Indian Journal of Clinical Anaesthesia 2021;8(Special Issue):36–44

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Clinical Anaesthesia

Journal homepage: www.ijca.in

Review Article

COVID 19 and obstetrics: anaesthetic challenges, co-morbid conditions and critical care

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ARTICLE INFO

Article history:
Received 13-04-2021
Accepted 12-05-2021
Available online 21-10-2021

Keywords:
COVID 19
Obstetrics anaesthesia
Critical care
Comorbidities

ABSTRACT

The WHO has declared severe acute respiratory syndrome corona virus-2 (SARS-CoV-2) as a pandemic; it affected approximately 44.5million people since its first breakout in December 2019. COVID-19 can present with wide spectrum of clinical manifestations which range from mild illness with myalgia only to acute respiratory distress syndrome with or without multi-organ dysfunction syndrome necessitating the advance critical care and life support. Pregnant women presenting to emergency department needs to be triaged based on imminent risk factors for maternal and fetal compromise, present haemodynamic status of mother with consideration of gestational age. Pregnant women with comorbid conditions require multidisciplinary team approach for better pregnancy outcomes, resource management and minimizing the risk infection to health care providers. This review emphasizes on management of labour, pregnancy outcomes, co-morbidities and complex critical situations associated with COVID-19 infected pregnant women. Development of safe medical practices and infection prevention protocols with involvement of multidisciplinary team including anaesthesiologist, obstetrician, neonatologist, critical care specialist, infectious disease experts and nursing staff for the perioperative management; is required to optimize the patient outcome and mitigate the infection risk to health personnel and their families.

1. Introduction

Severe acute respiratory syndrome corona virus-2(SARS-CoV-2) has been declared pandemic by WHO in March 2020.[1] The global burden of COVID-19 disease is approximately 43 million till date and numbers are increasing exponentially.[2]

Preparedness for the unpredictable setting of labour and delivery with their unique challenges warrants the institutional policies with multidisciplinary approach; as rescheduling and postponing is rarely an option.[3] Physiological changes in the pregnancy in immune system, respiratory physiology, and hormonal alterations may predispose pregnant women to severity of infection. Increased susceptibility to hypoxemia due to pregnancy associated anatomical and physiological changes in the cardio-respiratory system leading to high oxygen demands, hyper-coagulable state increasing the risk of pulmonary microvascular thrombosis,[4,5] and altered immune function causing unfavourable inflammatory response along with the hormonal alteration could play an important role in the course, susceptibility and outcome of COVID-19 in pregnant population.[6–8] Pregnant women with comorbidities and COVID-19 constitutes a high-risk subset which requires the hospitalization and close monitoring.[6–9] Maternal mortality of 0.1% to 1% attributed to COVID-19 has been reported.[10–14] As the evidence in evolving on the maternal course and mortality in COVID-19, it is imperative that pregnant women should be closely monitored for the

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https://doi.org/10.18231/j.ijca.2021.102

worsening of the disease.[10–14] The strategic preparedness and response plan in alignment with the evolving science and emerging data with expert evidence based opinion and guidelines may mitigate the risk associated with COVID- 19 infection.

2. Pathophysiology

Angiotensin converting enzyme (ACE2) receptor which is the entry point of SARS-CoV2, plays a critical role in COVID-19 infection. This enzyme primarily catalyse the conversion of angiotensin-I to a nonapeptide angiotensin and angiotensin-II to angiotensin (1-7), and also via counter regulation of renin-angiotensin system; have direct effect on multiple organs.[15,16]

SARS-CoV2 mainly infects the type II pneumocyte in lungs and proximal tubule epithelial cells of kidney in severe cases.[16] SARS-CoV2 mainly infects the type II pneumocyte in lungs and proximal tubule epithelial cells of kidney in severe cases.[15] The significant increase in the ACE2 mRNA in the kidney, placenta, and uterus may impact the vulnerability of pregnant woman for COVID-19 infection.[16]

3. General Considerations

Detailed history of presence of dry cough, fever, shortness of breath, close contact with COVID-19 patients, occupational exposure should be done at first contact with patient.[17,18] American College of Obstetricians and Gynecologists (ACOG)[19] and Centers for Disease Control and Prevention(CDC)[20] recommend priority COVID-19 testing for pregnant women admitted to hospital with suspected COVID-19 infection or who develop symptoms associated with COVID-19 infection during admission.

