HOSPITAL AND OPERATION THEATRE INDOOR AIR QUALITY ASSURANCE OPERATIONAL GUIDELINES

Address to:

Subject: Indoor Air Quality Assurance - Operating Theatres Infection Control

INTRODUCTION

While there is considerable evidence available to indicate that surgical site infections are a significant health risk to hospital patients, there is ongoing debate over the appropriate extent and frequency of microbiological surveillance of operating theatres.

In the healthcare facilities, the risk of acquiring infectious diseases is reasonably high. Transmission may be among the healthcare professionals, patients or visitors. Recent epidemic clearly demonstrated the hazards faced by the healthcare professionals. Severe acquired respiratory syndrome (SARS) was a grim reminder that healthcare work can be dangerous to health. Globally, healthcare professional encompassed more than 21% of all SARS patient. In countries like Canada and Singapore, healthcare professionals comprised of more than 40% of all SARS patients.

Exogenous infections of surgical wounds are caused predominantly by *Staphylococcus aureus*, and *Staphylococcus epidermidis*. *S. aureus* and *S. epidermidis* are shed into the environment by individual skin scales and, while healthy carriers have been found to shed few staphylococci, airborne contamination is inevitable owing to staff movement encountered during operating theatre activities. While there is evidence to indicate that most outbreaks are caused by heavy dispersers, every attempt should be made to minimize airborne transmission within operating theatres.
Principles

Healthcare facilities should implement proper design and ventilation of operating theatres as a means of controlling airborne contamination. Other strategies to prevent airborne microbial contaminants from entering surgical wounds should include:

- Ensuring that staff are educated and take appropriate precautions to prevent shedding of microbes; and
- Restricting excessive movement of staff within the operating theatre; and
- Taking appropriate action to ensure the indoor air quality in all operation theatre.

Standards

There are no nationally agreed standards on when to undertake microbiological sampling in the operating theatre, or on the interpretation of sampling results. However, there is sufficient evidence to support the undertaking of microbiological air sampling:

- as part of the commissioning of an operating theatre;
- after any major structural refurbishment (not including High Efficiency Particulate (HEPA) filter changes); and
- as deemed necessary by the Infection Control Unit.

Specialist microbiologist/infection control advice must be sought prior to undertaking air sampling in an operating theatre owing to the large number of factors that affect microbial air sampling results.

Types of Operating Theatres

Recommended standards may vary between types of operating theatres. Design standards for operating rooms are defined in the Private Hospital Guidelines.
HOSPITAL AND OPERATION THEATRE INDOOR AIR QUALITY ASSURANCE SOLUTION PROTOCOL – SOMA MEDICAL MALAYSIA

- It is our unique product - a low cost method for evaluating controlling and improving indoor environment quality for the prevention of bacteria, yeast and mold.
- It is a proactive approach toward ensuring proper indoor air quality assurance.
- It involves procedures for the performance of indoor air quality testing and inspections.
- It involves training requirements and guidelines for handling emergencies.
- It supplies standards for acceptable indoor air quality.

Contents and Scope

- Remedial solutions to mold, bacteria, fungi, mildew
- Surveys and assessments
- Training
- Problem solving
- Text and software for IAQ management
- Measurements of volatile compounds from building materials and furnishings
- Ventilation evaluations and remediation
- Bacteria, yeast and mold measurements
- Emergency response to IAQ
- Investigation of complaints
- Operation theater construction and renovation assistance
- Air cleaning filters

Benefits

- Significant reduction in liability
- Assurance of occupant comfort
- Reduction in insurance costs
- Reduction in HVAC maintenance costs
- Increased marketability of premises
The Solution

- **The use of Titanium dioxide (TiO$_2$)** When exposed to UV light in the sub 400 range of our Medilite and TiO$_2$ becomes a photo catalyst oxidizer (PCO) creating hydroxyl radicals and superoxide ions which are two times stronger disinfectants than chlorine and 1.5 times stronger a disinfectant than ozone.

- **The use of SM1152 Nano Photocatalyst** is a reaction that uses light to activate a substance which modifies the rate of a chemical reaction without being involved itself. And the photocatalyst is the substance which can modify the rate of chemical reaction using light irradiation. Chlorophyll of plants is a typical natural photocatalyst. This man-made nano photocatalyst creates strong oxidation agent and electronic holes to breakdown organic matter to carbon dioxide and water in the presence of photocatalyst, light and water.

**SOMA MEDICAL'S STERILIZATION PROTOCOL**

Integration of Soma Medical's Cleanature SM767B, UVMax SM212, UVMax SM14, HEPA filter and SM1152 Nano TiO$_2$ coating agents, all working in unison creates an optimum and comprehensive sterilization protocol for the eradication of bacteria, yeast and mold on a 24/7 basis.

