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Review Article

Perioperative Management of Adult COVID-19 Suspected or Positive Patient: A literature review of Available Evidences

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A B S T R A C T

Novel corona virus disease (SARS-CoV-2) has been declared a pandemic affecting over 100 countries and 34 million people globally. Though majority develop mild clinical constitutional symptoms, a significant number of patients manifest severe respiratory illness. The current (or future) pandemic situation can potentially overwhelm the health care resources in the coming times and may impair the delivery of optimal care to patients requiring surgical interventions. Planned and judicious utilization of manpower and resources is of prime importance. Routine or elective surgical procedures should be triaged and deferred and only emergency and time sensitive surgical interventions are allowed till epidemic is contained. Airway intervention during general anesthesia is a high-risk aerosol generating procedure (AGP) which exposes the anaesthesiologists to airborne particles with potential risk of transmission of COVID. It is therefore one of the most critical steps in the management of such a patient. Regional anaesthesia should be preferred for providing anesthesia care whenever possible considering the increased risk of exposure of anesthesiologist to virus during general anaesthesia (GA). This article attempts to discuss the basic epidemiology, pathology, presentation of COVID-19 along with the considerations for operating room preparedness, personal protective equipment required, anaesthesia conduct, waste disposal while managing a COVID positive or suspected case. We have also deliberated upon the specific considerations for a COVID patient undergoing regional anaesthesia, tracheostomy, COVID parturient and trauma emergencies.

Keywords: COVID-19, Pandemics, Operation Room Management, Tracheostomy, Anaesthesiology and Emergencies

Introduction

In December 2019, the city of Wuhan in Hubei province of China reported a pneumonia outbreak. By January 7, 2020, the World Health Organization (WHO) identified the infectious agent as a corona virus (SARS-COV-2). The disease quickly spread across borders and on March 11th, 2020 this was declared as a pandemic. By 4th May, 2020 the virus has infected over 34 million people worldwide and caused more than 2.39 million deaths making it one of the worst global outbreaks of any disease in a century.[1] The previously detected corona viruses (CoVs) have also caused epidemics in different parts of the world like SARS and MERS.[2] Although, estimated mortality from COVID-19 (2%) is lower than the previous SARS and MERS (10% and 35% respectively) the infectivity of novel SARS-CoV2 (nCoV) is much higher and this higher numbers of infected patients have overwhelmed all healthcare systems across the globe.[3,4]

The virus is transmitted primarily through respiratory droplets, direct contact and aerosols.[5] Healthcare professionals in direct care of patients are at increased risk of contracting the virus and many physicians have lost their lives while battling this pandemic. Hence, it is of immense importance to educate, train and protect healthcare workers to carry out their duties safely amidst the disease outbreak.[6] Anesthesiologists play a unique role in management of COVID patients in the peri-operative period, the emergency room or the intensive care unit and are more vulnerable to the infection.[7] Hence, a sound knowledge of the infectious characteristics, disease prevention, personal protection equipment (PPE) and sound working principles are of immense importance for any physician in general and the anaesthesiologist in particular. The disease affects both adult and pediatric populations albeit differently.[8,9] Adult patients who are suspected or confirmed COVID positive may need emergency surgical intervention and pose unique challenges for the anaesthesiologist. In the last few months innumerable medical literature have been published with respect to the epidemiology, pathogenesis, clinical features, infection control, prevention, and treatment of this disease. Different leading societies across the world have put forward working principles and guidelines for clinical management of COVID 19 patients. In this article we have tried to incorporate current existing literature across the world in addition to their own experiences of dealing with the disease and management of perioperative period from a tertiary care hospital in India for formulating a practical guidance towards safe practice of anaesthesia during such outbreaks. The search strategies for this review included search of electronic database PUBMED as well as manual search of cross references. A literature search was carried out using search words "Anaesthesia/ anaesthetic management" and "COVID/SARS-CoV2/ coronavirus disease positive" and "adult patients" and various articles/guidelines in English elaborating on anaesthetic considerations in Covid patients till April 20, 2022 were reviewed.

Pathogenesis

The SARS-CoV2 is a positive-stranded enveloped newly discovered RNA virus belonging to the subfamily Orthocoronavirinae of the Coronaviridae family (order Nidovirales), genus Beta coronavirus.[10] It has a diameter of approximately 60–140 nm. The genome of this novel CoV, isolated from patients in China, had 89% nucleotide identity with bat SARS-like-CoVZXC21 and 82% with that of human SARS-CoV. For this reason, the new virus was called SARS-CoV-2 or novel CoV.[11] Like other CoVs, it is sensitive to ultraviolet rays and heat. It can be effectively inactivated by number of disinfectants including ether, ethanol, aldehydes and chlorine-containing disinfectants etc but not chlorhexidine.[12] some important facts related to COVID-19 have been given in table-1.

