

Obstetrics in the time of Coronavirus: A Tertiary Maternity Centre's Preparations and Experience during the COVID-19 Pandemic

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Abstract

Objective Since the outbreak of Coronavirus Disease 2019 (COVID-19) in Singapore in January 2020, our maternity centre at Singapore General Hospital has devised and implemented contingency protocols to manage COVID-19 suspected or infected pregnant mothers. These aimed to deliver effective care while ensuring the safety of our front-line healthcare workers.

Methods The epidemiology and pathogenicity of SARS-COV-2 was compared to the Severe Acute Respiratory Syndrome outbreak in 2003. Our protocols were constructed following multidisciplinary discussions. These workflow processes include triage, isolation, determination of admission criteria and subsequent secured transfers to dedicated isolation wards. Intrapartum management policies including mode of delivery were reviewed with the focus on minimising maternal-fetal transmission. Postpartum care (breastfeeding and skin-to-skin contact) policies were re-evaluated.

Results The Centre conducted several multidisciplinary in-situ simulations which identified potential latent threats and deficiencies in infection containment. These were gaps in communication and co-ordination between operating theatre, obstetrics and neonatal teams resulting in delayed transfers. A particular vulnerability was the consistent breaches observed in the donning and doffing of personal protective equipment. This led to a need for additional personnel to guide and police strict adherence among healthcare workers.

Conclusion Operational readiness leverage on robust contingency protocols which must be subjected to simulation and scrutiny with subsequent revision. We recommend deploying additional supervisory manpower to maintain strict adherence to infection prevention protocols. Effective preparation is key in maintaining high clinical standards of obstetric care while ensuring safety of healthcare workers during this ongoing pandemic.

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Introduction

Since December 2019, the Coronavirus Disease 2019 (COVID-19) has affected more than 190,000 and has caused over 7800 deaths. (1) As this emerging disease has rapidly increased in numbers of cases and deaths globally, the World Health Organisation has declared a pandemic on 11 March 2020.

Since the first case of COVID-19 diagnosed on 23 January 2020 in Singapore there are now 313 cases of COVID-19 diagnosed. The majority of cases are stable and have been discharged, while 15 cases are still in critical condition (0.05%). There are currently no mortalities reported.(2) Singapore's aggressive response and containment of the outbreak has been singled out for praise by the World Health Organisation.(3) In particular, Singapore's approach for case detection has also been cited as the gold standard in an epidemiological study.(4)

Whilst there have been reports on COVID-19 in the non-pregnant population, data is limited on the effects of the disease in pregnancy. Previous studies on the effects SARS on pregnancy have shown an increased risk of adverse maternal and neonatal complications such as maternal mortality, spontaneous miscarriage, preterm delivery and intrauterine growth restriction.⁽⁵⁾ However, pregnant patients with COVID-19 were found to have fewer adverse maternal and neonatal complications compared to SARS.⁽⁶⁾ The pregnant mother and her newborn baby should be considered as important high-risk populations when drawing up protocols for prevention and management of COVID-19. Firstly, physiological changes in the pulmonary system predisposes pregnant mothers with respiratory infection to poorer outcomes compared to their non-pregnant counterparts. Data is scarce on the risk of mother-to-child transmission although studies have reported no known cases of vertical transmission thus far.

In Singapore, our maternity centre at Singapore General Hospital has devised and implemented contingency protocols to manage any suspected or infected COVID-19 pregnant mothers. These protocols were based on epidemiological findings and the impact of the infection on the pregnant mother, and serve to ensure the safety of our frontline healthcare workers.

Methods

We first studied the epidemiology and the pathogenicity of the COVID-19 virus since its outbreak in China in December 2019. The first imported case of COVID-19 infection was diagnosed in January 2020, prompting the need for contingency plans to manage suspected or infected mothers presenting to our maternity centre. Our centre is a tertiary referral centre for high-risk obstetric cases in Singapore. A detailed examination of our previous experience during the SARS outbreak in 2003 was conducted. We noted a difference in the virulence, pathogenicity and transmission between SARS and COVID-19 viruses. The primary mode of transmission for SARS was airborne while the mode of transmission of COVID-19 is by droplet,⁽⁷⁾ yet the latter is significantly more contagious.

