米国の事例

専門関係者の講習会資料より抜粋

空気感染疾患のコントロール

Airborne Infectious Disease Management

Methods for Temporary Negative Pressure Isolation

負圧による一時的隔離の方法

大型HEPAフィルター(空気清浄機)

米国 ミネソタ州保健部

Minnesota Department of Health
Office of Emergency Preparedness
Healthcare Systems Preparedness Program

環境のコントロール

Environmental controls

- 空気圧により空気の流れ方向のコントロール。
- 換気による空気中の感染浮遊物の希釈化。
- フィルターによる感染浮遊物の除去。

This user guide will focus on the **environmental controls** necessary for airborne infection isolation.

The ventilation parameters essential for airborne infection isolation rooms/areas include:

- **Pressure management** for appropriate airflow direction;
- Room air changes for **dilution ventilation**; and
- **Filtration** to remove infectious particles.

FIGURE 1
Illustrations used to identify ***Negatively*** *(top) and* ***Positively*** *(bottom) pressurized air space.*

Pressure management

空気圧のコントロール

For the purposes of this guide, pressure refers to the ***differential pressure between two spaces*** *(FIGURE 1)*.

In health care settings, the two spaces are typically the isolation room and the corridor. For AIIR, the room **should be negatively pressurized** in relation to the corridor. This helps to prevent infectious particles from escaping the room envelope.

If an anteroom is present between the AIIR and the corridor, the AIIR may be negatively or positively pressurized to the anteroom. However, if the AIIR is positively pressurized to the anteroom, the anteroom must be negatively pressurized to the corridor.

●●● A difference in pressure causes movement of air from areas at higher pressure to those at lower pressure. The greater the pressure difference, the greater the resulting air velocity. The movement of air is used to help provide containment of infectious particles by providing clean to dirty airflow. *Refer to Appendix D, "Using a Pressure Gauge to Measure Relative Pressurization Between Two Spaces" on page 24 for instructions on using a pressure gauge to determine differential pressure.*

●●● The differential pressure or pressure offset is established by mechanically adjusting the supply and exhaust air. *For a negative pressure room, the sum of the mechanically exhausted air must exceed the sum of the mechanically supplied air.* This offset forces air to enter the room under the door and through other leakages and prevents infectious particles from escaping.[9]

●●● In order to maintain consistent offset airflow, the difference between exhaust and supply should create a pressure differential of about *0.01 inch water gauge (in. w.g.) or 2.5 Pascals (Pa)*.[9] Pressure in this application is used to induce airflow from adjacent spaces into the isolation room. ▲

フィルターによる空気濾過は空気中浮遊感染物質による感染拡大のリスクを低減することができる。
HEPAフィルターは空気中浮遊物質の分離に有効であることが確認されている。
濾過性能は最低限 0.5μ以上の微粒子を90% 以上除去できること。

Dilution ventilation

Mechanical ventilation is used to exchange the air in a space. The time required for removing a given percentage of airborne particles from a room or space depends on the number of *air changes per hour (ACH)*, location of the ventilation inlet and outlet, and the physical configuration of the room or space *(FIGURE 2).*

Refer to Appendix E, "Using a HEPA Filter for Dilution Ventilation" on page 26. ▲

Filtration

For the purposes of this guide, **filtration** refers to the *process of passing air through a filter*. Hospital buildings have some of the highest filtration requirements. Without filtration, particle concentrations accumulate in indoor environments. This can cause toxic effects even in healthy people.

Filtration reduces the risk for transmitting airborne infectious agents. Depending upon their size, particles may be deposited in the upper respiratory tract or the lower respiratory tract of humans. Particles can also be deposited in open wounds during dressing changes or invasive procedures. *See Appendix F, "Microorganisms Associated with Airborne Transmission" on page 28.*

When used correctly, portable HEPA filters prove to be an effective method for achieving an airborne isolation environment.[12] When properly installed and maintained, filters for clinical spaces should be able to *remove at least 90% of particles (0.5 microns in size and larger)*[9] from outside and inside air.

For evaluation of hospital HVAC systems and HEPA filters refer to Appendix G, "Using a Particle Counter to Assess Indoor Air Quality and Filter Efficiency" on page 29.

For information on filter selection and performance, see Appendix H, "Data Interpretation" on page 34. See Appendix I, "Sample Log for Measuring Particle Counts" on page 36.▲

