

COMMITTEE OPINION

MANAGEMENT OF PREGNANCY AND BIRTH IN WOMEN WITH CORONAVIRUS DISEASE (COVID-19)

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This committee opinion was developed by the College of Obstetricians & Gynaecologists, Singapore, with inputs from the Academy of Medicine Singapore and Ministry of Health, Singapore.

INTRODUCTION

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus SARS-CoV-2 first identified in Wuhan City, China, in December 2019. This virus which causes illnesses ranging from the common cough to more severe infections in humans is spreading exponentially worldwide.

As much is still unknown, current opinions regarding management of COVID-19 positive women in pregnancy may change with the arrival of new knowledge. Hence these opinions stated here are not meant to be prescriptive but rather to guide decision-making processes of clinicians together with their patients. The care of patients has to be tailored individually but the basic principle is to safeguard the health of women and their babies, healthcare providers and healthcare facilities.

We recognise that each healthcare institution/facility has their own set-up and resources. As such, we recommend for each institution/facility to have their own local management protocol suited to their individual set-ups. In addition, we recommend for these protocols to be subjected to testing by simulation for purposes of evaluation and troubleshooting.

The focus of this document is on pregnant women with confirmed COVID-19 infection. However, since late March 2020, the local number of COVID-19 infections have been surging. With the increasing risk of COVID-19 transmission in the community, coupled with current evidence on pre-symptomatic or even asymptomatic transmission, with up to 18% of COVID-19 infections being possibly asymptomatic¹, some of the principles outlined in this document may also need to be applied to women who do not meet the case definitions. Healthcare professionals therefore need to adopt a high clinical suspicion for COVID-19 infection especially in women with symptoms or signs of acute respiratory infection¹⁻⁵, and adhere to infection prevention and control measures at all times, including that of PPE precautions.

NATURAL HISTORY AND SYMPTOMS

Most estimates of the incubation period for COVID-19 currently range from 1 to 14 days, and most commonly around 5 days. Majority of infections are asymptomatic or mild. 15% of infections are severe requiring supplemental oxygen and 5% are critical requiring mechanical ventilation. The typical signs and symptoms of COVID-19 include fever, dry cough, fatigue, sputum production, shortness of breath, sore throat, headache, myalgia or arthralgia, chills, nasal congestion and gastrointestinal symptoms such as nausea or vomiting and diarrhoea.⁶ Anosmia has also been described.

MODE OF TRANSMISSION

COVID-19 is primarily transmitted between people through respiratory droplets.^{2, 7-9} Droplet transmission can occur when a person is in close contact with someone who has respiratory symptoms such as sneezing or coughing, thereby being at risk of having his/her mucosae (mouth and nose) or

conjunctiva exposed to potentially infective droplets. In general, close contact involves being within approximately 2 metres of an infected person for a prolonged period of time. To allow for better triaging and risk stratification processes in light of the rapidly evolving COVID-19 situation, taking reference from Ministry of Health's latest case definition is advised. This can be found in the latest MOH circular disseminated to all registered medical practitioners.

Aside from respiratory droplets, transmission may also occur through fomites in the immediate environment around the infected person.¹⁰ This can happen through indirect contact with surfaces in the immediate environment or with objects used on the infected person. In addition, COVID-19 can also be transmitted if there is direct contact with other non-respiratory infectious secretions such as serum and blood.

Airborne spread has not been reported for COVID-19, although this mode of transmission is plausible in the case of aerosol-generating procedures conducted in health care facilities such as positive pressure ventilation (BiPAP and CPAP), endotracheal intubation, airway suction, nebuliser treatment, chest physiotherapy, sputum induction and bronchoscopy.

Faecal shedding has been demonstrated in some patients, and viable virus has been detected in a limited number of case reports. However, the faecal-oral route has not yet been shown to be a driver for COVID-19 transmission.

