

Expert Opinion

Operating Facilities:- Suggested Guidelines to Cope COVID-19 in Third World Countries

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Abstract

The whole world is passing through an unprecedented time during the pandemic of COVID-19. COVID-19 has affected all of medical practices in relation to patient management, availability of resources, logistics, safety and protection of healthcare workers and off course emergency management of healthcare facilities. Although surgeons are not frontline workers but provision of emergency and urgent surgeries without knowing status of patient in relation to COVID-19 put the surgical team at risk. Moreover our operative healthcare settings are not designed to deal with paradigm of COVID 19. We are living in a 3rd world country. Our resources are scarce and our theater settings are not up to mark. This article deals with suggested changes in already existing theater facilities or creating new facilities to come up with new requirement of COVID-19.

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Background

Starting from China in December 2019,¹ this pandemic rapidly spread across the globe and till now more than 7600265 people are affected with this pandemic across the globe and 125933 in Pakistan.² During management of these patients a large number of healthcare workers (HCWs) who are frontline workers are affected by this evil.^{3,4,5} Among these HCWs there is a big number of surgical staff that is affected by COVID-19 while dealing with surgical patients.^{6,7} To save these HCWs from this infection is the prime aim. Theater settings in Pakistan are not designed to deal with these patients. Majority of theater settings in 3rd world countries are not even

equipped with modulation, laminar airflow and HEPA filtration, which is usual practices in developed countries, let alone the availability of negative pressure rooms in our settings which is preferable setting for operating patients with covid-19.^{8,9}

There are many steps while doing surgery that can result in aerosols production in operation rooms (OR) like intubation/extubation, endoscopy, laparoscopy, and use of energy devices, which are highly dangerous ultimately subjecting the theater staff to SARS-COV-2 infection. So its safe to presume that surgical procedure in suspected/confirmed cases, can contaminate theater staff.^{10,11,12}

To prevent spread of infection among surgical staff, along with infection prevention measures like, hand hygiene, wearing of protective equipment, and triaging the patients, theater settings also needs to be changed to cope with this situation. The purpose of this article is to provide recommendation about theater settings based on some of author's practices and derived from various national and international guidelines for health professionals to improve health professionals and patients safety.

Recommendations

Pakistan is a poor country. Majority of our theaters are not according to the international standards. There maybe following OT settings present in Pakistan

1. Facility having modulation and laminar airflow and HEPA filtration, with central air conditioning, (rare).
2. Facility with laminar airflow and HEPA filtration with central air conditioning.
3. Facility having only laminar airflow with central air conditioning.
4. Facility without both of above, neither laminar air flow nor HEPA filtration, may be centrally air conditioned or having split air conditioning.
5. Majority of peripheral setting theater facilities in Pakistan and 3rd world countries are either have positive pressure rooms or no pressure gradient at all.

The Heating Ventilation and air conditioning (HVAC) system of operating setting usually varies between operating theaters (OT) even in one hospital and generally between operating theaters in different hospitals within same city, within different cities and countries. HVAC should be designed in such a way that it reduces the presence of airborne pathogens to a minimum during aerosol generation and other surgical procedures by effectively exhausting it and delivering non contaminated fresh air in incoming ducts.^{13,14,15,16}

So we suggested following recommendations for safe and effective environment in OTs for management of COVID-19 patients and non-COVID patients:

1. Operation theaters for non-tested/

suspected/confirmed COVID-19 positive patients: If possible, these OTs should be different and separate from OTs used for non-covid surgical patients surely confirmed by HR-PCR.^{8,9-18} Preferably there should be multiple operative rooms for COVID patients.

Location: These ORs should be located separate from main operation theater, near the COVID-19, ICU/HDU/Isolation rooms.

Entry and Exit: This OT should have separate entry to donning area and separate exit from doffing to prevent mixing of HCWs coming to and leaving OT.

Change Rooms: There should be separate change rooms both for males and female staff, having facility of showering at end of operation before leaving OT.

Donning and Doffing Area: There should be a separate donning and doffing rooms, in accordance with entries and exit pathway. The donning room should be near to scrub areas. There should be plenty of personal protective equipment (PPEs) available in donning room, along with facility for wearing PPEs and freely available hand sanitizer in both areas. There should be a red colored basket available for collection PPEs in doffing area.

HVAC System of COVID OT: This facility should have separate HVAC system with separate air handling unit (AHU) from rest of hospital facility^{9,18} and HEPA (High Efficiency Particulate Air) filters with Minimal filtering level of H13 (99.95) OR H14 (99.995%), installed in the incoming and outgoing/exhaust ducts for filtration of virus laden particles contaminated in theater from patient and AGPs procedure.¹⁹ These HEPA filters will be able to filter bacteria, virus-loaded particles, and aerosol of 0.3 micron and above with efficacy of 99.995%.¹⁹ Then question arises that how Corona virus whose size is 0.06 to 0.14 micron, can be filtered by HEPA. The answer is that the corona virus usually moves with droplets of saliva not naked thus presenting with a larger size droplets or virus laden particles and

filtered by HEPA efficiently(14)(20). Preferably this theater facility should have laminar airflow, with HEPA filters, to filter the air coming and going out of theater. But this is usually not present in many of 3rd world countries hospital especially in peripheral hospital settings.⁸

2. Preferably this operative facilities should be negative pressure operation room to reduce the spread of contaminated aerosol in suspected/confirmed cases of SARS-COVID-2 patient to surroundings beyond OR^{10,13,15,18,21} as negative pressure sucks in all virus laden particles into exhaust duct efficiently. If all the COVID theaters cannot have negative pressure then at least one room should have negative pressure where patient should be induced and then shifted to OR.⁸

3. Minimally opening the door during transfer of patient and then locking the door during surgery and reducing trafficking by using one entry/exit door can minimize the flow of contaminated air to out side^{17,18} thus reducing chances of spread of COVID infection.