Table 1. COVID-19 facts

Disease name	COVID-19
Causative agent	SARS-CoV2 or novel corona virus (nCoV)
Origin	Bats (cross species transmission via pangolin)
Transmission	Droplets, aerosols, close contacts
Incubation period	3 - 14 days
Case fatality rate	~ 2%
Symptoms	Wide range of constitutional symptoms (fever, sore throat, cough, myalgia, malaise, diarrhoea etc.), to pneumonia, acute respiratory distress syndrome, myocarditis, multiorgan dysfunction.
Diagnosis	Contact history, Clinical symptoms, CXR lung ultrasound or CT thorax findings. Lab test: (RT-PCR) of nasal and/or oropharyngeal swab, sputum, or ETA/BAL specimens.

CXR: Chest X-Ray; RT-PCR: Real time reverse-transcriptase polymerase chain reaction, ETA: endotracheal aspirate; BAL: bronchoalveolar lavage

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The first few cases of the COVID-19 disease were linked to direct exposure to the Seafood (from the wholesale livestock market, Wuhan), and due to animal-to-human transmission from bats. Subsequently, human-to-human transmission was confirmed and symptomatic people were found to be the most frequent source of COVID-19 spread. However, asymptomatic transmissions were also proposed subsequently.[13-17]

The transmission is through respiratory droplets, close contacts and possibly through aerosol in closed spaces. The average incubation period is 3 to 7 days and up to 2 weeks in certain cases. In addition to respiratory secretions, SARS-CoV-2 (nCoV) has been detected in blood, faeces and urine but their role in the spread of this infection has not been confirmed.[18]

The virus enters and then replicates inside the host cells utilizing the cell's machinery to create successive progenies of new viral particles that are released for infecting other cells.[19] The virus enters human respiratory epithelium using its surface spike proteins which bind to the angiotensin converting enzyme type 2 (ACE 2) receptor.[20] The virus incites innate and adaptive immune reaction and the subsequent inflammatory cascade are responsible for all the features of adult respiratory distress syndrome (ARDS) and other systemic organ involvement.[17,20-22]

Majority (81%) of the infected patients develop mild constitutional symptoms (table2).[23,24] Up to 1% of patients remain asymptomatic. In the prodromal period, patients are able to produce virus in there upper respiratory tract despite minimal symptoms, and unknowingly spread the disease.[25] Around 14% patients are more prone to manifest a severe form of the disease and 5% of them may require respiratory support in the intensive care unit (ICU). These include elderly patients with preexisting diseases like diabetes, hypertension, known respiratory ailments and other immunocompromised states.[24] Newer data suggest a trend towards atypical form of acute respiratory distress syndrome (ARDS) with two distinct phenotypes i.e. the 'L' and the 'H' subtypes have been described depending on the compliance and elastance of the affected lung.[26,27] A form of myocarditis has been found to be a common association which might lead to hemodynamic instability, heart failure, or even sudden cardiac death.[28-30] Subsequent studies have found pathologic involvement of other organ systems including liver, eye, nervous system, coagulation pathway and many atypical manifestations have been reported.[31-35] SARS-CoV-2-induced pneumonia is marked by hyperactivation of effector T cells and excessive production of inflammatory cytokines, particularly IL-6, IL-1, TNF, and interferon-γ known as cytokine storm.[19,22] They are thought to contribute to the pathological process that leads to plasma leakage, vascular permeability, and disseminated intravascular coagulation. These events also increase dissemination of the virus. In vitro studies have also pointed towards its effect on the porphyrin ring of Haemoglobin which renders it ineffective for carrying oxygen.[36] At the most, the current understanding of the complete immuno-pathogenesis of the disease is by far incomplete.

There are characteristic signs, symptoms, blood investigations and imaging findings in a case of COVID 19.[5,22,37,38] The confirmatory diagnosis is mainly based on contact history with clinical symptoms of covid along with a swab test for reverse transcription polymerase chain reaction RT-PCR. There Serological tests are not the mainstay of initial diagnosis and are primarily used for retrospective assessment of attack rate. Treatment is largely supportive and no effective antiviral therapy is yet available.[21] Isolation of patients and observation of social distancing thus remain best (and most cost-effective) method to contain the epidemic. Different antiviral agents like remedesivir, favilavir, interferons, ribavirin and ritonavir-lopinavir combination have been tried considering prior experience with them in treating other viral pneumonias, especially MERS and SARS.[39-44] Other agents include Interleukin-6 inhibitors like tocilizumab were used in an attempt to contain the cytokine storm.[45,46] However, most of these agents are in different phases of clinical trial and evidence is largely inconclusive.[47-50] Positive results have also been found with use of convalescent plasma and research is ongoing to gather more evidence towards its use in treatment.[51,52] Many vaccines were developed including novel mRNA vaccine whose developments were fast-tracked and there efficacy study is still underway.[53,54] Hydroxychloroquine, an antimalarial and anti-inflammatory drugs, has shown decrease in viral entry in host cell in in-vitro studies and has been promptly suggested by the Indian Council of Medical research (ICMR) for usage in healthcare workers working in high risk areas.[55-57] However, evidence towards the usage of this drug in prophylaxis is sparse and should be used with caution due to possible adverse effects.[58] In absence of a definitive mode of therapy, usage of PPE and observation of personal hygiene is of prime importance to prevent its spread to the health care workers (HCWs).