One major concern is whether the virus can be transmitted from the mother to the baby (vertical transmission). A study by Chen et al. looked at nine pregnant women diagnosed with COVID-19 in the third trimester.¹¹ In this study, there were no fetal deaths, neonatal deaths or neonatal asphyxia observed. In addition, amniotic fluid, cord blood and neonatal throat swab samples collected from six patients tested negative for COVID-19, suggesting no evidence of intrauterine infection through vertical infection in pregnancy. The virus was also not detected in the colostrum of COVID-19 patients in this study. However, the study did not collect samples from the birth canals, preventing the authors from making conclusions as to whether COVID-19 could be transmitted during vaginal delivery.

There have been two reported cases of neonates born to mothers with COVID-19 infection who have tested positive for COVID-19 themselves. However, for the first case in China, the neonatal throat swab sample was only collected approximately 30 hours after birth, thereby providing insufficient evidence for intrauterine infection.^{12,13} In the more recently reported case in London, the neonate was tested positive for the SARS-CoV-2 virus minutes after being born.¹⁴ However, there was also insufficient evidence to point to exactly when the newborn acquired the infection. Hence, it is currently not possible to make definitive conclusions on the basis of two cases to support the theory of intrauterine infection.

EFFECT ON THE PREGNANT MOTHER

Data regarding the effects of COVID-19 on the pregnant mother are currently limited. In general, pregnant women are more susceptible to respiratory pathogens and severe pneumonia. The immunosuppressive state of pregnancy, the physiological adaptive changes during pregnancy such as increased oxygen consumption, diaphragmatic elevation and edema of the respiratory tract mucosa contribute to a reduced tolerance to hypoxia.

In the case of the pandemic H1N1 2009 influenza virus infection, pregnant women were four times more likely to be admitted to hospital than the general population.¹⁵ However, the WHO-China Joint Mission on COVID-19 Final report published in February 2020 noted that as opposed to Influenza A (H1N1), pregnant women did not appear to be at a higher risk of severe disease compared to the general population.⁶ In an investigation of 147 pregnant women (64 confirmed, 82 suspected and 1 asymptomatic), 8% had severe disease and 1% were critical.⁶ Another systematic review of 108 pregnancies demonstrated found that 3% of pregnant mothers required maternal ICU admission for COVID-19 infection (3/108 cases).¹⁶ However, 2 of the above 3 cases were in women with existing comorbidities, with the first having poorly controlled diabetes mellitus coupled with obesity, and the second having chronic hypertension, diabetes mellitus and morbid obesity. This data is consistent with various papers in the non-pregnant population demonstrating the association between worse COVID-19 related clinical outcomes with that of an increasing number of comorbidities.^{17, 18} Majority of women in this study were discharged well without any major complications.

More data is needed before definitive conclusions can be made about the impact of COVID-19 on the course of disease in pregnant women.

EFFECT ON THE FETUS AND PERINATAL OUTCOMES

A recent systematic review looking at maternal and perinatal outcomes with COVID-19 found that most studies did not report any adverse events relating to perinatal outcomes.¹⁶ However, the review pointed to a study by Zhu et al.¹⁹ which reported one neonatal death and a total of six admissions to the neonatal intensive care unit. In this particular cohort, 6 out of 10 neonates were born prematurely, a factor which may have contributed to the morbidity described. With respect to the reported neonatal death, this involved a male newborn born at 34 weeks and 5 days of gestational age who subsequently developed refractory shock, gastric bleeding with multiple organ failure and disseminated intravascular coagulation. The neonate tested negative for the SARS-CoV-2 virus nine days after delivery, and the death was postulated to have been contributed by poor immune function of the neonate and massive viremia. In addition to these morbidities, intrauterine fetal distress also developed in 6 of the 10 cases reported, postulated to be related to maternal hypoxemia as a result of COVID-19 infection.

There are currently no existing scientific publications on the effect of COVID-19 infection on the fetus if the infection was acquired in the first and second trimester of pregnancy. However, data from the SARS epidemic are reassuring, which suggest no increased risk of fetal loss or congenital anomalies associated with infection early in pregnancy.²⁰ With specific reference to COVID-19, more data is required before definitive conclusions can be made on the risk of miscarriage or congenital anomalies with COVID-19 infection in the first and second trimester.