A detailed assessment of maternal vitals, signs of sepsis and confirmation of labour should be conducted by a multi-disciplinary team for severity of COVID infection. Women having sign of sepsis should also be investigated for COVID-19 as a cause of sepsis and to be managed accordingly.[17–20]

Vigilant monitoring of vital signs and oxygen saturation level, ABG analysis may be required to minimize maternal hypoxia, also for maternal stabilization. The efforts to limit viral transmission; detection, monitoring, prevention and timely management of complications are the key factors in management.[17,18] It is recommended to wear PPE, N95 and face-shield while caring for suspected and confirmed COVID-19 patients.[17,18,21]

4. Clinical Characteristics

In a systematic review[12] including over 11,000 pregnant women with suspected or confirmed COVID-19, most common symptoms reported were fever(40%), cough(39%), dyspnea(19%), loss of taste (15%), myalgia(10%), and diarrhoea(7%). Other less common symptoms are sore throat, rhinorrhea/nasal congestion, nausea/vomiting, and anosmia.[12,22,23] A prospective cohort study included 241 pregnant women with confirmed SARS-CoV-2 infection noted 61% were asymptomatic at the time of admission, but 30% of these patients develops symptoms prior to discharge and 5% among these cases were reported to be critical during the delivery and hospitalization.[24] In initially published data, no known difference was observed between the clinical manifestation or any predisposition to develop severe pneumonia of COVID-19 in pregnant and non-pregnant women of similar age group. Although recent data have suggested the possibility of increased risk of severe disease course among pregnant women especially elderly with co-morbidities, and those who acquire respiratory infections in the third trimester.[10,12,25]

COVID-19 in pregnant women poses threat to both mother and fetus along with diagnostic dilemma as pregnancy symptoms may overlap with covid symptoms such as fatigue, fever with ruptured membrane and chorioaminitis, physiological rhinitis, coughing and shortness of breath concomitant to acid reflux, headache with preeclampsia and; myalgia and diarrhoea with latent labour.[12]

5. Investigations

Common laboratory findings in a systematic review included lymphopenia (35%), leukocytosis (27%), elevated procalcitonin level (21%), abnormal liver profile (11%), and thrombocytopenia (8%).[12]

The high association of ground-glass opacities on chest computed tomography (CT) scan is observed in the patients who were tested positive for COVID-19. Chest radiography, especially CT-Scan with high sensitivity should be considered for detection of Covid-19 in symptomatic yet RT-PCR negative patients. The radiation doses in C-Xray (0.0005-0.01 mGy) and CT-Scan (0.01-0.66 mGy) usually is much lower than doses (>610 mGy) associated with adverse effects, even though informed written consent should always be obtained and abdominal shield to be applied for fetal protection.[26]

6. Medical Management

Medical therapy, during pregnancy and breast feeding relies on medication with proven safety; but safety data are often missing due to exclusion of pregnant women from early stages of clinical trials. Antiviral drugs (remdesevir, lopinavir- Ritonavir), hydroxy-chloroquine, tocilizumab and convalsecnt plasma have used in treatment of these patient with variable benefits. Drugs like angiotensin receptor blockers, angiotensin converting enzyme inhibitors and non-steroidal anti-inflammatory drugs should be avoided in pregnancy.[27]

6.1. Steroids

Steroids have been evaluated in patients with severe COVID-19 including acute respiratory distress syndrome and shock and; should be assessed on individual basis and intensive monitoring is required.[28] The Society for Maternal Fetal Medicine and ACOG recommends administration of antenatal betamethasone for fetal benefit in view of increased risk of premature rupture of membranes, preterm delivery and fetal growth restriction; between 24 weeks to 34 weeks of gestation. A single dose of 12mg betamethasone could be administered to reduce effect on maternal blood sugar and clinical condition; although for its administration urgent delivery should not be delayed.[19,29]

6.2. Anticoagulants

Pregnancy increases the risk for venous embolism and the risk per day is greatest in the weeks immediately after delivery.[30] Severe COVID-19 infection is also prone to develop the consumptive-coagulopathy and hypercoagulable state with markedly elevated D-Dimer level. Pre-emptive strategies include pre-hospital low dose aspirin or early use of low molecular weight heparin (LMWH) in hospitalised patient. All pregnant women with suspected or confirmed covid19 infection regardless of mode of birth; should receive prophylactic LMWH for ≥10 days upon admission to reduce risk of venous thrombo-embolism, unless birth is expected in 12 hrs or in presence of any clear contraindication.[31,32] Acute pulmonary embolism and ovarian vein thrombosis have been reported in pregnant women with COVID-19 infection.[33,34]

7. Labour Management

Individual assessment based on maternal/fetal condition, gestational age and potential for improvement by delaying elective birth must be conducted.[7] The current recommendation is continuous electronic fetal monitoring, as incidences of fetal compromise have been reported.