We enlisted multi-disciplinary collaborations with the High-Risk Obstetrics Unit, Labour Ward, Departments of Emergency Medicine, Infection Prevention and Epidemiology, Neonatal and Developmental Medicine, Anaesthesiology, the Operating Theatre Unit, the Division of Nursing and the Hospital's Security Department.

With expert advice and guidance from the various specialty departments, we identified 4 primary strategies which formed the basis of constructing our protocols and workflow processes. These were 1. Early detection of suspected cases and triaging, 2. Isolation and infection containment 3. Intrapartum care and 4. Training. Our protocols can be found in Figures S1 and S2.

Early Detection and Diagnosis of Suspected Cases

Early detection of any suspected cases is critically important so that they can be promptly isolated to minimise potential cross-infection of the public and our front-line healthcare workers. A set of questionnaires was adopted from the Ministry of Health Singapore to screen all pregnant mothers presenting to our centre. These questions include the presence of fever, cough, acute upper respiratory symptoms, and recent travel history. Temperature screening is also conducted to elicit any on-going febrile condition. All these processes are performed at specified screening posts located at all access points into the maternity centre and hospital. Mothers who are symptomatic would be encouraged to wear a surgical mask.

Subsequently, pregnant mothers are then assessed for any acute obstetric symptoms (such as painful uterine contractions, rupture of amniotic membranes) for appropriate triaging. Pregnant mothers who may be in active labour are either transferred to the labour ward or to dedicated isolation rooms at the Emergency Department for further assessment and management. This intrapartum management will be highlighted in another section. Pregnant mothers with non-urgent concerns requiring admission are transferred to specialised isolation wards with negatively-pressurised rooms. Multidisciplinary team opinion involving the infectious disease physician would also be sought. Microbiological diagnosis was confirmed in our on-site hospital laboratory via nasopharyngeal swabs. Chest imaging with plain radiograph or Computed Tomography is safe

in pregnancy.(8) COVID-19 infection per se is not an indication for delivery (9) unless there are maternal indications such as to improve oxygenation and resuscitation.

Isolation and Infection Containment

Dedicated isolation wards with negatively-pressured rooms and ante-chambers are available for suspected or infected cases of Coronavirus (COVID-19). These are single bed rooms fitted with specialised negatively-pressured ventilation systems to minimise cross-infection and transmission. Such facilities are also available at the Emergency Department. Specific gowning stations are assigned outside these rooms for donning of Personal Protection Equipment (PPE) and/or Powered Air-Purifying Respirator (PAPR) by staff prior entry into the isolation rooms and contact with the patients. This equipment will be highlighted in another section. Furthermore, visitors are barred from entry into these isolation wards to reduce the risk of transmission. Moreover, there are dedicated operating theatres designated for COVID-19 suspected or confirmed cases.

During the transfer of suspect or infected pregnant mothers from the triage-cum-screening posts, security personnel are enlisted to clear transfer routes and secure a designated lift for exclusive use for the patient. A dedicated Infection Prevention Nurse is also activated to ensure that there is no lapse in infection prevention practices and to avoid any potential breach in the infection containment process. These lifts are later subjected to rigorous decontamination processes by Environmental Services. All staff and personnel involved in the transfer of these cases are to don appropriate PPE, namely N95 mask, eye protection, isolation gown and gloves.

Once a suspect case has been detected at the triage-screening post, a dedicated obstetric team on-duty will be notified to attend to the mother and the on-call infectious disease physician consulted. Due to the potential risk of cross-infection of this obstetric team, every staff at our maternity centre is divided into several small teams to cover the hospital's obstetric clinical services. Each team is led by a consultant obstetrician directing a team of clinicians and midwives. The clinical roster was planned such that each team has minimal contact with the other teams while ensuring continuation of clinical services.

Intrapartum Care

Modifications in the routine intrapartum care of these pregnant women were made to align with the above principles of early triaging, isolation and infection containment. The following issues were identified:

1. Isolation Facilities

As the dedicated isolation wards and the isolation rooms at the Emergency Department are not equipped for vaginal delivery, arrangements had to be made to facilitate vaginal delivery in these sites. This includes the transfer of delivery and neonatal resuscitative equipment and intrapartum surveillance devices (such as electronic fetal monitors) from the labour ward to the designated isolation room. The list of equipment can be found in Table 1. Such transfers are time-consuming and may compromise maternal and fetal well-being in obstetric emergencies.