EFFECT ON PREGNANCY OUTCOMES

A recently published meta-analysis looked at the outcome of Coronavirus spectrum infections during pregnancy, 41 of which were COVID-19 infections.²¹ The study found that preterm birth before 37 weeks of gestation was the most common adverse pregnancy outcome for mothers with COVID-19, occurring in 41.1% of pregnancies. However, the study did not differentiate between that of spontaneous and iatrogenic preterm birth, hence it is not possible to attribute the high rates of

preterm birth to the effects of the COVID-19 infection itself. The study also found that miscarriage, pre-eclampsia, caesarean sections and perinatal death (7-11%) were more common in mothers with COVID-19 compared to the general population. However, it is important to note that the majority of cases included in this meta-analysis were complicated by pneumonia (91.8%), indicating a more severe spectrum of disease. Hence, the incidence of adverse pregnancy outcomes presented in the paper may not necessarily represent that of pregnant women with milder spectrums of COVID-19 infection.

DIAGNOSIS OF COVID-19 IN PREGNANCY

Diagnosis of COVID-19 in pregnancy would follow the general population i.e. by polymerase chain reaction (PCR) testing for the SARS-CoV-2 virus via a nasopharyngeal or oropharyngeal swab.

IMAGING IN PREGNANCY

If chest X-ray (CXR) or computerized tomography (CT) imaging are required as part of diagnosis or surveillance, the usual advice regarding the risks and benefits of diagnostic radiation in pregnancy should be given to the patient. For a CXR, patients should be reassured that the amount of radiation exposure is negligible (0.0005 - 0.01 mGy)²² and would not put the fetus at risk of miscarriage, congenital abnormalities or development of childhood malignancies. As for a CT chest, the radiation exposure is higher at approximately 0.01 - 0.66 mGy²², but still significantly below the threshold for radiation-induced teratogenesis. With the average annual background radiation amounting to 1.1 - 2.5 mGy, both CXR and CT chest modalities are safe from the fetal aspect in pregnancy if required for clinical management. In addition, the radiation exposure can be further mitigated with the use of an abdominal shield in pregnancy.

GENERAL INFECTION CONTROL MEASURES IN THE MANAGEMENT OF COVID-19 POSITIVE PATIENTS

All staff should be donned in full PPE before entering the room. Full PPE is defined as: N95 mask or powered air purifying respirator (PAPR), yellow gown, gloves and eye protection. Staff performing aerosol-generating procedures (e.g. collection of nasopharyngeal swabs, suctioning etc.) must wear full PPE.

Specimens from COVID-19 positive patients should be double-bagged and hand delivered via the porter to the relevant laboratories, with appropriate labelling as per local guidelines in order for the samples to be processed under strict biosafety requirements. Pneumatic tubes should not be used to dispatch specimens.

A surgical mask should be provided for the patient.

As the donning and doffing of PPE is a complex task especially if the use of a powered air purifying respirator (PAPR) is involved, it is critically important that healthcare staff undergo mask fitting and adequate training in these procedures. In addition, these procedures should ideally be directly observed and guided by a trained observer using checklists.

Safe doffing of PPE is critical. Used PPE is potentially contaminated with the SARS-CoV-2 virus.

MANAGEMENT OF COVID-19 POSITIVE PATIENTS IN THE ANTENATAL PERIOD

(a) Management of the mother

Multidisciplinary care

During acute illness with COVID-19 infection, management of the pregnant woman in terms of the infection should be similar to that of the general population. A multi-disciplinary approach involving a consultant infectious disease physician, consultant obstetrician, consultant anaesthetist and midwife/nurse-in-charge should ensue.

If elective delivery is indicated for the purposes of maternal resuscitation or if there are concerns about the fetal condition, the above multidisciplinary team should consider various factors such as the maternal condition, fetal condition, potential for improvement following elective delivery and the gestation of the pregnancy. The mother's condition should always be of the topmost priority.

Disposition

Disposition of the patient (isolation room in a general ward or negative pressure ward, isolation room in the delivery suite, intensive care unit) would depend on the severity of illness and need for invasive ventilation and support and the availability of facilities.