Hospital preparedness and emergency surgery

Global response to this pandemic has remained varied due to different levels of preparedness in the healthcare system.[59,60] Planned and judicious utilisation of manpower and resources is of prime importance. Many hospitals have been designated for dealing with only confirmed COVID cases. Each hospital should develop a diagnosis, management and infection control protocol with clear working guidelines for better interdisciplinary communication and standardisation of care. Prior experience of dealing with SARS and MERS should pave the way for a robust hospital policy.[61,62] Training programs and online tutorials for infection control including

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donning and doffing of PPE should be designed to spread awareness and knowledge among all levels of healthcare workers.[63] Specific roles of each team should be allotted, and healthcare personnel should be appointed for each role. Visual display of charts containing information on disease transmission and prevention to be relayed to all theatre staff to encourage adherence to infection control protocols. Conducting simulations and mock drills involving anaesthesiologists, nurses or assistants to familiarize with modifications in workflow, particularly on induction, extubation, airway crises, cardiopulmonary resuscitation, medical waste management are of prime importance. Regular attempts must be made to look after the mental health of medical professionals working in the hospital as well.[64]

Routine or elective surgical procedures should be triaged and deferred and only emergency and time sensitive surgical interventions are allowed till the epidemic is contained.[65,66] A triage system should be designed to categorize patients coming for emergency surgery.[67] Also, every patient requiring emergency surgery should be considered a potentially COVID-19 positive patient and hence, appropriate PPE and personal hygiene measures should be taken seriously.[68]

Clinical features and investigations in COVID 19

Risk factors

Male gender

Elderly population

Comorbidities, e.g.: Hypertension, diabetes, cerebral vascular disease, cardiovascular disease

Symptoms and signs

1. Fever
2. Fatigue
3. Dry cough
4. Myalgia
5. Dyspnoea
6. Diarrhoea and nausea

Investigation Blood tests

1. Lymphopenia or Leukocytosis
2. Thrombocytopenia
3. Neutrophilia
4. Elevated lactate dehydrogenase
5. Prolonged INR

Elevated CRP, normal Procalcitonin (unless superadded bacterial infection)

Imaging

1. Chest X-ray: consolidation (Reverse batwing pattern)
2. CT thorax: bilateral distribution of patchy shadows and ground glass opacity
3. USG chest: B-lines, subpleural shred sign, hepatisation of lungs

Complications

1. Shock
2. Acute respiratory distress syndrome (ARDS)
3. Sepsis
4. Renal failure
5. Arrhythmia
6. Heart failure
7. Sudden cardiac death
8. Multiorgan dysfunction

Infection control and PPE in perioperative setting

Universal precaution against the virus is the need of the hour. Hospitals and individual departments should ensure provision of appropriate PPE (Supplies of masks, goggles, and other personal protective equipment) to the staff.[69] The PPE may be in limited supply and a controlled access is warranted for proper utilization for appropriate situations. In addition, for aerosol-generating procedures (AGP), precautions against airborne transmission should also be employed.[70] Recommended standards of PPE can be checked from different societies.[71,72,69,73]

Commonly performed medical procedures that are often considered aerosol generating procedures (AGPs), or that create uncontrolled respiratory secretions , include:[74]

- Open suctioning of airways
- Sputum induction
- Cardiopulmonary resuscitation
- Mask ventilation
- Laryngoscopy, endotracheal intubation and extubation
- Non-invasive ventilation (e.g., BiPAP, CPAP)
- Rigid as well as fiber-optic bronchoscopy
- Awake fiber-optic intubation
- Tracheostomy
- Sternotomy with Oscillatory Sternal saw application
- Nebulization
- High flow oxygen delivery

Anaesthesiologists regularly get involved in AGP and hence appropriate PPE must be worn for performing such procedures.(68),(75) Respecting the prescribed sequence of donning and doffing of PPE is very important to avoid contamination and can pose a huge challenge to the inexperienced care providers. The authors advocate training of individual staff with simulation and e-learning videos showing the sequence of donning and doffing of PPE will go a long way in effectively containing this pandemic. The most experienced staff member should supervise these teaching and training activities for the benefit of all table 2.

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Table 2.Recommended PPE depending on the covid status of patients

Level	Patient status	PPE (all disposables)
I	Confirmed negative	surgical cap; gloves; surgical mask; and protective goggles with sterilized surgical gowns during tracheal intubation.
II	Potentially infective or suspected patients negative for COVID	surgical cap; impermeable surgical gown ; protective goggles or headshield, gloves; mask with a particulate respirator (US National Institute for Occupational Safety and Health-certified N95, EU standard FFP2, or equivalent) with updated respirator fit test; shoe covers.
III	Confirmed cases and Emergency cases with unknown status	Surgical cap/hood; impermeable surgical gown; protective goggles and face-hield, double-layer disposable latex gloves; particulate respirator; positive pressure head-gear (to cover the hair) and shoe cover.

