ISSUE 5

Livewire

INFECTION CONTROL

October, 2015

NEWS LETTER

FROM THE DESK OF EDITORIAL BOARD

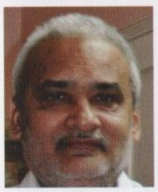
Dear Friends,

We hope that you have gone through the first four issues of Livewire infection control newsletter published till date. We believe that your minds are actively thinking on the issues raised by the stalwarts in the field especially on cluster infections.

With this issue, we are entering into the infection control activities per say. Once again, there are articles from experts in the field. We are beginning with the layout of the operation theatre. Once you go through, please think about the layout of your theatre and look at what is different, whether it needs to be changed, whether it is urgent. One may feel that such operation theatre layouts are required only for big institutions or in western countries. However, in the present day scenario, even NABH asks for such layout. If you are worried about the cost factor, we should be able to help you find cheap solutions to improve the layout and these are time tested and proven solutions.

We are working hard to get more experts write on this important subject and present useful reading material to you. Your feedback is welcome and we will try to give you answers to the best of our understanding. We are waiting to hear from you.

INFRASTRUCTURE



Dr. Mehul Shah,
Drashti Netralaya,
Gujarat

Dr. Mehul has done his graduation and post-graduation from Ahmedabad, did retina fellowship from Retina foundation and Sankara Nethralaya. He is working at Drashti Netralaya, developed special interest in Ocular trauma, Published 185 articles in peer reviewed journals, 4 chapters in books and reviewed 47 articles in international peer reviewed journals. He has experience of construction of state-of-the-art operation theatre approved by NABH and provided guidelines to number of hospitals to construct operation theatres.

Chain of Infection:

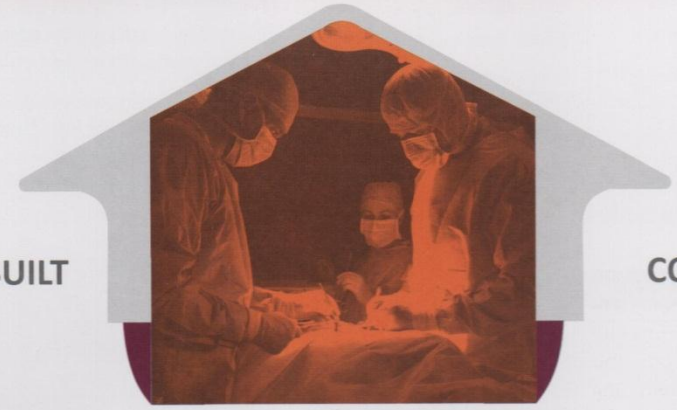
- **Causative agent** — microorganism capable of causing disease
- **Reservoir agent** — can survive, may/ may not multiply
- **Portal of exit** — respiratory, GI, GU tracts, skin & mucous membranes
- **Transmission** — direct & indirect contact, airborne, common vehicle
- **Portal of entry** — respiratory, GI, GU tracts, skin & mucous membranes
- **Host** — person lacking effective resistance
- **Adequate dose** — (of organisms needed for infection to occur)

MODE OF TRANSMISSION:

Specific rooms should be designated for performing surgical/clinical procedure

LOCATION OF OPERATION THEATRE SUITE

PURPOSE BUILT



CONVERTED

Separated from the main flow of hospital traffic and from the main corridors; however, it should be easily accessible from surgical wards and emergency rooms.

LAYOUT PRINCIPLES

- No direct exposure to exteriors
- A circulating passage all around the OR
- Separate entries for patient and staff
- No windows, no exhausts
- No toilet on the floor
- Access to recovery rooms by all operation rooms

The operating theatre should be zoned and access to these zones should be under control of the OT personnel. Aseptic and clean areas should be separated from the outer areas. This is easier to achieve in purpose-built units. Physical barriers may be needed in order to restrict access and maintain unidirectional movement of air in converted theatre units.