Reducing the number of non-critical appointments

If the woman is on Stay-Home Notice (SHN) or under quarantine, postpone non-critical appointments till the period of SHN or quarantine has passed. If necessary, teleconsultation can be considered as an alternative to face-to-face visits in these women, for example, in cases where medical management such as blood pressure management or titration of diabetic medications may be required.

Oxygen supplementation

Most pregnant women require an SpO₂ of 95% and above to maintain adequate fetal oxygenation.²³ Supplemental oxygen should be administered to prevent hypoxemia and reduce the work of breathing in pregnancy. This can be given via high-flow or non-rebreather masks, according to the patient's clinical condition and oxygen requirements. Non-invasive positive pressure ventilation (bilevel positive airway pressure [BiPAP]/ continuous positive airway pressure [CPAP]) is best avoided if possible in view of its aerosol-generating nature.

Maternal positioning

In general, pregnant women have improved uteroplacental oxygenation when lying in a lateral-decubitus position, regardless of the mother's respiratory status. This should be undertaken especially in mothers requiring supplemental oxygen or on mechanical ventilation.

Maternal investigations

As mentioned above, diagnosis of COVID-19 infection in pregnancy would follow that of the non-pregnant population, with polymerase chain reaction (PCR) testing for the SARS-CoV-2 virus via a nasal swab. Baseline investigations that should be performed include full blood count, renal panel, liver panel, coagulation profile (prothrombin time, activated partial thromboplastin time) and infective and

inflammatory markers such as C-reactive protein (CRP), procalcitonin and lactate dehydrogenase (LDH) levels for trending and prognostication. Of note, deranged coagulation function can be associated with COVID-19 infection in the non-pregnant population²⁴⁻²⁶, with reported median platelet counts (10^3 per mm^3) ranging from 168-213.5, with 12 to 36% having a platelet count of less than 150, median activated partial thromboplastin time ranging from 27 to 33 seconds (6-27% with increased time), and prothrombin time 11 to 12 seconds (5-11% with increased time).

(b) Management of the fetus

Fetal monitoring

During acute illness, fetal monitoring should be similar to that provided to any critically ill pregnant woman. The frequency and suitability of cardiotocography (CTG) should be decided on a case-by-case basis, taking into consideration the gestational age of the fetus and the maternal condition.

Ultrasound surveillance

Given that very little is currently known about the effects of the infection on the fetus, if first trimester maternal infection occurs, a detailed high-risk fetal anomaly scan at 20 weeks should be performed. Also, regular growth scans at 3 to 4 weekly intervals from 24 weeks can be considered for monitoring of fetal growth in cases of COVID-19 infection in pregnancy.

(c) Antenatal corticosteroids

If preterm delivery is indicated before 34 weeks of completed gestation, either for maternal or fetal conditions, intramuscular corticosteroids (dexamethasone/betamethasone) for fetal lung maturation should be considered on a case-by-case basis after discussion with an Infectious Diseases consultant physician and a consultant anaesthetist. There is currently no evidence to suggest that corticosteroids for fetal lung maturation cause any harm in the context of COVID-19 infection.

MANAGEMENT OF COVID-19 POSITIVE WOMEN IN THE INTRAPARTUM PERIOD

As above, during acute illness with COVID-19 infection, management of the infection in the pregnant woman should be similar to that of the general population. A multi-disciplinary approach involving a consultant infectious disease physician, consultant obstetrician, consultant anaesthetist, neonatologist and midwife/nurse-in-charge should ensue. However, additional precautions and measures will need to be undertaken in the period surrounding labour and delivery as discussed below.

(a) Location

COVID-19 positive women in labour who do not require extensive ventilator or ICU support can be managed in a single-person room with a closed door and dedicated bathroom. If aerosol-generating procedures are anticipated in a particular patient, the patient should then be housed in a negative pressure room.²⁷ However, even in the absence of aerosol-generating procedures, if facilities and resources permit, nursing in a negative pressure room can reduce cross-contamination from room to room and would be ideal. Regardless of location, each institution's protocol should aim to identify a safe and secure route for transfer of patients from the site of labour to the operating theatre, in the

event of need for an emergency caesarean section. These protocols involving transfer of patients should ideally undergo simulation for the purposes of evaluation and troubleshooting.