Planning and operation theater workflow management

Novel SARS-CoV2 pandemic has changed the normal workflow landscape of most surgical specialty department and most elective cardiac surgeries are currently postponed. However, the most urgent and emergent cardiac surgeries are often performed on very sick patients with multiple comorbidities who usually cannot be discharged home safely without correcting the cardiac ailment. If the surgery is 'urgent', it is either done in a suspected (due to lack of time for confirmation with rt-PCR tests) or confirmed nCoV infection. Therefore, we should have a dedicated OR and ICU to treat and care for these post-operative nCov positive patients. Their access should be completely separated from the non-infected patients' pathways to the OR and ICU/ recovery rooms, if locally feasible. Otherwise, a staggerd approach to keep these pathways separated is the next best option. At this juncture, it is worth mentioning that a temporary engineering and re-designing of OR architecture is necessaryfor complete isolation from the non-infected patients till the pandemic lasts and/or an effective vaccine becomes available against SARS-COV-2.

Elective surgery should remain postponed until WHO declares the pandemic is over. However, should it be necessary especially after we unlock, each patient should be screened for nCoV infection. This, has potential implications for the occupational safety of the health care work force.

Screening methods

As of now, the most relied upon test for screening nCoV is to isolate viral RNA by the rt-PCR method. Other proposed screening methods are Lung HRCT, serum antibody assay and kit based antigen and antibody tests for nCoV. None of them have enough (ideal) sensitivity or specificity to yield an error free screening. However, the former has achieved the highest sensitivity (upto 70%) with a meticulous sampling method.[76] A proper collection (depends on expertise and training of the staff doing the procedure) of a sample for virus detection is essential to minimize false negative results in a confirmatory test whereas in an antibody screening, it is essential to minimize false positive results which depends on the technology used.

Preoperative management of cardiac surgical patients

The evaluation by the anaesthesia team is the second triage of patients requiring cardiac surgery and risk stratification is done accordingly.[76] Anaesthesiologists should maintain a high index of suspicion for identifying COVID cases based on history, clinical examination, laboratory results, and imaging before engaging in care. If diagnosis has been established, the infection control team should intervene for isolation.[63]

A level 2 PPE is considered for preoperative assessment of confirmed cases. Apart from routine check-ups like airway assessment, anaesthetists should look for signs of shock, renal and liver failure in severe cases. Patients with severe disease or complications should have initial blood lactate levels and coagulation panels.[77] Preoperative arterial blood gas should be obtained in patients requiring any form of respiratory support. Lymphopenia with increased neutrophil : lymphocyte ratio and a low lymphocyte: C-Reactive protein ratio predicts a more severe illness.[78] Many patients of COVID 19 may have asymptomatic thrombocytopenia and hence a platelet count is mandatory for all patients.[79] Considering high incidence of myocarditis and renal dysfunction in vulnerable patient groups with severe disease, a 12 lead electrocardiogram and blood levels of urea creatinine and serum electrolytes are obtained in our institution.[80] The authors strongly recommend a Chest x-ray in all cases. A bedside point of care ultrasound (POCUS) of chest including echo to screen for severe pneumonia and cardiac function should be considered.[81]

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The medications of the patient must be noted. There has been considerable confusion regarding continuation of ACE inhibitor and angiotensin receptor blocker (ARB) medications in the perioperative period, considering a theoretical risk of increasing viral entry by upregulation of ACE-2 receptors with use of such medications. However current consensus guidelines are in favour of continuation of these medications as continuation has been found to decrease all-cause mortality in COVID patients.[82,83] Few authors prefer general anaesthesia (GA) for all confirmed cases to prevent coughing in awake patients, while few guidelines are clearly in favor of regional anaesthesia wherever possible. The decision must be taken depending upon patient condition and expertise.[76,84]

Operating room preparedness

A complete knowledge of airflow within the OR is crucial to minimizing the risk of infection. Every OR gets its ambient air supply from their individualized air handling units (AHU). Operations on confirmed cases should be performed in an airborne infection isolation room (AIIR). Such isolation room or operation theatres (OT) should be preferably located in the end of the complex clearly mentioning "COVID-19 surgery" to notify staff and prevent accidental breach of infection control protocols. Only personnel involved in direct care should enter the dedicated OT. Such 'isolation' OR should have a negative pressure with a minimum of 12 air exchanges per hour.[85,86] If a negative pressure operating room is not available, air conditioning of the operating room should be turned off and all doors should be kept closed. (76) The patients should be shifted in and out of the main operation room directly without keeping them in any "holding area". Appropriate operation of laminar air flow and a functional high-efficiency particulate arrest filter (HEPA filter) must be ensured in all the AHUs.