THE OUTER ZONE:
A main access door
An accessible area for the removal of waste
A sluice
Storage for medical and surgical supplies
An entrance to the changing facilities

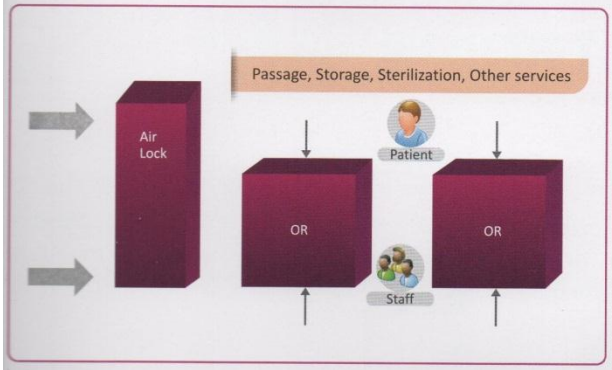
THE CLEAN OR SEMI-RESTRICTED ZONE:
A sterile supplies store
An anaesthetic room
A recovery area
A scrub-up area
A clean corridor
Rest rooms for the staff
No entry with street clothes.

ASEPTIC OR RESTRICTED AREA:
The operating room
The sterile preparation room (preparation of sterile surgical instruments and equipment)
Area restricted to working. Staff working in this area should change into theatre clothes, should wear masks and gowns, and, where necessary, should wear sterile gloves

BARRIERS:

Zones	Type of Barrier	
Outer	Physical	Sluice, storage, waste disposal, outside corridor, changing rooms
Clean	Partial	Supply store, scrub area, anaesthetic room, recovery room
Aseptic	Physical	Sterile preparation, autoclave access

SCHEMATIC DIAGRAM



Multiple doors and barriers.

Operation theatre's main door should not face exterior directly.

Ceiling: AC ducts, electric panels and wiring is to be covered under false ceiling, it may be seamless or a bio-guard modular ceiling.

- Flooring: Seamless PVC is ideal
- We may use granites with minimum joints
- Marble is an improper option

Ideally, there should be one table for one operation room.

More people generate more carbon dioxide, more heat. 28 cm volume needed for a team of 10 people.

Floor, walls ideally should be seam-less if we use PVC for seamless floor and wall. Walls may be treated with stainless steel. Flooring should be minimally porous like granite and marble should be avoided.

WHY DO WE NEED AIR CONDITIONER IN HOSPITAL?

- The need to restrict air movement within and between various departments.
- Specific requirements for ventilation & filtration to dilute and remove contaminants in the form of airborne microorganisms, viruses, odour, hazardous chemicals and radioactive substances.
- Different types of temperature and humidity requirements for various areas.
- Permit accurate control of environmental conditions.
- Control of air quality and air movement

OPERATION ROOM AIR QUALITY

- Acceptable indoor climate
- Remove odors and anesthetic gases
- Reduce risk of infection

ACCEPTABLE INDOOR AIR QUALITY CAN BE ACHIEVED BY

- Contaminant source control
- Proper ventilation
- Humidity management
- Adequate filtration

PARAMETER	Desired range
Temperature	20-23°C
Relative humidity	30-60%
Air movement	From clean to less clean areas
Pressure	+ve air pressure by manometric control
Air changes	Minimum 15 total air changes per hour

EMPTY OPERATION ROOM SHOULD HAVE:

- Less than 35 colony-forming units (CFU) of bacteria/m^3 of air
- Less than one CFU of *Clostridium perfingens or Staphylococcus aureus* in 30 m^3
- During operation, less than 180 CFU/ m^3 of air using ultraclean laminar flow in the theatre
- Less than 20 CFU/m^3 at the periphery of the enclosure and less than 10 CFU/m^3 at the centre
- Conventional OR 150-300 CFU/m^3 ultraclean LAF 10 CFU/m^3

DESIGN PARAMETERS

Air changes: 15-20/hour

Filtration: Filter all air with appropriate pre-filters (e.g. filtration efficiency of 30%) followed by final filter (e.g.90%)

Air supply: Air should enter from the ceiling and be exhausted near the floor (important: furniture or other portable items placed against a wall exhaust at floor level will inhibit the air changeover in a theatre and therefore, should be monitored and abated)

Ultraviolet Germicidal Irradiation (UVGI): Do not use UVGI in the OR

Doors: Keep OT doors closed except as needed for passage of equipment

Emergency exit : is essential

Traffic: Limit the number of personnel entering the OT to only those necessary for the surgical procedure. The microbial level in the OT is directly proportional to the number of people moving about in the theatre.