(b) Maternal monitoring and investigations

Continuous SpO₂ and maternal heart rate monitoring is recommended throughout labour. SpO₂ should be kept $\geq 95\%$. 4 hourly temperature and blood pressure monitoring in stable women as per usual obstetric recommendations should be performed.

As mentioned in the section above, baseline investigations that should be performed in a pregnant COVID-19 positive woman include that of full blood count, renal panel, liver panel, coagulation profile (prothrombin time, activated partial thromboplastin time) and infective and inflammatory markers such as C-reactive protein (CRP), procalcitonin and lactate dehydrogenase (LDH) levels for trending and prognostication. The deranged coagulation function that can be observed in COVID-19 infection as discussed above is of even more relevance and importance in the intrapartum period. This is especially so in the context of neuraxial anaesthesia used in labour such as epidural anaesthesia or spinal anaesthesia, which may be contraindicated in the presence of coagulopathy or significant thrombocytopenia. Also, additional measures may be required to be undertaken as part of postpartum haemorrhage prophylaxis in patients with coagulopathy.

(c) Lateral positioning

As mentioned in the section above, pregnant women have improved uteroplacental oxygenation when lying in a lateral-decubitus position, regardless of the mother's respiratory status. This can be undertaken in the intrapartum period as well to improve fetal oxygenation.

(d) Fetal monitoring

Continuous CTG monitoring in the intrapartum period is recommended.

(e) Analgesia

Entonox

The opinion surrounding the use of Entonox as potentially an aerosol-generating procedure is mixed. The Royal College of Obstetricians and Gynaecologists state the lack of evidence of it being an aerosol-generating procedure, and hence do not recommend against its use in COVID-19 positive women in labour, as long as it is used with a single-patient microbiological filter.²⁸ However, the Australian Society of Anaesthetists recognises Entonox and other inhalational sedation as potential aerosol-generating procedures.²⁹ The decision of whether Entonox should be allowed as an analgesic option during labour requires balancing out potential risk of aerosolisation with Entonox, the availability of other anaesthetic options as discussed below, the availability of a single-patient microbiological filter and that of a negative pressure labour ward room. This discussion should be undertaken with each hospital's infection control team and facilities management. In the event of Entonox use, healthcare professionals undertaking the care of the woman should don full PPE given its potentially aerosol-generating effect.

Pethidine

The use of Pethidine as a pain relief option in COVID-19 positive patients is not contraindicated. However, a potential side effect of pethidine is that of significant respiratory depression seen as an increase in fractional inspiratory-expiratory oxygen difference and PETCO₂ and as a decrease in minute ventilation and respiratory rate.³⁰ This should therefore be used with caution in COVID-19 patients who may already have existing respiratory compromise on a background of pneumonia infection.

Epidural/spinal anaesthesia

There is no evidence that epidural or spinal anaesthesia is contraindicated in the presence of COVID-19 infection. These should be recommended early on in labour for women with COVID-19 infection, as it may minimise the need for general anaesthesia, which involves aerosol-generating procedures, if urgent delivery is required. However, as discussed above, the association of coagulopathy with COVID-19 infection may preclude safe use of epidural or spinal anaesthesia in certain patients. Decisions regarding suitability of epidural or spinal anaesthesia in these cases should thus be undertaken on a case-by-case basis by a consultant anaesthetist.

General anaesthesia

General anaesthesia is associated with aerosol-generating procedures such as endotracheal intubation and suctioning. Healthcare staff involved in the care of women undergoing general anaesthesia should be fully equipped with the appropriate PPE/PAPR for protection against transmission. It is prudent to minimize the number of medical staff in the operating theatre at time of intubation.