Only closed breathing circuits must be used for provision of general anaesthesia. Heat and moisture exchanger filters (HMEF) must be installed between the proximal end of the endotracheal tube and the distal end of the circuit near the Y-piece and must be replaced every 3-4 hours. The authors recommend using an additional filter on the expiratory limb of the breathing circuit.[86] The exact viral filtration efficiency (VFE) needed to prevent SARS-CoV2 transmission is not known but one with >99.99% VFE should be used. Both HMEF and the soda lime should be changed after each CoV positive case. For sampling of anaesthetic gases and carbon dioxide (CO_2), the sampling line should be connected to the machine side of the HMEF. If sampled gases are returned to the breathing circuit they need to be filtered. Water traps do have built in filters and if it is not available, a 0.2 micron drug injection filter similar to that used in epidural kits can be placed at the water trap. If the sampled gas is routed to the scavenging system, additional filtration may not be necessary as there are standards for managing biohazards in it. [TABLE _] Unfiltered sampled gas should not be exhausted directly into the OR environment or a passive scavenging system.[87] In our institution all the surfaces of the anaesthesia workstation are covered with a transparent plastic sheet which does not interfere with handling the machine and the sheet is discarded after each case.

Protection of HCW

Every attempt should be made to minimise the number of personnels (anaesthesiologist, perfusionist, surgeon and nurses) entering inside the OT (the Red zone). Before securing the airway and connecting the same to the closed circuit breathing system followed by insertion of TEE probe, nasopharyngeal temperature probe, rest of the team member can wait in a separate containment room. The anaesthetic drug trolley, difficult airway cart, regional anaesthesia cart and resuscitation carts should be prepared in the containment room/ ante room and brought in the isolation operation room only when needed. The members of the intubation team should ideally exclude practitioners with significant vulnerability such as elderly, diabetic, immunosuppressed, pregnant or having serious chronic illness.

Cardiac surgical procedures can be potentially prolonged. Therefore both the anaesthesiogist and the surgeon should make necessary provisions to keep wearing the PPE during the expected duration of the surgery. Before the start of surgery, the anesthesiologist should put all the required drugs including rescue medications and equipments onto a tray and avoid handling the drug trolley during the case. In case of need for additional items, hand hygiene and glove changing must be performed before entering the ante room again. Disposable equipment are preferred. Electronic anaesthesia charts are preferred if available, which can be retrieved later from an area outside the infected zone. During the procedure, a "runner" in full PPE should be ready outside the OT complex to supply additional drugs or equipment and send out specimens such as ABG samples and frozen section specimens.[86] Personnel exiting the OT should discard their used gowns and gloves and perform hand hygiene before leaving.

Effective communication strategies must be formulated and rehearsed in advanced as verbal communication is very difficult with level three PPE. All patients must be given a facemask during transfer to the operation room. Route from ward to operating theatre should be cleared to minimize contact with others patients. De-briefing may be considered to improve team practices to effectively perform highly sophisticated maneuvers in a sophisticated setup and to minimize stress.

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General anaesthesia

Airway intervention (intubation and extubation) during general anesthesia (GA) is a high risk AGP which exposes the HCWs to risk of transmission of nCOV. It is thus one of the most crucial steps in management. It is recommended that only three personals be inside the room during intubation. They are: the most experienced physician to perform intubation, a second physician should be in one side of the patient for assisting/rescuing in un-anticipated difficulty and the third staff member (OT technician/nursing staff) to help administer drug and monitor the patient.

Monitoring

No special monitoring is necessary other than ASA standard parameters routinely employed in the cardiac surgical patients including invasive arterial and central venous catheterisation. Transesophageal echocardiography (TEE) and naso-pharyngeal temperature probe should be inserted after endo-tracheal intubation to minimize aerosol generation. TEE probe should be used sparingly in cases where it is absolutely essential like mitral valve repairs, OPCAB etc. The established recommendations for indications of pert-operative TEE during cardiac surgery does not apply during this pandemic and we have to be extremely careful while handling the probe following its use in a nCoV positive patient. All bare surfaces of the probe and flat parts of the machinery and equipments which cannot be sterilised need to be covered with transparent polyurethane sheets to protect them from contamination. After the procedure these coverings should be discarded and the TEE and temperature probes should be sterilized by immersing them under freshly prepared 'cidex' solution for at least 30 minutes.

Induction and Airway management

Leading airway societies across the world have laid down practical guidelines for successful intubation at first attempt while generating minimum aerosol.[88-92]The anaesthesia providers should be in full level 3 PPE during intubation and minimum number of personnel should be allowed during procedure depending on the anticipated difficulty of airway management. Endotracheal intubation is preferred over supraglottic devices. A standard airway cart and a working pre intubation checklist is prepared. Following principles are suggested for induction of GA and airway management.