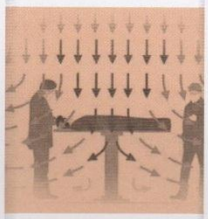
Laminar flow & ultraclean air

- **Thermai Comfort for Surgicai Team:**

  - Amount of heat production in OR depends upon activity of surgical team, lighting, equipment
  - Average 2 kw or 1750 kcal/hour

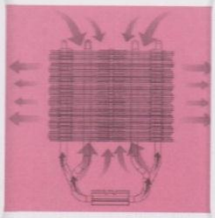
- **Operation Room Ventilation:**

  - 28 m^3 of air needed for team of 10 people
  - 0.24 ml^3 air needed for odour suppression
  - Minimum 10 exchanges/hour is necessary but 15 to 20 exchanges are desirable
  - If we look at LAF ultra clean theaters, air exchange rate is 300/hour



Direction of Airflow:

- Direction of airflow should be from clean to less clean areas
- Airflow rate of 0.28-0.47 m/sec is desirable across an open door to prevent backflow into cleaner areas
- In ultraclean air enclosures, the airflow should not be less than 0.2 m/sec at one metre above the door



Humidity:

- Low humidity - static electricity - *Klebsiella growth*
- High humidity - *Pseudomonas* growth and increased transmission
- Ideal relative humidity - 50%

TYPES OF AIR SUPPLY

- Plenum Ventilation: This is the most frequently used system in general purpose operating rooms. The bacterial counts at the wound site should be no more than 50-500 colony forming units (CFU) per cubic meter
- Laminar Flow Ventilation (Ultraclean Ventilation): This system is unidirectional and delivers air flow over the operating table of 300 air changes per hour. A bacterial count of 10 CFU or less per cubic meter at the wound site is achieved
- Wall Mounted Air Conditioners: More for comfort than for clean air delivery. They should not be used as air delivery systems. The units are usually mounted on the hot outside wall and the air is directed down and back onto the unit itself (towards the wall). The operating table does not receive any significant air changes and the bacterial counts remain unaffected
- Free-standing Air Conditioners: These are cooling units with no filtration of air

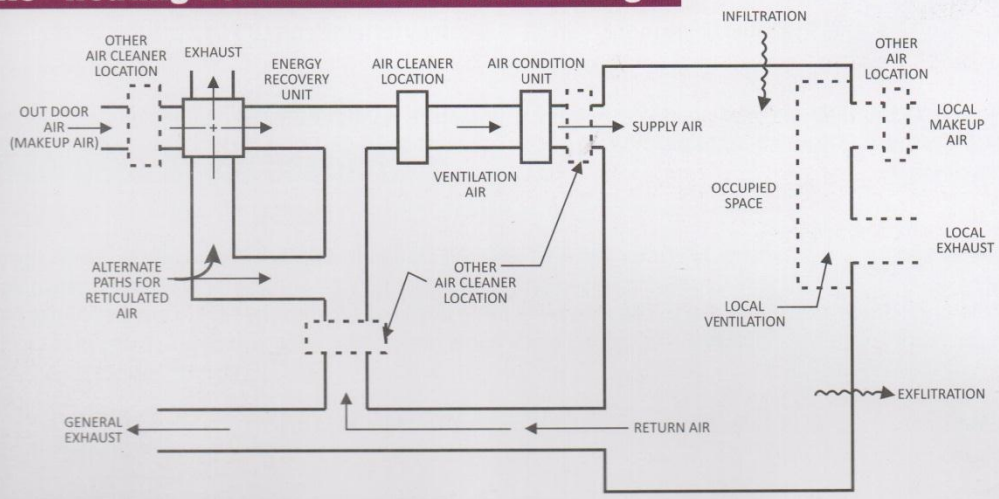
VERIFICATION OF AIRFLOW

- Air flows can be examined using an innocuous smoke-producing substance such as titanium chloride
- A swab is held under the inlet grill and the air movements are followed around the operating theatre and out through the doors
- The floor seals and the baffle outlets should be checked
- The air flows are then followed to the outer zone and to the extract ventilators and grills. Any reversal of airflow, particularly from the outer zone inwards, should be recorded