(f) Mode of delivery

There is currently no evidence of maternal to neonatal transmission through vaginal secretions or faeces during vaginal delivery. As such, there is currently no evidence to favour one mode of birth (vaginal delivery versus caesarean section) over another in terms of prevention of neonatal infection. Mode of delivery should be discussed on a case-by-case basis with the woman, taking into her preferences and other obstetric indications. However, for women choosing a trial of normal vaginal delivery, they need to be informed of:

1. The lack of data and uncertainty surrounding the risk of perinatal transmission during vaginal deliveries.
2. The unpredictability of labour and risk of fetal distress necessitating Category 1 caesarean section which may experience a longer than usual decision to delivery interval because of the need for healthcare staff to don full PPE.
3. Potential logistical issues which may arise and vary from institution to institution such as issues surrounding transfer of patients from location of labour to the operating theatre (distance, time required, operational difficulties, clearance of lifts etc.) and availability of a negative pressure operating theatre.

These aspects should be discussed appropriately with the patient to allow for proper decision making and informed consent. A low threshold for caesarean section can be adopted in view of these considerations.

In some situations of significant maternal respiratory compromise where urgent delivery may be required for maternal indications, caesarean section may allow for a more expeditious delivery for maternal benefit.

Instrumental deliveries (vacuum-assisted delivery, forceps delivery) are not contraindicated if required for obstetric indications.

If caesarean section is required, this should ideally be performed in a negative pressure operating room. All surgical personnel (including surgeons, anaesthesiologists, nurses, neonatal team) should don full appropriate PPE before entering the operating room. Only essential personnel should be present in the operating theatre to minimise unnecessary exposure. If a negative pressure operating room is unavailable, thorough and adequate decontamination should be performed according to hospital guidelines.

Water births are not recommended as healthcare staff are unable to use appropriate protective equipment in this setting.

(g) Delayed cord clamping

There is currently still no conclusive evidence regarding the risks of neonatal transmission via vaginal secretions. In addition, as part of the aim to minimise the contact time between the neonate and the COVID-19 positive mother, we recommend against delayed cord clamping so that the baby can be quickly cleaned, dried and isolated from the mother as soon as possible. If the mother is very keen to proceed with delayed cord clamping, this decision can be undertaken ideally after the patient has had an opportunity to discuss this with the obstetrician, neonatologist and ID physician.

(h) Neonatal standby

Neonatal team standby at the time of delivery to receive the baby should be undertaken so as to prepare for potential need for neonatal resuscitation. This is especially so as maternal hypoxemia as a result of maternal COVID-19 infection or pneumonia may be associated with a higher risk of fetal distress.

(i) Clinical samples to consider for collection at the time of delivery (to be taken in full PPE)

1. Umbilical cord blood for PCR – to look for fetal infection.
2. Placenta swab (fetal surface swab) for PCR - to determine intrauterine exposure to the virus.
3. Full thickness biopsy of the placenta for histology (fetal and maternal surfaces – put stitch in maternal surface) – to evaluate for morphological and histological changes in placentas of COVID-19 positive pregnancies which may be associated with adverse pregnancy outcomes.

All specimens from COVID-19 positive patients should be double-bagged and hand delivered via the porter to the relevant laboratories, with appropriate labelling as per local guidelines in order for the samples to be processed under strict biosafety requirements. Pneumatic tubes should not be used to dispatch specimens.

(j) Disposal of placenta

Claiming of the placenta of COVID-19 positive mothers should not be allowed as the placenta is considered a biohazard in these cases. The placenta should be placed in 3 biohazard bags prior to disposal. If Caesarean delivery is performed, placenta is to be similarly placed in 3 biohazard bags and disposed of in the Operating Theatre.

(k) Disposition of neonate

Neonates born to mothers with COVID-19 infection should be sent to their appropriate location of disposition as soon as possible after delivery for monitoring and isolation.

