

Hospital Ventilation

衛福部 疾病管制署
中區傳染病防治醫療網
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1. What is Ventilation ?

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a) Ventilation is a process

- Outside Clean Air – In
- Inside Dirty Air – Out
- By Natural or Mechanical Means

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b) Natural Ventilation

- Flow process by wind and temperature
- Windows / door opening
- Lack of control
- Unreliable driving forces – inadequate or too much
- No adjustment
- Fresh air – 100%

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c) Mechanical Ventilation

- Controlled rate of air change
- Incoming supply air filtrated
- Dilute and remove pollutants
- Installation, operation and maintenance cost
- Fresh air mechanically driven
- Supply and extract ventilation system

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2. What is HVAC ?

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- a) H = Heating
V = Ventilation
AC = Air-conditioning

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- b) To control
- Temperature
 - Relative humidity
 - Odors
 - Air movement

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c) Design Considerations of HVAC System

- Quality of outdoor air
- Outdoor air intake
- Filters
- Location of ventilation equipment
- Recirculation
- Variable air volume (VAV) & Constant air volume (CAV) systems
- Ventilation rates
- Climatic conditions
- Ventilation controls

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3. Why is HVAC system important in hospital

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a) What are the symptoms of poor Indoor Air Quality (IAQ) ?

- Sick Building Syndrome (SBS)
- Building Related Illness (BRI)
- Discomfort

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b) Sick Building Syndrome (SBS)

- Headache
- Nausea
- Dizziness
- Poor concentration
- Chest tightness
- Flu-like symptoms
- Nose and Throat irritation

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c) Building Related Illness (BRI)

- Allergic reactions
 - Hypersensitivity pneumonitis
 - Formaldehyde
 - Radon
- Infectious diseases
 - Legionnaire's disease
 - Humidifier fever

These are clinically defined illnesses and usually associated with indoor air pollutants.

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d) Air Contaminants

- Airborne particles – bacteria, virus, smoke, etc.
- Volatile organic compounds = building materials, cleaning agents, cosmetics, paints, etc.
- Tobacco smoke
- Asbestos = sprays, ceiling tiles, pipe lagging, insulation boards, chemical
- Formaldehyde = VOC, chemical ingredient in building materials and fabrics
- Combustion gases = carbon dioxide, nitrogen oxides (NO & NO₂)
- Ozone = Produced from ultra-violet light (UV)
- Respiratory products and body odour = CO₂
- Micro-organisms = Bacteria, fungi and viruses

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4. Hospital Ventilation Guidelines and Standards

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a) Centres for Disease Control and Prevention (CDC)'s recommendations

- Engineering Control
 - Local Exhaust Ventilation (i.e. source control)
 - General Ventilation
 - Air cleaning (HEAP filter, UVGI)

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a) Centres for Disease Control and Prevention (CDC)'s recommendations (Cont')

- General Ventilation considerations
 - Dilution and removal of contaminants
 - Air-flow patterns within room
 - Air-flow direction in facilities
 - Negative pressure in rooms
 - TB isolation rooms

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b) CDC's recommendations for Airborne Infection Isolation (AII)

- Isolation of Patient infected with organisms spread via airborne droplet nuclei <5 um in diameter
- ≥ 6ACH for construction before 2001
- ≥ 12 ACH for new construction as of 2001
- Negative pressure from corridor into the room
- Air preferably exhausted to outside
- Air may be recirculated, return air filtered through HEPA

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d) World Health Organization (WHO)'s Hospital Infection Control Guideline for SARS and Recommendations in Descending Order of Preference

- Negative pressure rooms with the door closed
- Single rooms with their own bathroom facilities
- Cohort placement in an area with an independent air supply, exhaust system and bathroom facilities

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e) Hospital Guidelines & Standards Comparison

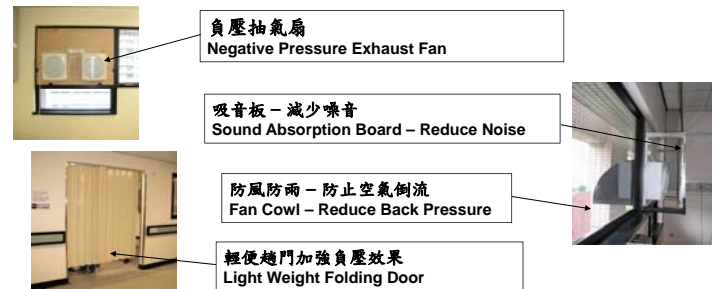
AIA
ASHARE
CDC
OSHA
HTM2025

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5. Genesis of Negative Pressure System

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a) 負壓系統的誕生
The Genesis of a Negative Pressure System