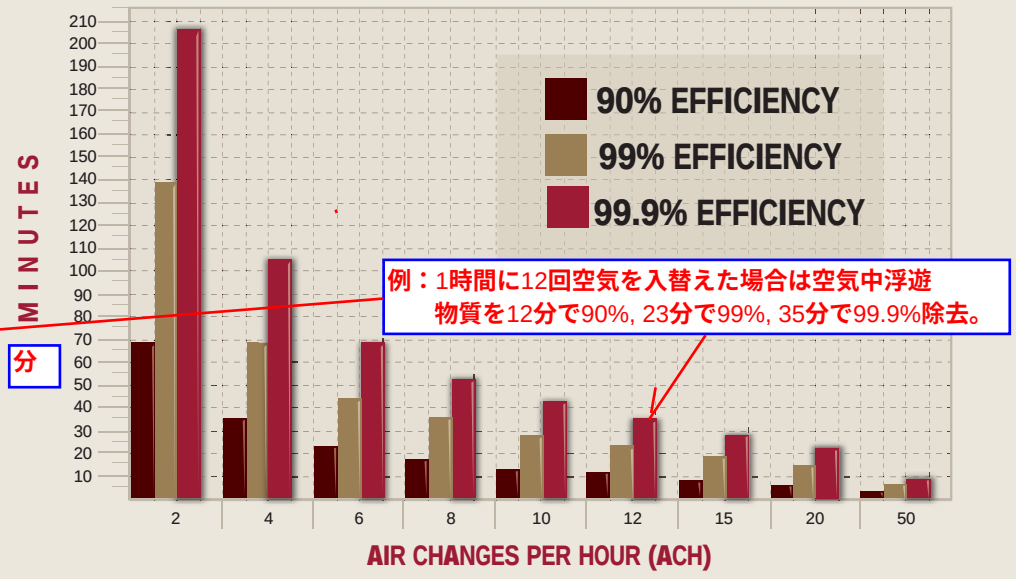
FIGURE 2: *ACH AND TIME REQUIRED FOR REMOVAL EFFICIENCIES*

Time (minutes) required for removal of 90%, 99%, and 99.9% of airborne-contaminants.

空気中浮遊物質を90%, 99%,99.9%除去するための必要時間（一時間当たりの空気の入替回数毎に）

ACH	90% EFFICIENCY	99% EFFICIENCY	99.9% EFFICIENCY
2	69	138	207
4	35	69	104
6	23	46	69
8	17	35	52
10	14	28	41
12	12	23	35
15	9	18	28
20	7	14	21
50	3	6	8

Modified from Table B.1, CDC Guidelines for Environmental Infection Control in Health-Care Facilities, 2003.[5]



Perfect mixing of air is assumed. For rooms with stagnant air spaces, the time required may be much longer than shown. This is intended only as an approximation and is for ideal ventilation configurations.

HEPAフィルターの排気を直接外部に排出する事例

Discharging air to the outside

Creates negative pressure room (airflow into patient room from the corridor or anteroom)

Steps for discharging air to the outside

1. Select a room
2. Set up pre-constructed window adapter
3. Set up HEPA machine and flex duct
4. Seal return air grille
5. Turn on HEPA machine and adjust flow

This option is one of the two preferred methods for achieving TNPI.

In this method, a HEPA filter is used to exhaust room air outside through the window. (Clearly, a window is required for this method.) *(FIGURE 4)*

- The two main purposes of the HEPA machine in this application are to **clean contaminated air** and **induce negative pressure** in the room.
- Because the discharged air is HEPA filtered, no extra consideration for air discharge location is required.

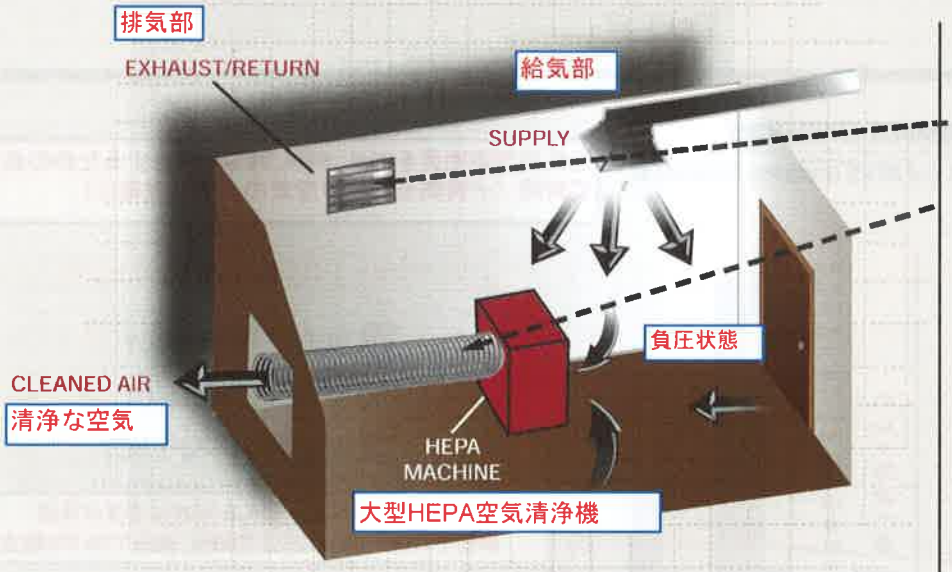


FIGURE 4

***HEPA fan** exhausting clean air outside through the window.*

To prevent pulling air from return air system, the exhaust/return grilles should be sealed with tape.

Set up HEPA machine and flex duct.

tip Becoming familiar with operating the negative pressure HEPA filter machine on a regular basis (e.g., during construction projects), will better prepare the

Step 2: Calculate necessary HEPA output airflow

推奨空気入替回数は1時間当り12回

The recommended air change rate is 12 ACH.

Using the volume and the recommended air change rate, ***calculate the necessary HEPA output airflow*** using the formula to the right:

ACH = Air changes per hour

Airflow = Mechanically exhausted airflow rate in cubic feet per minute (cfm)

Volume = Room air volume (length x width x height) in cubic feet (ft^3)

$$\text{Airflow} = \frac{\text{ACH} \times \text{Volume}}{60}$$