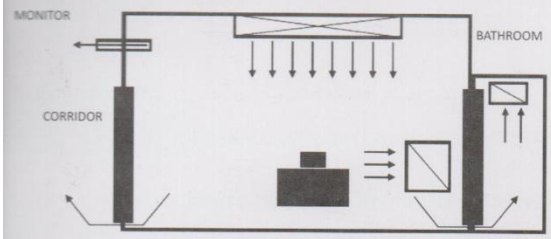
IDEAL SITUATION

- Windows should remain closed
- The operating theatre should be maintained at positive pressure
- Air should be introduced from the ceiling and should be exhausted near the floor in order to prevent bacterial contamination in the operative field
- Air changes should be at least 20 changes per hour
- Air should first pass through a series of dust filters and then enter the room through a HEPA filter
- Split-unit air conditioning is not allowed
- Humidity should be controlled and maintained between 50-55%
- Temperature should be controlled and maintained between 18-25 Degree Celsius

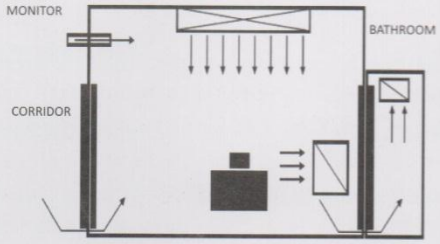
HVAC - Heating Ventilation Air Conditioning



Positive Pressure



Negative Pressure



ELECTRICITY:

- Controlled power by online UPS with enough backup time for equipment (pure sign wave)
- Lighting backup - online sign wave UPS
- Enough sockets, enough lighting

SCRUB AREAS:

- Clean water - filtered water
- No touch cocks - foot controlled/sensor controlled
- Scrub accessories on mobile rack
- Timer with solenoid valves

DRAINAGE:

- Sinks should have closed/covered drainage with minimal possibility of spillage
- Drainage facilities for drainage of waste water after floor wash

Special Consideration-Infected Cases:

- Special system to be developed for infected cases
- Patient flow is to be specially designed

Operation Room For Infected Cases:

Dedicated facility with the following features:

- Negative pressure
- Dedicated sterilization set-up
- Dedicated equipment - microscope, vitrectomy, linen and other devices
- Time scheduling of doctors and staff for working in an infected OR

IF FACILITY IS NEAR CONSTRUCTION/RENOVATION SITE:

Item	Recommendation
Demolition site	Shroud the site if possible to reduce environmental contamination.
Dust-generating equipment	Prior to placing dust-generating equipment , evaluate the location to ensure that dust produced by the equipment will not enter the building through open doorway or windows, or through ventilation air intakes.
Construction materials storage	Locate this storage away from the facility and ventilation air intakes.
Adjacent air intakes	Seal off affected intakes, if possible, or move if funds permit.
HVAC system	Consult with the facility engineer about pressure differentials and air recirculation option: keep facility air pressure positive to outside air,
Filters	Ensure that filter are properly installed: change roughing filter frequently to prevent dust build on high-efficiency filter.
Windows	Seal and caulk to prevent entry of airborne fungal spores.
Door	Keep closed as much as possible; do not prop open; seal and caulk unused doors (i.e., those that are not designated as emergency exit); use mats with tacky surface at outside entrance.
Water utilities	Note location reative to construction area to prevent intrusion of dust into water systems.
Medical gas piping	Ensure that these lines/pipes are insulated during periods of vibration.
Rooftop	Temporarily closed off during active demolition/construction those rooftop areas that are normally open to the public (e,g., rooftop atrium)
Dust generation	Provide methods (e.g., misting the area with water) to minimize dust.
Immunocompromised patient	Use walk-ways protected from demolotion/construction sites; avoid outside areas closed to these sites; avoid rooftop.
Pedestrian traffiic	Closed off entry ways as needed to minimize dust intrusion.
Truck traffic	Reroute if possible, or arrange for frequent street cleaning.
Education and awareness+	Encourage reporting of hazardous or unsafe incidents associated with construction.