1. The most experienced person in airway management should intubate.
2. Preoxygenation in spontaneously breathing patient for at least 5 minutes with passive flow of 100% oxygen with properly fitting anatomical facemask making a two handed tight seal with lowest required flow from a closed circuit having HMEF in situ. During preoxygenation, the patient's nose and mouth are covered with two layers of wet gauze to block some of the patient's secretions and place the anesthesia mask superimposed onto the wet gauze, with care not to obstruct the patient's airway.
3. Intravenous modified rapid sequence induction is done, opioids being given slowly or after the induction drug to prevent reflex coughing. Etomidate considered in patients with hemodynamic instability or poor myocardial contractility.
4. Use suxamethonium (2 mg/kg) or rocuronium (1.2 mg/kg) before intubation depending on the patient's preoperative serum K+ level.
5. In case of desaturation small tidal volumes ventilation by second person while maintaining tight seal of the mask.
6. Before proceeding for intubation, disconnect the facemask and HME filter, decrease the flows to minimum and use a circuit blocker to prevent OT contamination.
7. Intubate using a Videolaryngoscope (preferably) with disposable blades (with a transparent plastic cover to protect screen and handle) and proper sized endotracheal tube (ETT) with a pre-inserted stylet or bougie in all cases as it permits increasing the anesthesiologists' distance from the patient while improves success at first attempt.
8. After intubation, disconnect the circuit blocker, reinstate flows and reconnect HME filter before connecting back the circuit assembly to the endotracheal tube.
9. ETT position is confirmed by visible bilateral chest rise, EtCo2 and ultrasound.
10. The outer gloves, the coverings of the laryngoscopic handle are discarded after the procedure, hand hygiene is performed, and a new pair of gloves is worn. Seal all used equipment in a double zip-locked bag, discard single use equipment and remove for decontamination and disinfection.
11. Avoid awake fibreoptic intubation unless specifically indicated. In such a situation patient's airway is anaesthetised with lidocaine lozenges instead of atomizer. Also, emergency tracheostomy or cricothyrotomy backup is kept.
12. A difficult airway plan is followed for management of unanticipated difficult airways. In absence of videolaryngoscope, a conventional Macintosh blade laryngoscopes can be used. There have been reports on use of transparent aerosol boxes or transparent sheets to cover the patient fully or at least the upper body during airway management to decrease contamination. However, the efficacy of such methods is not yet established. In personal experiences of the authors these make the procedure more cumbersome (increases average time to successful placement of

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ETT) [Ref-Australian study] and are better reserved for extubation rather than intubation.

Maintenance[65,68,76]

1. Minimise circuit disconnection. Clamp the ETT if disconnection is required.
2. Use a closed suction system. Bronchial aspirate should be sent for analysis utilizing this closed suction system in suspected cases in whom screening test could not be performed as mentioned earlier.
3. Use a lung protective ventilation strategy with low tidal volume (4-6ml/kg) and minimum PEEP to maintain a minute ventilation that ensures normocapnia.
4. If the respiratory system compliance can be checked in the ventilators, titrate PEEP titration to maintain maximum compliance, ensuring driving pressure is less than 14cm H2O and peak airway pressure less than 30cm H2O.
5. Maintenance of anaesthesia with inhalational agent or TIVA with opioid for analgesia. Fluid strategy depending on invasiveness of surgery that maintains a urine output of at least 0.5 ml/kg/hour. Liberal fluid strategy to be avoided

Recovery and extubation[68,76,89]

1. In suspected cases post-surgery, patients should be ideally shifted to the COVID-ICU and extubation deferred till the nCoV test results are obtained.
2. Antiemetic prophylaxis to prevent vomiting or retching which may generate aerosol.
3. Paracetamol 15mg/kg and ketorolac 0.5mg/kg at end of surgery unless contraindicated.
4. Deep extubation after full reversal of muscle paralysis while spontaneous breathing is allowed. Consider extubation over a supraglottic airway device connected to a closed circuit to prevent airway compromise in select cases.
5. Patients should be monitored in the OT till full consciousness is regained.

Transfer out of patient

1. If the patients are stable after surgery, cover them with disposable operating sheets and transfer back to the negative-pressure ward or isolation ward through a dedicated lobby and elevator. The patient must wear a surgical mask or N95 mask during transfer. The surfaces of passageways and the elevator should be cleaned and covered.
2. During transfer, the circulating staff should wear proper PPE outside the operating room.
3. If the patient is kept intubated, or needs ICU care a single-patient-use respiratory bag/ Bain's circuit or a transport ventilator must be used during transfer. Minimise the number and duration of breathing circuit disconnections. Paralyze before any disconnection of breathing circuit.

Regional anesthesia and analgesia (RA) (see table-4)

Sole RA should be preferred for providing anesthesia care wherever possible considering the increased risk of exposure of anesthesiologist to virus during GA. RA lowers the risk of postoperative respiratory and other complications, and that these are not AGPs. Theoretical risk of seeding infection into the central nervous system in viraemic patients during neuraxial anesthesia might be neglected as previous studies have refuted the claim that these procedures result in central nervous system involvement in patients with human-immunodeficiency virus or varicella. If the nature of surgical procedure/ duration of surgery indicates high chances of conversion to GA, it would be wise to choose GA in the beginning as emergency intraoperative need for GA would be undesirable and riskier and the same should be previously confirmed with the surgeon.[84,93]

