紫消燈在醫療上的應用



衛生署 疾病管制局 中區傳染病防治醫療網 王任賢 指揮官

Outline

- What is UVGI?
- Upper room UVGI
- Complementary role of UVGI
- Avoiding direct exposure or overexposure
- Appropriate settings for upper room UVGI
- Monitoring and maintenance
- UVGI air cleaners

Ultraviolet irradiation



Ultra-Violet (UV) Light

- Vaccum UV UVV 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





Baltimore Veterans Administration Hospital Pilot Ward Experience

Riley R. and Wells W. 1956-1961

Materials and Methods

- 第一階段:在六間負壓TB病房的出風口外放置 一動物養殖籠,裡面飼養150-240隻天竺鼠實 驗用天竺鼠均先經30天檢疫且TST(-)實驗後天 竺鼠均接受系列之TST,TST若轉陽性則必須 接受解剖
- 第二階段:負壓房間的出風口外分成兩股,一 股接受UV照射,另一股則無。感染的天竺鼠
 並依抗藥性模式而判定被何人傳染。

結果(一)

- •天竺鼠平均感染時間為10日
- TB的感染劑量為1 in 11,000-12,500 ft³ of air
- 14/63隻感染的天竺鼠是被一TB laryngitis的人所 傳染,此人之住院日數只佔總人日數的1%
- 130住院病人中,其中8人傳給了46%的天竺鼠
 - •未治療病患的傳染力是治療病患的10-50倍
 - •非抗藥性結核的傳染力是抗藥性結核的4-8倍

結果(二)

- 絕大多數新感染結核病的天竺鼠解剖時,
 肺部均只有一個tubercle,表示都只感染到
 一隻結核菌
- 也有些新感染結核病的天竺鼠解剖時,肺
 部並沒有任何發炎反應
- · 經過UV處理的空氣不會感染任何天竺鼠



How much UVGI do we need to kill *M. tuberculosis*?



Inactivation

6 200 μJ/cm² *10 000 μJ/cm² 13 800 μJ/cm² 17 600 μJ/cm²

90% 99% 99.9% 99.9% 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

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



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



Upper room UVGI





Upper room UVGI





Upper room UVGI

- May be capable of air disinfection equivalent to 10-20 air changes per hour
- Air disinfection is decreased by as much as 80% with incomplete air mixing



WHO recommendations

- Priority should be given to achieving adequate air changes per hour using ventilation systems
- If not possible, UVGI is a complementary intervention
- Upper room UVGI devices must be properly designed, installed, maintained and operated



UVGI is a complementary infection control measure

- Requires air mixing to be effective
- > 70% humidity may reduce efficacy
- Does not provide fresh air or directional airflow
- Precautions necessary to avoid short term effects on the skin and eyes



UVGI Occupational Exposure Limit

At the 254 nanometre wavelength,

- The occupational exposure limit is $6,000 \ \mu J/cm^2$ for a daily 8-hour shift
- Corresponds to a maximum irradiance of 0.2 $\mu W/cm^2$ for an 8 hour exposure

 μ J = micro Joules μ W = micro Watts



UVGI monitoring to ensure radiation level is:



Effective for disinfecting the air
Safe for room occupants

UVGI meter

UVGI measurement devices

- International Light meter model 1400A with SEL240 detector, or
- Gigahertz-Optik model X911 UVC meter with UV-3718-4 detector



22



UVGI must be shielded when room is occupied







Example of unshielded device



Appropriate settings for UVGI

- Large, overcrowded congregate settings where:
 - TB is often undiagnosed
 - Ventilation is insufficient
- Examples
 - Emergency (casualty) departments
 - Waiting areas in health facilities
 - Homeless shelters
 - Sputum induction booth

Upper-air UVGI is suitable for a particular room if:

- There is a high ceiling (so people cannot look into the lamp)
- Fans or ventilation system mix the disinfected upper room air with the potentially contaminated air below
- There is not <u>so</u> much ventilation that air doesn't have time to be irradiated

Little "near field" protection



Is this a rational location?



UVGI is not useful here either





UVGI is not needed here







Monitoring and maintenance

- Designate a person to be responsible for routinely:
- Monitoring radiation levels
- Cleaning (turn off before cleaning)
- Replacing bulbs as recommended by manufacturer
- Keeping records of monitoring and maintenance activities



UVGI cleaning





UVGI cleaning



Applications of UVGI

- Upper air disinfection
- Duct irradiation
- Air cleaners





UV Radiation

- Used to supplement other engineering controls
- Duct Irradiation
 - To recirculate air from an isolation room back into the room.
 - Used in general use areas where air is recirculated back into general ventilation
- Upper Room Air Irradiation
 - Mounted on ceiling or wall



Summary

- Upper air UVGI may be capable of disinfecting equivalent to 10-20 air changes per hour if properly designed, installed and maintained
- Eye and skin risks can be avoided by shielding and measuring to ensure no overexposure
- Upper air UVGI is a complementary intervention to adequate ventilation

懇請賜教