DESIGNING A GOOD OPHTHALMIC OPERATION THEATRE

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Designing an ophthalmic operation theatre (OT) is a professional job. An ideal OT gives immense confidence to the surgeon and provides safety for the patient. Having one's own OT, whatever may be the size of the practice, will be economical, practical & convenient to an ophthalmologist.

A shared stand-alone ophthalmic surgicentre is an excellent concept for a group of single-doctor clinics in today's scenario. However, even the minimal of standard norms of an ideal OT are often not followed while designing and maintaining an ophthalmic OT, mostly due to ignorance.

In this article, let us share some inputs that would be useful for a doctor starting his or her OT or considering an upgradation. It is important to remember that it is not just the structure of the OT that is important but the function too needs to be superb.

INTRODUCTION

An OT is the 'eye' of any surgical setup. The word 'theatre' was picked up from the traditional semi-circular amphitheatres of yesteryears and students used to observe surgeries. The patient is the centrepoint of a well-functioning OT. Maintenance of vital functions, prevention of infections, promotion of healing, and monitoring of safety, comfort and economy are important. Establishing an OT needs specialized planning and execution and is not a simple civil engineering job. A 'civil-mechanical-electrical-electronic-bio-medical-interior designing' combined effort is needed. The involvement of the surgeon, anaesthesiologist and OT technicians right from the early stages of planning makes sense. OT complexes are designed and built to carry out investigative, diagnostic, therapeutic and palliative surgical procedures. They need to be customized to the requirements of the surgeons using that facility and the prevailing practices of that community. The functioning of an OT complex includes surgery scheduling, administration, staffing, sterilization techniques and audit management, and all these need to be incorporated into the design. The aim is to provide maximum benefit to the majority of patients arriving in the OT. So, it is important to keep in mind both present as well as future needs.

DIFFERENT ZONES OF THE OT COMPLEX

The flow of the patients, the staff and the materials are the three factors to be considered during every stage of design and execution. In ophthalmology, if space is a constraint, the passage for materials can be cut short, as neither the loads nor waste will be in large quantities. They can be managed along other flows at the beginning and end of the day. Also, in the majority of ophthalmic OTs, the instrument cleaning and autoclave facility is incorporated within the OT.

There are three zones in an OT complex, based on varying degrees of cleanliness. The microbial count progressively diminishes from the outer to the inner zones and is maintained by a differential protocols of cleaning and, if there is a positive pressure ventilation, by a decreasing gradient from the inner zone to the outer zone.

1. PROTECTIVE OR OUTER ZONE

- Changing rooms for medical and paramedical staff and patients
- Transfer bay
- Administrative staff
- Pre- and post-operative rooms

2. CLEAN ZONE OR BARRIER ZONE

Connects the protective zone to the aseptic zone

- OT stores, records and equipment storeroom
- Closed-circuit TV and video area
- Fire extinguishers
- Gas cylinders
- Instrument washing and autoclave room
- Anaesthesia room
- Patient pre- and post-operative recovery area
- Refrigerator
- Scrubbing zone
- Sluice room

3. ASEPTIC ZONE inside of OTs

DESCRIPTION OF SUB AREAS

(1) **Pre-operative check-in area (reception):** Receive the patients here and offer comfortable seating. Provide some privacy, and lockers and toilets for the staff and patients.

(2) **Post-operative units:** At least a few facilities need to be provided for those who undergo GA, preferably adjacent to the OT, in the outer zone/room. They should contain medication storage, hand washing area, stretchers, wheelchair, monitors, oxygen and suction. Up to 80 sq ft should be allocated for each patient bed, with a clearance of 5 ft between beds and 4 ft to the adjacent wall for the last patient.