Regional anesthesia(RA) considerations in COVID positive patient

- RA should be performed in designated COVID OT avoiding block room or other common areas to prevent cross contamination
- The most experienced anaesthesiologist should perform the RA procedure.
- Careful patient selection to be able to conduct entire surgery under regional anaesthesia
- Rule out thrombocytopenia
- Contact and droplet precautions for OT personnel. The use of N95/ FFP3 masks/PAPR (full form) to be considered for prolonged close contact with a positive patient in a closed setting
- Virus particles are viable for longer on plastic than cardboard; consider sterile paper drapes instead of plastic ones.
- Deep sedation to be avoided to reduce the need for any airway interventions
- Supplemental oxygen with oxygen mask with least possible oxygen flow preferred over the nasal prongs. The surgical mask can be used over the oxygen mask to limit the dispersion of droplets.
- Pack the required equipment and drugs in a plastic bag before the procedure. The ultrasound equipment, including the transducer, should be protected using plastic covers.
- As the Virus has been isolated from cerebrospinal fluid (CSF) in patients who suffered from with COVID-19 encephalitis, avoid CSF to drip freely after

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lumbar puncture attempt should be made to reduce contamination by not allowing the CSF to drip freely after lumbar puncture
- If intraoperative conversion to GA is required, the emergency airway procedure should be followed
- Continuous catheter techniques can be resource intensive and may require frequent patient contact. The decision to insert and maintain perineural catheters needs to individualised
- Regional blocks under GA should only be performed if it does not require repositioning of the patient.
- Blocks that cause minimal respiratory compromise preferred (infraclavicular brachial plexus block > supraclavicular brachial plexus block > interscalene block)

Special anaesthetic considerations in COVID Obstetric patients

Anesthetic considerations specific to a parturient with covid-19 have been summarized.[94-96]

Anesthetic considerations for a COVID-19 parturient

- Consider early epidural labour analgesia to minimise need for GA in case of later decision of emergency caesarean section.
- Insert a hygroscopic filter in the circuit if Entonox is necessary, to prevent the circuit from being contaminated with the virus.
- Spinal anaesthesia is preferred in elective Cesarean sections.
- Thrombocytopenia should be ruled out
- A single, small case series suggested the possibility of excessive intraoperative hypotension and suggested use of prophylactic vasopressors but this has not been substantiated.
- In case of absolute indications for GA all standard precautions for COVID 19 should be taken .
- Post dural puncture headache should be managed conservatively and epidural blood patch should be considered only when absolutely necessary.

Special considerations in tracheostomy

Tracheostomy is a highly aerosol generating procedure the personal protection of healthcare personnel should be maximum. The National tracheostomy safety project (NTSP) in the United Kingdom has laid down practical guidelines for surgical and anaesthesia teams to manage tracheostomy during COVID 19.(97) In absence of much data the following principles should be kept in mind. (Table-6)

Principles for tracheostomy in COVID 19 patients

- Delay elective tracheostomy until the patient is non infective
- Choice between percutaneous tracheostomy and surgical tracheostomy should be based on operator skill. However the latter is preferred as it does not require bronchoscopic guidance.
- Negative pressure operation theatres preferred
- Use surgical ties instead of diathermy to minimise vapour plumes.
- Advance the ETT in situ beyond the surgical window to protect the cuff during opening the neck.
- Stop ventilation or consider switching to manual ventilation with reduced pressure and decrease rate to minimize aerosol generation when the neck is opened.
- Use only cuffed non fenestrated tracheostomy tubes
- important to meticulously check the position of the tube in the 30-degree 'ICU nursing' position in which the patient will spend the next few days or weeks. This should minimise the requirement for its inspection or manipulation of a tracheostomy tube following the procedure.
- Consider clamping the ETT before the circuit is disconnected and reconnected to the TT.

Considerations for managing trauma emergencies during COVID-19

The current global COVID-19 pandemic situation can potentially overwhelm the health care resources and may impair the delivery of optimal care to trauma patients requiring immediate time sensitive procedures. Regionalized trauma systems should have pre-formulated plans to ensure access to care for sick trauma patients who may themselves be afflicted with COVID-19. Immediate life-saving interventions in a trauma victim should not be delayed and care should be provided while taking all personal protection measures. American college of surgeons have released point of care strategies for trauma centers. The following polices should be followed for trauma bay:[98,99]

1. Determining COVID-19 status of the trauma patient should not lead to delay in the assessment and care, though diligent precautions and strict use of PPE should be ensured in all.
2. During history taking add questions about fever, upper respiratory symptoms, COVID-19 exposure history, travel history to history and take appropriate isolation measures.
3. If a patient has upper respiratory symptoms, immediately place a face mask on the patient.
4. The number of HCWs involved in patient care should be minimized.
5. Disposable resuscitation packages should be used instead of trolley and team members should have predesignated roles.
6. Protocols should be made for airway management for

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potential COVID patients requiring emergent intubation giving due consideration to the available resources.
7. Focused assessment sonography in trauma (FAST) exams should be conducted only when it will change the management.
8. Procedures like chest tubes might be aerosol generating while emergency decompressing thoracotomy (EDT) should really be restricted to penetrating chest trauma with signs of life.
9. In case of need for cardiopulmonary resuscitation (CPR), "Protected Code Blue" has been emphasized wherein the use of PAPRs rather than N-95 masks and specialized PPEs is advised during resuscitation owing to the high risk of aerosol generation. This would require being prepared in anticipation.