**List of equipments**

1. Medical germicidal air purification system. Cleanature SM767B
2. UVMax SM212 cassette unit for 1-1.5 hp air conditioning system
3. UVMax™ SM14 suspended/wall mounted
4. HEPA filter
5. SM1152 Nano TiO$_2$ Sol Coating Agent
Specifications

Cleanature SM767 Medical Germicidal Air Purifier

Filter
- Electrostatic + HEPA + Activate carbon + photo catalyst
- Static plasma: with honeycomb type of aluminium

Negative ion generation rate
- 5 x 106 ions / s

Ultraviolet light (UVC)
- Yes intensity 23,000 µW/cm² (Quartz Lamp)

Air Sensor
- Dust, odor, air hydrogen, ammonia, hydrogen sulfide, ethane, toluena, air methane, butane and carbon

Ozone application
- Yes (≤ 0.05 ppm)

Purification rate
- ≥ 99.997%

Anti-bacteria rate
- ≥ 90%

Airflow rate
- 400 cfm/70m³/H (low)
- 450 cfm/150m³/H (medium)
- 500 cfm/210m³/h (high)

Air exchange rate
- 2 hours (low)
- 1 hour (medium)
- 0.6 hour (high)

Recommended room use
- 60 m² (650 ft²)

Power supply
- 110 – 230V, 50-60Hz (≤ 55W)

Product dimension
- 580 x 450 x 240 mm

Customized HEPA minipleat filters for Medical Germicidal Air Purification system model SM767B offer outstanding performance and energy cost saving characteristics. Our separatorless minipleat design allows much more filter media into the same area conventional corrugated separator filters occupy. More media = extended filter life and less static pressure. In fact, at a 100 F.P.M. velocity measured volumetrically, a pressure drop as low as 19” W.G. is obtainable in clean room applications. Manufactured in HEPA and ULPA efficiencies ranging up to and including 99.99999+% @ 0.12 microns. These advanced and versatile filters are DOP, PSL scan and/or laser tested as required.

UVMax™ SM212 cassette unit for 1-1.5 hp air conditioning system

Ultraviolet light (UVC)
- Yes
  - Intensity 18,000 µW/cm²

Bulb lifespan
- 12,000 hours operational

Energy used
- ≥ 90%

Power supply
- 220-230 V 50 Hz (6 W)

Product dimension
- 9"
UVMax™ SM313 socket unit for 1.5hp and above air conditioning system & ducting

Ultraviolet light (UVC) Yes
Intensity 24,000 µW/cm²
Bulb lifespan 12,000 hours operational
Energy used ≥ 90%
Power supply 220-240 V 50 Hz (9 W)
Product dimension 9”

UVMax™ SM14 suspended/wall mounted

Ultraviolet light (UVC) Yes
Intensity 24,000 µW/cm²
Bulb lifespan 9,000 hours operational
Energy used ≥ 90%
Power supply 240 V 50 Hz (12 W)
Product dimension 22”

Medilite Medical Air Purification Lamp

Negative ions > 800,000 ions/cm³
Colour Temperature 2700(warm) & 4100 (cool)
Light Output (Lumens) 1350(warm & 1680(cool)
Total Length 15 cm
Anti-bacteria rate ≥ 90%
Average lifespan 8,000 operational hrs
Coverage area 70 sq ft
Power supply 220 – 240V, 50/60Hz
Fitting (≤ 25W) E27 Medium Base
Nano TiO₂ Sol Coating Agent (SM1152)

**Appearance**
Transparent liquid

**Dispersive type**
Solution

**Odor**
None

**PH**
7-8.5

**Boiling Point**
100°C/212°F

**Volatile**
None

**Freezing Point**
0°C/32°F

**Flash Point**
Non flammable

**Average primary particle size Acc. to GB/T 19591-2004**
< 4nm

**Crystal structure Acc. to GB/T 19591-2004**
Anatase

**Specific surface area (BET) Acc. to ISO 9277:1995**
160± 30m²/g

**Coagulation index Acc. to GB/T 19591-2004**
2 to 4

**Material academic duration**
Permanent

**Coating duration acc. to outdoor simulation environment**
> 2 years

**Primary drying time**
30 minutes

**Final setting time**
2 weeks

**Saturated stream pressure**
2333Pa acc. to H₂O 1 PN 20°C

**Opposite stream density**
< 1.0 acc. to H₂O

**Solubility**
Dissolve in water, miscible in oil

**True specific gravity**
1.0075 – 1.01

**Viscosity, dynamic**
1.0050 mPa.s

**Vaporize velocity**
< 1.00 acc. to H₂O
THE INTEGRATION

Comprehensive Sterilization Protocol 24/7

Cleanature SM767 Medical Germicidal Air Purification System

Medilite Air Purifying Lamp

UVMAX SM14 ceiling mounted UVC

SM1152 Nano TiO₂ coating

UVMAX SM212 for split system AC

UVMAX SM313 for Ducting

UVMAX SM14 ceiling mounted UVC

SM1152 Nano TiO₂ coating

SOMA MEDICAL’S Operation Theatre Solution Protocol

Installed in a Typical Layout for a Conventional 20’L x 15’W x 12’H Hospital Operation Theatre

UVMAX SM313 for Ducting

Air conditioning ducting

Cleanature SM767 Medical Germicidal Air Purification System

UVMAX SM212 for split system AC

Medilite germicidal lamp

UVMAX SM14 ceiling mounted UVC

SM1152 Nano TiO₂ coating
SOMA MEDICAL- (I.A.Q.A.) System Operation Guidelines

Spraying of SM1152 Nano TiO₂ for ceiling, walls and flooring (The operation theatre is closed for one day to facilitate spraying of TiO₂ coating solution).