2. Donning and Doffing of PPE

a. Managing vaginal delivery in these isolation wards involve repeated donning and doffing of PPE for the attending healthcare workers entering and leaving these rooms. This also applies for staff changing shifts and also during patient transfers to operating theatre if a caesarean section was indicated. Moreover, assigning a dedicated midwife and delivery team decreases the overall effective manpower for obstetric service.

b. Labour progress can vary between pregnant mothers and this variability has implications for the care of the women. Long labours require more shift changes and repeated donning and doffing of PPE. Rapid labours may risk delivery in the absence of an attending staff given the time required to don the PPE.

3. Intrapartum Analgesia

The isolation rooms in our institution are not equipped to deliver Entonox. Even if available, our institution does not have single-patient microbiological filters which are recommended for the delivery of Entonox in this

situation. (10) The immediate implication is the requirement for an attending anaesthesia team to provide an epidural service which is not contraindicated. They are also required to observe similar PPE requirements.

4. *Operating Theatre*

a. A dedicated operating theatre was designated for COVID-19 suspected or infected cases. This was located at some distance from both the isolation ward as well as labour ward. Hence, transferring the patient requiring caesarean section is time-consuming. In addition, the route from ward to operating theatre had to be standardised and secured to prevent cross contamination.

b. Regional anaesthesia is preferred over general anaesthesia given the aerosol generating nature of the latter. (10) It is important to exclude thrombocytopenia in patients with severe COVID-19.(11)

5. *Perinatal Care*

a. Despite the absence of evidence at the time, the authors felt it prudent to have a separate room or designated area as far as reasonably possible from the mother, for the neonatal team to receive the newborn infant. This room or area needs to be equipped with the necessary neonatal resuscitative equipment including an open-care unit with the appropriate oxygen and air supplies, suctioning set-up, and a transport incubator. To minimise exposure, the number of neonatal personnel should be aligned with the anticipated neonatal needs. Full PPE is required in preparation for the possible naso-opharyngeal suctioning and mask positive pressure ventilation. Contingency plans for a multiple pregnancy delivery were also made.

b. The authors will discuss the limited evidence when counselling mothers for: 1. Delayed cord clamping, 2. Skin-to-skin contact and 3. Breastfeeding. The authors erred on the side of caution in the interest of minimising mother-to-child transmission. We suggested immediate cord clamping of the umbilical cord, avoidance of skin-to-skin contact and direct breastfeeding. (9,12,13) However, if the mother was keen to have any of these, these were permitted with precautions such as good hand hygiene and wearing a surgical mask. (10,14,15)

Training and Simulation

During disease outbreaks, PPE in healthcare institutions is the vital link to curb potential spread of disease. It is mandatory for every healthcare worker to undergo training in appropriate and proper use of PPE. This includes correct sequencing of donning and doffing of PPE. Teaching through electronic refresher modules is mandated for every staff in the hospital. In addition, reminders on strict observance of hand hygiene as well as updates on hand hygiene compliance are frequently emphasised and reinforced in the hospital.

Training in the handling of PAPR is conducted by the Occupational and Environmental Unit for doctors and nurses. This includes the maintenance and checking on the functionality of the PAPR equipment, as well as its cleaning and disinfection.

Emphasis was placed on training including scenario modelling coupled with simulation dry-runs. Our objective was to foster understanding between different departments in the adoption and implementation of the newly-developed algorithms and protocols, so that each party is fully aware of its roles and level of participation in the event of encountering a true COVID-19 suspect or confirmed pregnant mother. This included physical dry-runs between the various stations and venues (such as labour ward, isolation ward, designated operating theatre and the emergency department), while assessing the logistics and feasibility of our developed pathways and algorithms. In addition, we conducted a separate in-situ simulation on a healthy patient who was planned for an elective caesarean section. This was conducted with her full consent. The caesarean section was performed with full PPE and full infection control protocols with the objective of identifying potential gaps or deficiencies for improvement. A post-mortem meeting with all multidisciplinary participants was conducted to identify areas of deficiencies and to propose measure to address them. All clinicians from our maternity centre are kept abreast of these finalised processes.