A surgical mask or N95 must be applied to the patient while shifting and throughout the stay in labour/operating room.[17,19,23,28]

7.1. Mode of birth

Rational decision regarding the mode of birth should be based on obstetric indication and patient's preferences unless urgent delivery consequent to maternal deterioration is warranted.[17,18] In systematic reviews of 252 and 538 pregnant women with COVID-19, 15% -20% had preterm births, and 70% - 85% were caesarean deliveries although these studies predominantly reported symptomatic women (≈75%).[35,36]

7.2. Labour analgesia

Epidural anaesthesia in early labour in suspect and confirm covid-19 parturient is the preferred choice of labour analgesia; as intense pain and puffing may increase the risk of aerosolisation.[17] It further avoids the general anaesthesia (GA) if need for caesarean delivery arises. It unintentionally increases the risk of intra-partum pyrexia and; in presence of systemic inflammatory response (SIRS) the rise in temperature may be high.[37] The nitrous oxide programs suspension in labour and delivery units should be considered in view of insufficient information regarding safety of its use in this pandemic.[17]

The Society of Obstetric Anesthesia and Perinatology (SOAP) suggest limiting use of intravenous, patient-controlled analgesia due to risk of undetected respiratory depression especially in COVID-19 patient. This concern has made a necessary shift to non-opioid analgesia.[38]

7.3. Pregnancy outcomes

Covid-19 can affect pregnancy outcome especially in symptomatic patients and in late pregnancy,[25] as it increases the chance of preterm delivery and spontaneous rupture of membrane and the contributing factors are fever, hypoxia, shock and deteriorating maternal condition. A prospective multi-centric cohort study demonstrated COVID-19 infected pregnant women have more infection related morbidity in terms of preterm delivery (primary outcome) 13.8% vs 6.7%, (aOR 2.12,95% CI 1.32 – 3.36, p= 0.002); premature rupture of membrane 9.8% vs 5%, (aOR 1.70, 95% CI 1.11- 2.57, p=0.013) and neonatal intensive care unit admissions 23vs 18, 9.3%vs 2.4% (aOR 4.62, 95% CI 2.43-8.94, p<0.001) and importantly 90% of them were asymptomatic at time of admission.[39] Similarly, another cohort study[12] in pregnant women with covid-19 has showed higher odds of preterm delivery (3.01, 1.16 to 7.85) and neonatal ICU admission (3.13, 2.05 to 4.78).

8. Obstetric Anaesthesia

8.1. Pre-operative assessment

Investigation to assess leukopenia, lymphocytosis and lymphopenia from complete blood count, coagulation profile, organ functions from liver function test and renal function test, look for consolidations on chest x-ray and CT-thorax for the presence of multi-lobar ground glass appearance are the valuable aids for preoperative risk assessment.

8.2. Neuraxial anaesthesia

Neuraxial anesthesia with single-shot subarachnoid blockade or an epidural should be preferred if the parturient oxygen saturation is adequate (≥94%) as it helps in avoiding any exacerbation of respiratory complications

with intubation and mechanical ventilation.[40]

The working epidural catheter in situ for labour analgesia can be used to achieve rapid onset of surgical anaesthesia plane by administering a top-up with potent local anesthetics; it also provides good post-op analgesia.[23] There is a possibility of excessive hypotension with regional anaesthesia as the circulatory system is highly susceptible to SARS-CoV-2 infection with the probable reason being the binding of SARS-CoV-2 with the ACE2 receptor.[26,41]

Thrombocytopenia have been reported in up to one-third of severe COVID-19 patients, so anaesthesiologists must be vigilant regarding the potential for developing thrombocytopenia and use of anticoagulant therapy while performing neuraxial procedures in a COVID-19 positive parturient. Platelet count evaluation before performing regional anesthesia is advisable.[42] A platelet count of $70{,}000 \times 10^6$/L has low risk for spinal epidural hematoma, and even lower levels should be considered in cases such as those with a high risk for respiratory compromise with GA.[30] Neurologic complications or deterioration have not been reported following neuraxial procedures in obstetric patients with COVID-19 infection.[43]