**During surgery- (or during working hours for general open areas)**

- Cleanature SM767 will be in operational on automatic mode. The unit works 20 minutes and stops 40 minutes periodically 24/7 perpendicular to each other to allow uniform circulation.
- Medilite germicidal lamp will be activated 24/7 in the operation theatre.
- UVMax SM212 & UVMax SM313 installed into existing air conditioning system will be activated 24/7 in the operation theatre (no human contact since the light is concealed inside the ducting/air conditioning system).

**Between surgery- (or after working hours for general open areas)**

- Cleanature SM767 will be in operational on automatic mode. The unit works 20 minutes and stops 40 minutes periodically 24/7 perpendicular to each other to allow uniform circulation.
- Medilite germicidal lamp will be activated 24/7 in the operation theatre.
- UVMax SM14 ceiling mounted will ONLY be activated in the event the operation theatre is not being utilized for surgery (no direct human contact).
- UVMax SM212 & UVMax SM313 installed into existing air conditioning system will be activated 24/7 in the operation theatre.

**General Theatre Sterilization Protocol**

- Daily OT floor is swept thoroughly then mopped with plain water.
- Complete washing of the theatre including walls, door, floors and equipment is done once a month with detergents.
- Fans, light, clock and A/C vents inside the theatre are wiped once a month.
- Equipment like microscopes should be cleaned separately with Isopropyl alcohol except lens. Lenses should be cleaned once a week with lens cleaning solutions.
- Tables, saline stands, revolving stools should be cleaned monthly with antiseptic liquid concentrate (Chlorhexidine, Gluconate 75%) 10 ml should be diluted to 500 ml of water or Benzalkonium chloride (10%).
- Air conditioner filter must be cleaned once in a month.
- Air conditioner should be sent for servicing & cleaning once in 6 months.
- Periodic culture is done once in a month from areas such as hand wash, autoclave, needles, knifes and gas sterilized items.
- Keep the doors of the operating theatre always closed.
PLANNING FOR AIR SAMPLING

Healthcare workers should:

- prior to air sampling, obtain the air sampling equipment from a laboratory that is able to process the specimens;
- establish laboratory time-lines for sample collection, processing and provision of results; and
- consult with the hospital microbiologist/engineer. Healthcare workers (HCW) working in rural/regional areas should consult with the Medical Microbiologist and their Hospital Engineer before proceeding with microbiological air sampling. Private hospitals should consult with their in-house or consultancy service microbiologist and engineer.

HOW TO AIR SAMPLE

There are several different types of air samplers available and the manufacturer’s instructions for use must be followed. If available, the preferred method is to use a sampler that can be turned on by a timer or remote control. Moreover, air samples should be taken after all the following conditions have been met:

- all new or refurbishment work has been completed;
- all engineering commissioning procedures have been completed;
- the ventilation system has been running continuously for 24 hours following completion of structural work (during this time the theatre surfaces and fixed equipment can be cleaned); and
- ducting and air diffuser plates have been cleaned.

METHOD

The following process is recommended:

1. A single sample should be collected from each operating theatre.
2. The air sampler should be checked to ensure that it is clean before use. Follow the manufacturer’s instructions.
3. The theatre being sampled should have been left vacant for a minimum of 15 minutes, but preferably one hour, before sampling proceeds to avoid false-positive results due to recent theatre usage. The theatre doors must be kept closed prior to and during the sampling period.
4. Staff should wear theatre attire and a surgical mask, and the hands should be washed and sterile gloves worn.
5. Using aseptic technique, proceed with setting up and placing the agar strips or plate into the sampler.
6. The air sampler should be placed in the middle of the theatre table or secured on a trolley where the theatre table is usually located.
7. The air sampler should then be switched on either by remote control or manually, before leaving the room. **Note: doors must be kept closed and the theatre empty until sampling is complete.**
8. The sampling equipment will determine the volume of air sampled. Sampling volume needs to be greater than 0.25 m\(^3\) (250 L) and optimally around 1 m\(^3\) (1000 L).
9. Once sampling is completed, remove the test strips/agar plate aseptically to avoid contamination. The agar strip/plate and request form should be clearly labelled and the amount of air sampled recorded.

Any variation from the above operating theatre conditions should be noted on the laboratory request form as this information will influence interpretation of results.

**RESULTS AND INTERPRETATION**

Preliminary culture results are rarely available until after 24 hours incubation. **With this recommended I.A.Q. solution protocol the Aerobic cultures on non-selective medium should not exceed 20 colony-forming units (cfu) of bacteria and fungi per cubic meter of air for a conventional theatre (below acceptable levels of 30 cfu).** These figures are not rigid standards and are intended as a guideline only. If the result exceeds these limits contact your Microbiologist/Infection Control Practitioner for interpretation and advice on further action.

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