Results

Our dry-runs and in-situ simulation identified deficiencies and potential problems such as:

1. Gaps in communication and co-ordination between operating theatre, obstetrics and neonatal teams
2. Consistent breaches in infection prevention: for example:
 - a. Navigating the patient trolley through narrow corridors with inadvertent contamination of the walls and furniture
 - b. During the donning and doffing processes of PPE
 - c. Missed steps in infection control measures, for example, repeating hand hygiene during the WHO's 5 moments of hand hygiene.(16)
3. Significant delay of 45 minutes from time of decision to transfer to the designated COVID-19 operating theatre. This was contributed by time to transfer the patient and equipment, compounded by inefficient communication between the various teams.
4. The process of urinary catheterisation before the caesarean was time consuming as it required the assistant to don and doff the PPE multiple times before the start of surgery.
5. Intubation and extubation during general anaesthesia are aerosol generating procedures. All non-anaesthetic members should evacuate the operating theatre to minimise exposure.

To date, there has not been any obstetric case of COVID-19.

Discussion

The pregnant mother is at higher risk of a poorer clinical outcome from pneumonia compared to their non-pregnant counterparts. The Spanish Flu pandemic in 1918, the Asian flu epidemic in 1957 and SARS in 2003 have shown higher mortality rates from 25% to 50%. (5,17,18) Physiological changes during pregnancy increases the risk of severe respiratory compromise. The gravid uterus has been shown to elevate the diaphragm by 4cm in the third trimester, reducing the functional residual capacity. In addition, oxygen consumption is increased by 20% leading to an intolerance of hypoxia. These lead to rapid deterioration of a pregnant mother during severe respiratory infections leading to possible iatrogenic preterm delivery. (19)

The fetus is also at risk of a poor clinical outcome. While little is known on the risks of miscarriage or congenital effects of COVID-19, increased risk of preterm delivery, fetal distress, premature rupture of membranes has been reported. (6) Although reports published thus far have shown no evidence of vertical transmission (6,20), the baby may still be exposed to viral shedding in maternal stools (21) during vaginal delivery, or to respiratory droplets from the mother.

Protocols and Simulation

Simulation drills have been proven to be essential in testing protocols and providing effective training for multi-disciplinary teams. (22–24) In the setting of COVID-19, the key areas of concern are in infection containment during labour and delivery, and during transfer of the patient to operating theatre for caesarean deliveries. Our dry run and in-situ simulation identified deficiencies such as gaps in communication and co-ordination and breaches in infection prevention. This led to an unacceptable delay of up to 45 minutes from time of decision to transfer to operating theatre. Reviewing and improving the effective communication mechanisms between teams will be important step in improving this time interval. Simulation has also taught us that urinary catheterisation should be done in the ward prior to transfer to operating theatre. Simple measures such as steering clear of the operating theatre during aerosol generating procedures such as intubation and extubation were only uncovered as a result of simulation.

Further changes arising from the debrief sessions, included developing a checklist of the steps, a laminated preparation list (Table 1) and a list of contacts of personnel for easy referencing. These were attached to a pre-prepared trolley with contained the necessary equipment for obstetric care. This allowed expeditious transfer to the isolation ward or emergency department if a vaginal birth was anticipated.

Dedicated personnel should be on site to guide and remind the attending team of the correct steps in donning and doffing off the PPE and PAPR, where missteps and errors can be easily committed in the heat of the

moment, leading to potential breaches in infection containment. In addition, infographics (Figures 1 and 2) were put up on the walls in designated gowning and degowning stations for staff as guides to staff and reminders on the correct steps of the donning and doffing of PPE.

With such a rapidly changing situation, it is vital that the latest changes in protocols are rapidly and effectively disseminated to all staff. The best laid plans can easily go awry with poor communication. Staff were regularly updated via encrypted healthcare messaging applications (eg. TigerConnect) and emails.