(l) Recommended postnatal neonatal samples

These should be collected as soon as possible by the neonatal team after transfer of baby to their allocated disposition according to local guidelines. Some neonatal samples to consider taking include:

1. Neonatal airway nasopharyngeal swab for PCR
2. Neonatal blood, urine, stool for PCR
3. Neonatal surface swab for PCR

MANAGEMENT OF COVID-19 POSITIVE WOMEN IN THE POSTPARTUM PERIOD

(a) Medical management

During acute illness with COVID-19 infection, management of COVID-19 in the postpartum woman should be similar to that of the general population. Discharge criteria should be met as per local Infectious Diseases guidelines under the direction of an Infectious Disease Consultant.

(b) Breast-feeding

As mentioned above, as the virus has not been detected in the colostrum of COVID-19 positive mothers, there is currently no evidence to suggest a risk of transmission through breast-feeding. However, as breast-feeding requires close contact of the mother with the neonate, direct breast-feeding is of concern if the mother is still COVID-19 positive. Expression of breast milk via breast pumps and using the expressed breast milk to bottle feed the neonates while the mother is still COVID-19 positive may risk spread through fomites or surfaces. Mothers who are keen to continue breast-feeding after their own recovery should be advised to express their breastmilk for the purposes of maintenance of milk production. Once these mothers test negative for COVID-19, they can then be allowed to breastfeed their infant.

Should parents be keen to proceed with breast-feeding, this should be a decision made after discussion with the parents, obstetricians, neonatologists and ID physicians. In this scenario, one suggestion is for expressed breast milk to be given by a care-giver with careful attention to decontamination of the bottle if the baby is isolated. As for direct breastfeeding, mothers should wear a mask and practice the recommended hand hygiene measures to minimise spread to the baby.

(c) Thromboprophylaxis

A formal venous thromboprophylaxis risk assessment is recommended for all postpartum women. Thromboprophylaxis can be administered according to usual local obstetric guidelines in the absence of contraindications such as existing coagulopathy. If there are any doubts regarding suitability of thromboprophylaxis in an ill patient, discussion with a consultant Infectious Diseases physician, a consultant anaesthetist/intensivist and a consultant haematologist should ensue.

REFERENCES

1. Mizumoto K, Kagaya K, Zarebski A, et al. Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. *Euro Surveill.* 2020. DOI:10.2807/1560-7917.
2. Hoehl S, Rabenau H, Berger A, et al. Evidence of SARS-CoV-2 infection in returning travelers from Wuhan, China. *N Engl J Med.* 2020. DOI:10.1056/NEJMc2001899.
3. He X, Lau E, Wu PW, et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. *MedRxiv.* 2020. DOI:10.1101/2020.03.15.20036707.
4. Chen S, Liao E, Shao Y. Clinical analysis of pregnant women with 2019 novel coronavirus pneumonia. *J Med Virol.* 2020. DOI: 10.1002/jmv.25789.
5. Wei WE, Li Z, Chiew CJ, et al. Presymptomatic transmission of SARS-CoV-2 . Singapore, January 23 – March 16, 2020. *MMWR Morb Mortal Wkly Rep.* 2020; 69(14): 411-415.
6. WHO-China Joint Mission. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). 16-24 Feb 2020. <https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf> (accessed March 22, 2020).
7. Wang W, Xu Y, Gao R, et al. Detection of SARS-CoV-2 in different types of clinical specimens. *JAMA.* 2020. DOI:10.1001/jama.2020.3786.
8. Pan Y, Zhang D, Poon L, et al. Viral load of SARS-CoV-2 in clinical samples. *Lancet Infect Dis.* 2020. DOI: 10.106/S1473-3099(20)30113-4.
9. Wölfel R, Corman VC, Guggemos W, et al. Virological assessment of hospitalized patients with COVID-2019. *Nature.* 2020. DOI: 10.1038/s41586-020-2196-x.
10. Ong SW, Tan YK, Chia PY, Lee TH, Ng OT, Wong MS, et al. Air, surface environmental, and personal protective equipment contamination by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from a symptomatic patient. *JAMA.* 2020 Mar 4.
11. Chen H et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. *Lancet* 2020. [https://doi.org/10.1016/S0140-6736\(20\)30360-3](https://doi.org/10.1016/S0140-6736(20)30360-3).
12. Niu Y, Yue H. Wuhan Tongji Hospital diagnoses first case of neonatal infection with new coronavirus. Feb 5, 2020. <http://society.people.com.cn/n1/2020/0205/c1008-31572959.html> (accessed Feb 7, 2020; in Chinese).
13. Zhang Z, Wang C, Gao CC. Neonatal coronavirus expert confirmed at 30 hours of birth: vertical transmission from mother to infant. Feb 5, 2020. http://www.cnr.cn/hubei/yuanchuang/20200205/t20200205_524961963.shtml (accessed Feb 10, 2020; in Chinese).
14. The Guardian. Newborn baby tests positive for coronavirus in London. March 14, 2020. <https://www.theguardian.com/world/2020/mar/14/newborn-baby-tests-positive-for-coronavirus-in-london> (accessed March 22, 2020)