4. The ventilation system of most of the operation theaters are designed to be positive pressure in OR to reduce ingress of polluted air from the surroundings to theater to reduce wound infection. This positive pressure inside OR can potentially results in spreading COVID infection from within OR to outside to the corridors if a COVID positive patient is operated here. To convert a positive pressure OR to negative pressure OR is difficult, time consuming, costly and complex.^{21,22} But non formal negative pressure can be generated:

- a. By putting 2 to 3 heavy exhaust fans below the level of operation table sucking the air out of OR, along with sealing of all of walls.
- b. By changing pressure gradient of central air conditioning AHU by putting incoming air at low pressure and exhausting air at high pressure, with a pressure differential of 2.5 to 5 Pa, a sort of negative pressure will be generated.⁹

5. If this HVAC system of COVID OT is attached with rest of hospital and other non-COVID OR, it should be detached from them or duct going to them should be blocked to prevent spread of virus-laden particles to those areas.

6. Moreover the recirculation of air in HVAC by AHU should be stopped if present and convert them into non-re-circulatory type (100% once through system) by taking all incoming air fresh by the AHU. Usually this provision is available with AHUs.

7. The air before exhaustion, should also pass through HEPA to filter the virus laden particles and droplets, to save contamination of HCWs by exhausted air. If HVAC system with air conditioning have not the facility of HEPA filtration then this system should be converted to non re-circulatory type by converting AHU to take full new fresh air for circulation (100% once through), and discarding all exhausted air out side after proper treatment by⁹

1. 1% hypochlorite or
2. UVC light for 15 minutes or
3. Heating it up to 75 degree C for 45 minutes, or
4. Disposing it about 3 meters higher than rooftop away from air sucking source of AHU and populated area to prevent infection of population.

There will be some compromise on air-conditioning but chances of recirculation of contaminated air will reduced much.

8. Normal positive pressure rooms. Another suitable, practical, and cost effective option is without converting a positive pressure room to negative pressure rooms, the facility can be made useful with help of modalities that reduce efflux of polluted air into the corridor.^{22,23} These are **In-room air filters** like portable HEPA filters system having capability of 99.97% filtration of virus laden particulate thus reducing virus load in COVID-OT.²³ If portable HEPA filtration is combined with UVC light for disinfection, it will become much more effective.²⁴

9. In the absence of permanent fitted HEPA filtration in the HVAC system, an installation of **portable HEPA filtration system** in the theater will

be to remove viral particles without converting them to a negative pressure room.²² This will reduce a lot of viral load.

10. Minimum requirement is that the HVAC and AHU should be able to do a minimum of 20 to 25 air exchanges per hour. This rate of air exchange with results in 99.9% of viral particles removal within 21 minutes (7 cycles).^{9,18,22,25}
11. By installation of vertical laminar flow; virus laden particles and aerosols production at operating site will flow down to the floor and will exit through the vents to exhaust duct. In this way it may not circulate widely in the operating room. So this will help to reduce spread of aerosol in theater minimizing exposure of equipment and theater staff.^{8,22}
12. To make laminar airflow more effective, there should be minimum staff trafficking in the theater and spare staff should not be present in the theater especially at intubation/extubation.⁸
13. There should be minimum and necessary equipment in theater for required surgical procedure and it should be rationally streamlined in theater to prevent hindrance to airflow.
14. The pathway of shifting of corona suspected/confirmed patient from isolation ward/HDU/ICU should be predefined, cleared during shifting both to theater and back to designated area.
15. **Non-Central Air Conditioning Rooms:** If a theater with re-circulatory air conditioning cannot be converted to non-re-circulatory type then central air-conditioning should be stopped. Stand-alone room air conditioner with capacity 2-tone refrigeration should be installed. In this way single room re-circulatory system will be devised. Fresh air intake through fan filter unit will provide dust free air. Exhaust fan should be kept operational. Set the room temperature between 24 to 30 C and humidity between 40 to 70%. In humid climate set the temperature near 30 C. This will provide a comfortable atmosphere for operation while wearing full PPEs.

Future Directions

This is an uncertain and unprecedented time. Situation is changing day to day. Presently pandemic is at peak in our country, but its declining in many other parts of world. Still the situation is not clear about the occurrence of second surge of COVID-19. Vaccination is still distant. Surgeons have to take leadership role. They have to make urgent future plans for dedicated COVID OR with proper central air-conditioning having provision of altering pressure in OR, separate AHU, with dedicated fresh air cycles,

and having facility of negative pressure, equipped with HEPA filter to filter 0.3 micron or less virus particles and totally separate from non COVID OR with no air leak.

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