8.3. General anaesthesia (GA)

Emergency CS mandates a systematic protocol and preparedness for minimizing the risk of cross infection. GA may be indicated in emergency situation and with deteriorating maternal respiratory function ($SpO2 \leq 93\%$) or pre-existing indications. It poses high risk of exposure to health personnel involving direct close contact during airway management while intubation and extubation.[21]

The dedicated operating room and anteroom should be equipped with a negative pressure system. Breathing circuit filter must be applied each limb of circuit as interface between anaesthesia machine and patient. Rapid sequence induction after libral doses of muscle relaxant with avoidance of manual mask ventilation is recommended. For efficient airway management intubation should be done by experienced anaesthesiologist, preferably with video laryngoscope to minimize both time and attempt for intubation. Care should be taken to place tube at correct depth and to further avoid auscultation and minimize need for subsequent cuff deflation. Position of tube can be determined by chest expansion and $EtCO2$. Pregnant women have more propensity of unanticipated difficult airway so intubation checklist and difficult intubation cart should be ready beforehand. Extubation, a high aerosol generating procedure; should be done in the operation theatre in presence of minimum possible staff after clamping of tube; and under the clear plastic drapes to limit viral spread.

8.4. Postoperative pain

Given the uncertainty, ACOG,[19] WHO,[21] the Society for Maternal Fetal Medicine[29] and the European Medicines Agency[44] recommend not avoiding NSAIDs in COVID-19 patients when clinically indicated for postoperative pain, tocolysis and prevention of preeclampsia in some high-risk patients. Epidural analgesia or transverse abdominis block and paracetamol iv infusion can be administered for postoperative pain. Greater occipital nerve block for post dural puncture headache could be an option. Tramadol and opioids have concern of respiratory failure in moderate to severe COVID patients although in mild and asymptomatic case they are feasible options.

8.5. Postpartum haemorrhage (PPH)

It is a multimodal approach based on timely utilization of established medical and surgical strategies aimed at improving the outcome of patient. Indication for blood transfusion should be carefully evaluated and if feasible single unit transfusion followed by reassessment for further need except major obstetric haemorrhage. Transfusion related acute lung injury may aggravate the severity of ARDS in covid19 patients. In absence of active DIC or active hypercoagulable state, early use of tranexamic acid should be considered.[31] Carboprost use in the management of postpartum haemorrhage is known to be associated with unexpectedly severe bronchospasm which further can complicate management of COVID-19.[45] Individualised goal directed therapy; and monitoring with point of care devices and quick laboratory tests is recommended in major postpartum haemorrhage.

8.6. Interventional radiology (IR)

Prophylactic occlusion balloon placement for the prevention and management of PPH in morbidly adherent placenta; as an organ saving procedure can be performed whenever deemed to be necessary; with proper precautions and PPE and strict adherence to infection control protocol in designed suite only or infection control strategies as per institutional protocols. These measures may add to the complexity and duration/ procedural time due to unfamiliarity and lack of practice so all the attempts at vascular access should be made with USG guidance to increase the chance of access at first attempt. All fixed and essential contact surface should be covered with clear plastic drapes that can be changed between patients.[46]

9. Vertical Transmission

The risk of congenital infection with SARS-CoV-2 is unclear.[17] Fachhetti et al reported the evidence for maternal-fetal transmission; it was most likely propagated by circulating virus-infected fetal mononuclear cells. SARS-

CoV-2 S and N proteins were strongly expressed in the placenta of a COVID-19 pregnant woman whose newborn developed COVID-19 pneumonia soon after the birth and tested positive for viral RNA.[47] Penfield et al found 3 out of 11 placental membrane swab positive for SARS-CoV2 in moderate to severely ill covid19 patients; as clinical signs of vertical transmission were absent in these cases the possibility of intrapartum viral exposure cannot be ruled out.[48] Few studies have demonstrated the finding of SARS-CoV-2 IgM in neonates born to mothers infected with COVID-19 during pregnancy.[49,50] The Royal College of Obstetricians and Gynecologists (RCOG) recommends delayed cord clamping in absence of any other contraindication as it is unlikely to increase risk of transmission.[17]