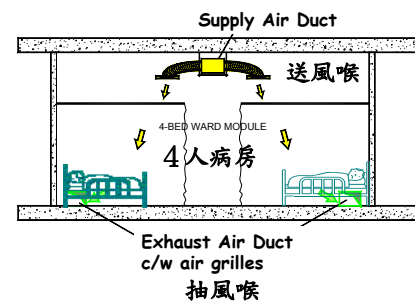
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b) 演進期
Growth



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c) 成熟期
Maturity



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6. Negative Pressure System Verification

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a) Air Pressure Balancing

- To prevent escape of droplet nuclei, negative pressure
- To maintain pressure relationship – clean to dirty

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b) Airflow Pattern

- Air flowing from corridor, through ante-room into isolation room
- Temperature differential

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c) Smoke Trail Test (STT)

- Air flow – Vertical
- Air flow - Horizontal

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7. Air Purification Systems

- Air filtration system
- Ultra-Violet light
- Ozone

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a) Air filtration System

Some common air contaminants Size (Microns)

- Pollen : 5 – 100
- Virus : 0.001 – 0.05
- Aerosol : 0.005 – 50
- Human Hair : 70 – 100
- Bacteria : 0.35 – 10
- Tobacco smoke : 0.01 – 0.5
- Household dust : 0.05 – 100

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a) Air filtration System - Air Filters

- Pre-filters
 - Washable panel filter < 50%
 - Disposable filter < 50%
- Final filters
 - High Efficiency Filter (**Bag filter**) = 85~95%
- High Efficiency Particulate Air (**HEPA**) filter = 0.3 micron & 99.97%

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b) Ultra-Violet (UV) Light – nm-nanometer

- Vacuum UV – UVC 90-200 nm
- Short Wave UV – UVC 200-280 nm
- Middle Wave UV – UVB 280-320 nm
- Long Wave UV – UVA 320-400 nm
- Greatest Germicidal Effectiveness – 250-265 nm

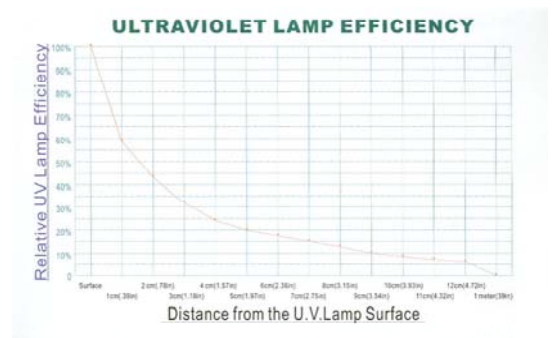
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b) Ultra-Violet - Factors Affecting Killing Rate

- Air Velocity – Higher velocity, more UVC energy
- Temperature – Within the system, too cold, too hot, too humid, etc.
- Relative Humidity (RH) – Higher RH, more UVC energy
- UV Light source location – Before or after the object e.g. ducting, fan coil units

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b) Ultra-Violet - UV Lamp Efficiency (Information source from RoboClean (HK) Co., Ltd.)



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b) Ultra-Violet - Safety

- Avoid exposure to UV rays e.g. eyes, skin problem
- Improve Ventilation when UVV is used (generation of Ozone)
- Avoid direct exposure of plastic material

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c) Ozone (O₃) - 臭氧之功能

- 殺菌
- 防腐
- 保鮮
- 解毒
- 醫療
- 增氧
- 美容
- 漂白

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c) Ozone (O₃) - 臭氧的濃度國制上的標準

- 國際臭氧協會規定 0.05ppm(10小時/日)
- 美國國家標準規定(FDA) 0.05ppm (8小時/日)
- 德國國家標準規定0.10ppm
- 日本國家標準規定0.10ppm
- 法國國家標準規定0.12ppm

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c) Ozone (O₃) - 臭氧副作用

- 腐蝕性氣體
- 因氧化, 損壞物質
- 濃度越高, 損壞性越強
- 對健康有壞影響
- 0.01 – 0.025 ppm 可以嗅到
- 0.2 – 0.4 ppm 低度刺激感, 眼, 鼻, 喉
- 1 – 3 ppm 頭痛, 胸口痛, 咳嗽
- > 5 ppm 心跳加速, 咳嗽, 脈搏加快, 頭暈

以上資料大部份來自以下網站:-
<http://www.biddy-light.com.tw/tech/OZONE-page.htm>

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8. Measuring Equipment

- a) Air Flow Measurement
 - Anemometer
- b) Temperature Measurement
 - Thermometer

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9. 同心同德 Teamwork



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Thank You !!!

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