(3) **Staff room:** This can be between the outer and barrier zones, where the staff can change from street cloths into OT attire; so, lockers need to be provided. Barrier and aseptic zones should not be entered at any time of the day without changing over to OT attire, which includes a cap and a mask.

(4) **Sanitary facility for the staff:** One wash basin and one Western closet (WC) should be provided for 10 to 20 persons. Inclusion of toilet facilities within the OT complex or in changing rooms is not acceptable; they should be located in the outer zone, away from the OT, with non-sharing sanitary lines.

(5) **The anaesthesia gas/cylinder manifold room:** A definite area needs to be designated. It should be in a cool and clean area, preferably in the outer or barrier zone and should be constructed with fire-resistant materials, with ventilation to allow leaking gases to escape. Separate zones for empty and full cylinders needs to be provided.

(6) Comfortable, easily cleaned chairs, one writing table, a book case, computer, TV, etc., may be arranged for the staff in the barrier zone.

(7) **Store room:** This is designed to store less frequently used equipment, surgical instruments and the supply and medicines in the OT. This is to be located in the barrier zone, and should have lockable cupboards as well as shelves, preferably made of 304 grade stainless steel. Proper inventory needs to be maintained to prevent medicines running out of stock. I recommend storing of 1.5 times the average monthly usage.

(8) **Theatre sterile supply unit (TSSU):** The following conditions need to be satisfied:
   i. Temperature between 18 and 22°C; humidity of 40 to 50%.
   ii. Air conditioned with 10 to 12 air exchanges per hour.
   iii. Storage of sterile drapes, gloves, gowns, etc.

(9) **Scrub zone:** This should be planned within the barrier zone. Elbow or foot or infrared sensor-operated taps would be ideal. It is essential to have non-slippery flooring in this area.

TYPES OF OT COMPLEXES

There are three main categories of OTs:

1. The **single- theatre suite,** with OT, scrub-up, exit bay and staff change areas. This suites single surgeon practices, but the three zones still need to be maintained.

2. The **twin theatre suite,** with facilities similar to the above-mentioned category, but with a common barrier zone to which the OTs open.

3. **OT complexes of three or more OTs** can be similar to the twin theatre suite or built along a single central corridor (the hotel design) or a single peripheral corridor (the track design) or a double corridor (the clean nucleus design). In the last one, the OTs are separated from the outer wall of the building, but this demands larger amount of floor space.

GUIDELINES TO BE CONSIDERED WHILE PLANNING AN OT

1. Location: Low-rise buildings of two or three storeys are preferred because of natural light and ventilation. The OT should be separated from the general people areas and air movement of the rest of the hospital. The OT complex in a multistorey building should, ideally, be on the first floor and not on the top floor. A bed lift is essential even if it is an eye hospital, to handle emergencies.
2. Adequate and appropriate space should be allotted for a sluice room for cleaning and storing housekeeping material.
3. Provision should be made for an emergency exit.
4. Provision for air flow, air-conditioning, dehumidifying and temperature controls.
5. Operation rooms: The number and size can be as per the requirement but the recommended size is 18 ft × 20 ft × 11 ft per OT. The size should not be lesser than 16 ft as adequate space is needed around the sterile zone for the trolleys, microscope, staff movement and appliances. A sealed glass window can be planned on one side. Main door to the OT complex has to be at least 4 to 5 ft wide. The doors of the OT should be of the top spring-loaded flap type, operable on both sides, although, ideally, there should be sliding doors to avoid air currents. All fittings in the OT should be of the flush type and made of steel. No storage areas

should be provided inside the OT. The surfaces and flooring should be slip-resistant, strong, non-wetting, impervious and have minimum joints. Vitrified tiles and vinyl are excellent materials for use. If vitrified tiles are used, spacers are given between the tiles, which is then filled with epoxy. This makes them functionally jointless. Recommended minimum conductivity is 1M ohm and maximum 10M ohms, but this may not be a critical factor at all in an ophthalmic OT. Even in other OTs, the need for antistatic flooring has diminished as flammable anaesthetic agents are no longer in use.