15. Jamieson DJ et al. H1N1 2009 influenza virus infection during pregnancy in the USA. *Lancet* 2009;374:451-458.
16. Zaigham M, Andersson O. Maternal and perinatal outcomes with COVID-19: a systematic review of 108 pregnancies. *Acta Obstet Gynecol Scand*. 2020. DOI: 10.1111/aogs.13867.
17. Guan WJ et al. Comorbidity and its impact on 1590 patients with Covid-19 in China: A Nationwide Analysis. *European Respiratory Data Journal* Jan 2020, 2000547; DOI: 10.1183/13993003.00547-2020] [Li B, Yang J, Zhao F, et al. Prevalence and impact of cardiovascular metabolic diseases on COVID-19 in China. *Clin Res Cardiol*. 2020; doi: 10.1007/s00392-020-01626-9.
18. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China. Summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. *JAMA*. 2020. DOI: 10.1001/jama.20202648.
19. Zhu H, Wang L, Fang C, et al. Clinical analysis of 10 neonates born to mothers with 2019- nCoV pneumonia. *Transl Pediatr*. 2020;9:51-60.
20. Shek CC, Ng PC, Fung GP, Cheng FW, Chan PK, Peiris MJ, et al. Infants born to mothers with severe acute respiratory syndrome. *Pediatrics* 2003 Oct;112(4):e254.
21. Daniele Di Mascio et al. Outcome of Coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. *American Journal of Obstetrics and Gynaecology*. March 2020. (Preprint)
22. Guidelines for diagnostic imaging during pregnancy and lactation. Committee Opinion No. 723. American College of Obstetricians and Gynecologists. *Obstet Gynecol* 2017;130:e210–6.
23. Schultz MJ, Dunser MW, Dondorp AM, et al. Current challenges in the management of sepsis in ICUs in resource-poor settings and suggestions for the future. *Intensive Care Med*. 2017;43:612-624.
24. Guan W, Yu N, Liang W, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Eng J Med*. 2020. DOI: 10.1056/NEJMoa2002032.
25. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet*. 2020; 395: 507-513.
26. Yang W, Cao Q, Qin L, et al. Clinical characteristics and imaging manifestations of the 2019 novel coronavirus disease (COVID-19): A multi-center study in Wenzhou city, Zhejiang, China. *J Infect*. 2020; 80(4): 388-393.
27. Centers for Disease Control and Prevention. Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings. Feb 2020. https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html#Patient_Placement (accessed March 22, 2020).
28. Royal College of Obstetricians and Gynaecologists. Coronavirus (COVID-19) Infection in Pregnancy – Information for Healthcare Professionals. Version 4. March 21, 2020.

<https://www.rcog.org.uk/globalassets/documents/guidelines/2020-03-21-covid19-pregnancy-guidance-2118.pdf> (accessed March 22, 2020).

29. Australian Society of Anaesthetists. Anaesthesia and caring for patients during the COVID-19 outbreak. https://www.asa.org.au/wordpress/wp-content/uploads/News/eNews/covid-19/ASA_airway_management.pdf (accessed March 22, 2020)
30. Tarkkila P et al. Comparison of respiratory effects of tramadol and pethidine. Eur J Anaesthesiol. 1998 Jan;15(1):64-8.

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