Recommendation on caesarean section

The recently published guidelines from the RCOG on the management of COVID-19 in pregnancy discussed the mode of delivery. With no evidence to favour one mode of delivery over the other, the RCOG's view was to take into account the mother's preferences and obstetric indications present. (10)

Given the practical challenges identified in vaginal delivery in our institution, the authors have proposed consideration for elective caesarean section instead. This is also supported by Chen et al who reported a series of nine patients infected with COVID-19 who had caesarean sections in their third trimester. None of the neonates had evidence of vertically transmitted intrauterine infection.(6) This information is used when counselling mothers on mode of delivery. Mothers who still wish to have a vaginal delivery after counselling will have their wishes respected.

The high rate of fetal compromise reported during labour (6) increases the risk of requiring a category 1 caesarean section. There are difficulties in arranging a category 1 caesarean section from our hospital's isolation ward, being situated in a different block from the labour ward and the operating theatres. Timely delivery in the event of fetal distress during labour is difficult to achieve. Given the high rate of fetal compromise, we would monitor the fetuses with continuous electronic fetal monitoring.

Provisions have also been made in our protocols to allow perimortem caesarean section if clinically indicated. Infection containment principles will still apply in this event.

Although there have not been any reported cases of vertically transmitted intrauterine infection from the Chinese experience (6,25), the COVID-19 virus was found in a stool sample from a patient with diarrhoea. (21) The authors are concerned that viral shedding in stools may infect the neonate during vaginal birth.

However, in patients that present in imminent delivery, delivery by caesarean section may be difficult to achieve safely. In such situations, vaginal delivery should proceed with special precautions pertaining to infection containment.

Recommendations for Postpartum Management

The authors believe that there is a need to reduce the risk of transmission to the baby after delivery. Steps to reduce this risk of transmission may include avoiding delayed cord clamping, skin-to-skin contact and breastfeeding. In addition, in our protocol, the newborn will be transferred to a separate room or to the ante-chamber for neonatal management to reduce the risk of droplet transmission. However, the evidence to support these measures is lacking and it is important to discuss them with the mother.

Direct breastfeeding has been discouraged in preference to formula-feeding. Wang et al reported an advisory panel from the Department of Neonatology, National Clinical Research Center for Child Health and Disorders and Ministry of Education Key Laboratory of Child Development and Disorders in China, advising avoiding breastfeeding from mothers with probable or laboratory-confirmed 2019-nCoV infection until the recovery of confirmed mothers or rejection of probable infection.(26) Although breastmilk tested in six cases of mothers with COVID-19 were found to be negative for the virus (6), the close proximity of breastfeeding exposes the infant to respiratory droplets which risks transmission. In contrast, other organisations such as the RCOG, ACOG, CDC are far less draconian and permit breastfeeding with precautions such as good hand hygiene and wearing a facemask (10,14,15).

Another controversial area concerns the practice of separating mother and baby to prevent the risk of neonatal

transmission until the mother is fully recovered or is found to be negative for the COVID-19 virus. Again, evidence for this is limited. RCOG has cautioned against routine separation of mother and baby given the detrimental effects on feeding and bonding. (10) Efforts should be made to discuss these issues with the mother and her perinatal management individualised to her wishes.

The strengths of our paper include the meticulous and detailed nature of our protocols which encompasses the principles of detection, containment, intrapartum care and training. In addition, these protocols were developed after rigorous literature review and multidisciplinary discussion. While our centre has not yet managed a patient with suspected or diagnosed COVID-19, our multiple simulation runs have identified deficiencies in the protocols which we have addressed in this paper.

Conclusion

Operational readiness leverage on robust well-designed contingency protocols, so that they can be deployed without delay in real-life situations or crisis. Such protocols will serve to maintain high standards of obstetric care to our suspected or infected pregnant mothers while ensuring the safety of our front-line healthcare workers. Now that COVID-19 has been officially declared a pandemic, continuing revisions of the pathways and algorithms are necessary to ensure the appropriate counter-measures are developed and put in place to protect maternal and child wellbeing as well as the safety of the healthcare workers.

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Disclosure of Interests

The authors declare that there are no conflicts of interests.

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All authors have approved of the final manuscript and accept responsibility for the paper published

Ethics

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Table 1 - Sample of Preparation List.docx available at <https://authorea.com/users/304942/articles/435507-obstetrics-in-the-time-of-coronavirus-a-tertiary-maternity-centre-s-preparations-and-experience-during-the-covid-19-pandemic>