Walls can also be tiled with vitrified tiles up to 7 ft or up to full height. Other good alternatives for the wall are vinyl, stainless steel or washable polyurethane paint. The ceiling can be painted with polyurethane paint, which does not shred over time and is washable. Corners should be coved to ease the cleaning process. Pleasing, light colours make the surroundings aesthetic. A semi-matt wall surface reflects less light than a highly gloss finish and is less tiring to the eyes of the OT team.

6. There should be only one operation table per OT. Adequate electric points should be given on the wall (at 5 ft height from the floor). One scrub station with two taps is sufficient for two to three OTs. Piped music, surveillance cameras, TV, computer network, etc., are all part of the modern OT.
7. Corridors should measure about 8 to 9 ft wide for easy movement of people, wheelchairs and machines.
8. Oxygen, nitrous oxide, compressed air and suction for each OT and in the post-operative recovery zone should be provided. They can be piped to a central facility, if provided, or locally made available with standalone cylinders and gadgets.
9. Provision for adequate and continuous clean water supply: Besides hospitals, regular water supply via a separate overhead tank is desirable for the OT. Elbow taps are cumbersome, and foot taps or sensor taps are more comfortable. A good water filter and softening system can be fixed to the outlet of this tank. The water supplied to the OT needs to be clean, and need not be sterile.
10. Proper and separate drainage system should be provided and the pipes should be as far away as possible, before joining them to the general drainage system. Cockroaches are known to come in through the drain pipes, and the system should have cockroach-proof system. .
11. A pre-operative area with a reception and a separate designated area for paediatric patients is desirable.
2. Sufficient general illumination should be there for the anaesthetist to see the veins, names of the drugs, etc.
13. Safety in the working place is essential, and needs to be looked into at every step. Fire alarms, extinguishers and smoke detectors have to be incorporated.
14. Provision for expansion of the OT complex should be thought of in the planning stages itself. It may not be built right now, but a provision for some cushion for expansion is always rewarding.

In general, multiuse of OTs instead of multiple OTs, offer advantages of efficient manpower utilization, economical maintenance and better training of the support staff. However, it is not ideal to share the OTwith other specialities in a multispeciality hospital as the needs for an ophthalmic OT are totally different from others.

VENTILATION

Ventilation should be on the principle that the direction of air flow is from the OT towards the main entrance. There should be no interchanged air movement between one OT and another. Efficient ventilation will dilute the effect of contamination and anaesthetic agents. There are two types of air conditioning systems: recirculating and non-recirculating. Non-recirculating systems convey cool filtered air into the OT with, ideally, 20 air exchanges per hour. Anaesthetic agents in the OT air are also automatically removed. These are ideal but are expensive. Air exchanges are heavy on air conditioning needs as cool air is pumped out continuously. There are devices available that transfer the coolness of the outgoing air to the incoming air, without actual mixing. The re-circulating system takes some or all of the air, re-adjusts the temperature, filters it and circulates air back into the room.

- Up to 20 air exchanges/hour for recirculated air.
- Only up to 80% recirculation of air to prevent build-up of anaesthetic and other gases.
- Ultraclean laminar air flow - the filtered air delivery must be 90% efficient in removing particles more than 0.5 mm.
- A positive pressure of 5 cm H_2O from the ceiling of the OT downwards and outwards is desirable to push the air out of the OT.
- Relative humidity of 40 to 60% should be maintained.
- Temperature is maintained between 20 and 24°C. Temperature should be adjusted to the requirement of the patient, especially in paediatric surgeries.

However in an ophthalmic OT, the above mentioned elaborate system can be replaced with fan filter units, which deliver filtered air of desirable quality and positive pressure locally to the surgical area. These filters can also be retrofitted in an existing OT.

CONCLUSION

Today is the era of evidence-based medicine, and it is important to provide maximum importance to planning an OT complex within the limitations of finance and space. Efforts should be made to conform to the standards that are laid down. While the newer ophthalmic OTs may fulfill many of the theoretical requirements, the pre-existing OTs can also do with certain structural changes and be drastically altered in terms of the functioning details so as to provide safety to the patients.