Trauma patients requiring surgery should preferably all be screened and tested for COVID-19 preoperatively to minimize exposure of HCWs.(100) Patients requiring urgent/emergent operative treatment of their injuries, when COVID-19 test results cannot be made available prior to the intervention, it is advised to treat all such patients as COVID-19 positive to prevent nosocomial spread of the infection until test results prove otherwise. (101) In a COVID positive patient, whenever feasible and without increasing patient morbidity, consideration should be given to managing the fracture conservatively or postponing surgical management until the disease is controlled. Categorization of emergency surgeries in those who are COVID-19 confirmed or suspected and COVID-19 negative operating rooms is desirable. Guiding principles for managing trauma emergencies in COVID era should be to: (102,103)

1. Uphold the wellbeing of patients and HCWs.
2. Care should be as expeditious as possible in critical life/limb saving interventions for unstable patients while maintaining optimal care
3. Conserve scant healthcare resources and consider outpatient-based management whenever possible.
4. Trauma teams should be restructured with an active and stand-by team.
5. Develop a hospital policy for managing patients in the operating room with known or suspected COVID-19 infection.
6. Due to public fear of disease transmission, blood supply should be monitored and restrictive transfusion strategies should be encouraged when appropriate.
7. An infectious screen should be integrated in care.
8. When treating patients with injuries that may involve the mucosal surfaces of the head/face, nose, and pharynx, these procedures must be considered aerosol-generating, and all appropriate institutional PPE guidelines should be followed.
9. Consideration should be given to treating the injuries conservatively whenever possible to minimize spread of SARS-CoV-2 and optimize resource allocation.
10. Expeditious treatment of fractures with minimal intervention under local anaesthesia whenever feasible and without affecting patient outcome should be preferred.
11. Video consultation and/or examination of the patient may be used to assist decision making. Follow-up can be done by a telehealth visit whenever possible.
12. Trauma surgeries which can be safely deferred for delayed management in majority cases include most facial injuries, orbit fractures and all nasal fractures, except drainage of a septal hematoma.
13. Nasal surgeries are high-risk AGPs. Topical local anesthetic with vasoconstrictor on intranasal pledgets would be preferred to aerosolized medications for nasal surgeries.
14. Since the pandemic situation is dynamic, spokespersons from various trauma specialties should have regular meetings to formulate and revise guidelines, so as to modify their tactics as needed.

Post procedure disinfection and waste disposal

Clear cut working guidelines, that incorporate directives on waste disposal and disinfection of operating rooms after a surgery should be adopted. It is important to designate an infection control team for development of guidelines, monitoring staff adherence, and revising protocols as the situation is updated.(86,94)

1. Equipment, supplies, and medications must be used for only one patient. Devices that directly contact the patient's respiratory secretions, skin or mucosa should be single use viz. breathing circuit, video laryngoscope blade, anesthesia masks, filters, suction tubes, catheters, end-expiratory carbon dioxide sampling tubes, water traps, etc.
2. The recommended disinfection procedure of the ventilator on the anesthesia machine consists of either disassembly and sterilization with high temperature, if feasible, or disinfection with 12% hydrogen peroxide or ozone (≥100 mg/m3) using a disinfection machine. The surface of the anesthesia machine, laryngoscope handles, and other non- disposable equipment should be cleaned and disinfected with 2 to 3% hydrogen peroxide, 2 to 5 g/l chlorine disinfectant wipes, or 75% alcohol wipes after the completion of each case and again at the end of the shift.
3. The anesthesia cart and other anesthesia facilities must be cleaned and disinfected similarly.
4. The transfer bed used for patients with COVID-19 should be cleaned and disinfected with 2 to 5 g/l chlorine disinfectant.
5. All medical waste should be double-bagged and labeled

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"COVID-19," along with the the category. Before being taken out of the contaminated area, all the packing bags should be sealed and sprayed with chlorinated disinfectant or covered with an additional bag and sealed.

6. All healthcare workers participating in the surgery should remove their PPE and place them in a designated waste bag in the doffing area and perform hand hygiene.
7. Disinfection of a room after aerosol generating procedure should be done for 20 minutes to one hour depending on the agent used.

Conclusion

With every SARS like viral pandemic, the progress of humanity is pushed behind by few years. The COVID-19 is posing a huge burden to the existing health care system. In the perioperative setting taking adequate measures is of prime importance to prevent infection among healthcare workers. The knowledge regarding the disease is still evolving. In this article, we have outlined perioperative concerns and have suggested methods to overcome potential obstacles based on available evidences. Careful adaptation of working principles and implmentations of protocols based on local needs can help in prevention of disease spread while optimizing care to the patients.

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