10. Care of Infant and Breast Feeding

Neonates of positive or suspect mothers should be tested for COVID-19 within 24 hours with nasopharyngeal/throat swabs and also for the presence of IgG and IgM antibodies.[17] Being considered as high risk contacts they should be kept in isolation from other healthy infants, irrespective of the result of testing. Breast feeding initiation as earliest possible should be done, if mother's general condition permits. Risk of infection via airborne droplets from mother should be taken care with using N95 mask; and practising appropriate hygiene measures such as hand washing before touching baby and cleaning of breasts.[20]

The mother and healthy infants should be kept together in immediate post-partum period with provision for close monitoring and early involvement of the neonatal care whenever deemed necessary. If separation is advised, expressed milk can be fed to baby with help of healthy assistant, while following strict sterilisation guidelines.[19,20]

11. Co-morbid Conditions

Increased maternal age, high body mass index, chronic hypertension, chronic renal disease and pre-existing diabetes were associated with severe covid-19 in pregnancy. Pre-existing maternal co-morbidity was a risk factor for intensive care unit (ICU) admission (OR 4.21, 1.06 to 16.72) and invasive ventilation (OR 4.48, 1.40 to 14.37), analysed from result of 77 cohort studies including over 11,000 pregnant and recently pregnant women.[12] Severe maternal disease can lead to complex management challenges and has shown to be associated with higher incidence of preterm and caesarean births.

Utilization of the medical early warning scores and close monitoring of patients for signs of clinical deterioration such as rapidly progressive respiratory failure and shock, to respond immediately with supportive care intervention are important to optimize the outcomes.

11.1. Anaemia

The incidence and severity of anaemia is likely to increase during pandemic due to changes in lifestyle, diet, lack of early detection due to infrequent ANCs. Measures to optimise the patients's red cell mass, reduce peri-operative blood loss and enhance anaemia tolerance can results in reduced transfusion rate as patient may be admitted for emergency surgery leaving no time for correction[31]. Low ferritin level(<30ng/ml) which is a good indicator of iron deficiency could be misleading in this pandemic time as it also increases with viral infection including covid-19. Hence transferrin saturation <20% and increased CRP level (>4mg/ml) are also recommended as concurrent supporting investigation to rule out viraemia and acute inflammation.[51]

11.2. Gestational diabetes

Pregnant woman with gestational diabetes constitutes a high risk group, may be more vulnerable to the severe effects of covid-19. Oral glucose tolerance test(OGTT) have high sensitivity to diagnose GDM, but in present scenario carries exposure risk to both clinician and pregnant women based on need of travelling, multiple visits, time spent in potentially infected area. Performing HbA_1C and RBS test at first appointment to detect overt diabetes and identify those at highest risk for gestational diabetes to reduce the need for OGTT in pregnancy and post-partum follow-up is a pragmatic option. All guidelines support use of an early pregnancy HbA_1C ≥41 mmol/mol (5.9%) to identify GDM. Fasting VPG <4.7mmol/L is considered non-GDM and ≥5.1mmol/L confirms GDM, based on the WHO criteria using HAPO (hypoglycaemia and adverse pregnancy outcome (odds ratio of 1.75).[52]

The stress of infection, accompanied by severe anxiety and use of high doses of corticosteroids in high risk patients, is likely to worsen glycemic control and the risk of secondary infections; hence such patients preferably should receive insulin if medical management is required.[53]

11.3. Preeclampsia:

Normally in pregnancy upregulation of ACE2 receptor mediates conversion of vasoconstrictor angiotensin-II to vasodilator angiotensin(1-7) and by virtue of this maintain low blood pressure by affecting the circulatory system; but SARS-CoV2 infection causes ACE2 downregulation which can cause vasoconstriction, inflammation and procoagulant effect by lowering angiotensin(1-7) level; and due to these reasons pre-eclampsia may be more common in pregnant women with covid-19.Whereas hypertension which is also a cardiovascular manifestation of COVID-19 might misdirect the pre-eclampsia management.[54]

Magnesium sulphate commonly used for seizure prophylaxis as well as neonatal neuro-protection should be individualized. Severe COVID-19 infection, especially with

renal failure may cause magnesium toxicity which further depresses respiration.

11.4. Cardiovascular diseases

Patients with pre-existing cardiovascular disease and risk factors are more likely to experience adverse outcomes associated with the novel COVID-19 disease. Additionally, consistent reports of cardiac injury and de novo cardiac complications, including possible myocarditis, arrhythmia, and heart failure in patients without prior cardiovascular disease or significant risk factors are emerging, possibly due to an accentuated host immune response and cytokine release syndrome. Clinician should avoid NSAIDs in pre-existing CVD or develop new-onset cardiac dysfunction during the course of the illness.[55]

11.5. Renal diseases

Pregnant women with underlying kidney disease are at a higher risk of developing maternal complications such as worsening of kidney disease and secondary preeclampsia and associated fetal complications include preterm birth, fetal growth restriction, stillbirth, and neonatal death.[8] Increased kidney blood flow and glomerular hyperfiltration in healthy pregnant women, result in lower serum creatinine levels; therefor cut-off for serum creatinine defining AKI is lower(>0.8mg/dl) in pregnant population. It is preferable to initiate dialysis in pregnant women with chronic kidney disease, once the estimated glomerular filtration rate (eGFR) declines < 20mL/min/1.73 m2 or the blood urea nitrogen increases >50 - 60 mg/dL as untreated uremia is associated with poor fetal outcomes[56]. Kidney replacement therapies like continuous kidney replacement therapy or haemo-dialysis have risk of hypotension which may compromise fetal circulation. The limited availability of dialysis, during the COVID-19 pandemic, especially in low resource settings should be anticipated and close monitoring of the eGFR and planning for dialysis initiation needs to be done. Thus, women with kidney disease warrants close monitoring throughout the pregnancy.

During the COVID-19 pandemic, visits can be done via video conferencing, and patients should be taught to monitor blood pressure and symptoms of worsening kidney disease and preeclampsia at home so that they can promptly report. Low dose aspirin may be considered in patients with COVID-19 to mitigate the risk of preeclampsia in this subset of patients.[8]

Dialysis: Bed side dialysis machine should be left in same area for future dialysis. Continous Renal Replacement Therapy (CRRT) machine are free standing and can function anywhere in hospital using sterile bagged replacement fluid and dialysate, but operating costs are high.[57]

Other extra corporeal therapy for COVID-19: Use of cytokine removal therapies with cytosorb, oxiris and other devices is unproven and is not recommended except in context of clinical trial.[57]

12. Critical Care

WHO recommends maternal peripheral oxygen saturation (SpO2) should be maintained at ≥95% and in patients with acute respiratory distress syndrome (ARDS); the partial pressure of oxygen should be ≥70 mmHg to maintain an oxygen diffusion gradient across the placenta.[21] Oxygen supplementation via nasal mask, face mask, helmets, high flow nasal canula and continuous positive airway pressure (CPAP) may be needed to maintain oxygen saturation. They may need invasive ventilation with lung protective ventilation strategies. High positive end-expiratory pressure (>10 mmHg) is known to decreases the preload and cardiac output, requires close maternal and fetal monitoring.

Pregnancy as such is not a contraindication to the prone position for short period of time, if feasible and comfortable. It can be alternated with lateral position in pregnant women including those at term.[58] Patient with cytokine storms and morbid manifestations of COVID-19 infection such as severe pneumonia, ARDS, presence of shock and multi-organ dysfunction syndrome (MODS), respiratory failure associated with disease severity and require ICU admission for advanced ventilatory and circulatory support.[23]

Hypotensive and desaturated patients must be prioritized and managed at the earliest, and to be evaluated as cardiac, non-cardiac, and septic causes. Cardiovascular causes of desaturation in COVID-19 include systolic failure from viral myocarditis, congestive cardiac failure, and pulmonary edema.[59]

Bedside transthoracic echocardiography (TTE) can be utilized to determine status of left ventricular contractility and inferior vena-cava; also for the assessment of cardiac causes of hypoxia and hypotension which will further guide the fluid and vasopressor requirement. COVID parturient with moderate to severe spectrum or with acute respiratory distress syndrome should maintain neutral fluid balance by monitoring hourly input- output charting to avoid fluid overload.[59,60]

Extracorporeal membrane oxygenation (ECMO) should be considered in hypoxia refractory to mechanical ventilation. Permissive hypercapnia (PCO_2 <60 mmHg) and ECMO do not appear to be harmful to the fetus, but data are limited.[60] ECMO in peripartum period requires special consideration as anticoagulants used during this may complicate hemostasis at placental site.[61]

Acute kidney injury (AKI) in peri-partum period in women with COVID-19 can be attributed to multiple etiologies such as preeclampsia, peripartum sepsis, thrombotic microangiopathies, acute cortical necrosis, acute pyelonephritis, glomerulonephritis, volume depletion due to fever, diuretic use and fluid restriction, haemorrhage, obstructive pathology; and direct tubular injury, cytokine

storm secondary to covid-19 infection and further complicates the management.[8]

The Centers for Disease Control in a recent report of 91,412 pregnant women noted that 1.5% vs 0.9% pregnant women required intensive care and 0.5% vs 0.3% mechanical ventilation as compared to non-pregnant women even after adjusting confounding factors such as age, comorbities, and ethnicity; which was in contrast with previously published literature.[62] In another systematic review[12] 49% had pneumonia and 30% received oxygen by cannula, 13% of them had severe disease; 4% of them were admitted to an (ICU) with 3% received invasive ventilation and 0.8% required extracorporeal membrane oxygenation (ECMO) and mortality was 0.6%.

Clear policies for crisis and contingency standards for cardio-pulmonary resuscitation (CPR) are essential as it is a resource intensive, carries risk to provider and also associated with very poor outcome.[63,64] Measures to reduce risks related to aerosolized transmission include consistent use of PPE and face shield by the code team, performance of intubation by experienced personnel, using HEPA filter in the exhalation limb and emphasis on replacement of manual chest compression with the mechanical CPR to reduce the number of CPR providers. The International Liaison Committee on Resuscitation (ILCOR) systematic review suggests use of defibrillation as it is unlikely to generate aerosol.[63]

The parturient should receive care in dedicated COVID-ICU after return of spontaneous circulation and perform the perimortem caesarean section, if indicated. A study on clinical outcomes of in-hopital cardiac arrest on 54 patients with COVID-19, reported 100% mortality rate following CPR while the overall survival to discharge before this pandemic was 25%.[64]

13. Psychological Impact

The socioeconomic impact of COVID-19 along with psychological changes of pregnancy and postpartum period adversely affect the mental health and women may feel secluded, experience several changes and also vulnerable to develop anxiety and depression. Tele-health and group video sessions can be useful tools to provide preventive measures and psychological support during this crucial time.[65]

14. Challenges

Unfamiliar working environment, multidisciplinary team, potential resource depletion, critical ill patient with limited physiological reserve, clinician stress and fatigue are the frequently encountered hurdles. PPE may impede clear communication so prior briefing and role allocation should be done. Closed loop communication system, if available or a white board with marker pen should be utilized to limit communication errors.

15. Education

Regular and repeated multimedia visual aids training followed by supervised practice along with simulation based training for donning and doffing, airway management, emergency situations and CPR is highly recommended.

16. Conclusions

In conclusion, pregnant patients constitute a vulnerable population that requires multidisciplinary care during the COVID-19 pandemic. We are still unaware of the exact risk and the long term consequences of COVID-19 to the mother and the baby so careful monitoring of pregnancies and measures to prevent neonatal infection are warranted. Guiding principles for COVID-19 management are intensive training, early intervention, meticulous planning, vigilant infection control, efficient airway management, clear communication and standardised practice. Robust estimates of disease severity are still lacking, and the proportionate risk of severe maternal morbidity and mortality related to COVID-19 cannot be determined without analysing large scale population based data from several countries adjusting for several confounding factors and outcome modifiers. Therefore, the need for rigorous data collection and transparent reporting cannot be overemphasized. However, on the basis of available data, and in line with the precautionary principle, the risk of COVID-19 in pregnancy should not be down-played to avoid falsely reassuring the healthcare professionals and the public.

Development of safe medical practices and infection prevention protocols with involvement of multidisciplinary team including anaesthesiologist, obstetrician, neonatologist, critical care specialist, infectious disease experts and nursing staff for the perioperative management; is required to optimize the patient outcome and mitigate the infection risk to health personnel and their families.

17. Source of Funding

None.'

18. Conflict of Interest

The authors declare no conflict of interest.

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Cite this article: Choudhary S, Gupta S, Yadav AK. COVID 19 and obstetrics: anaesthetic challenges, co-morbid conditions and critical care. *Indian J Clin Anaesth* 2021;8(Special Issue):36-44.