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Guidance for the clinical management of infants born to mothers with suspected/confirmed COVID-19 in Singapore

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ABSTRACT

In this paper, we provide guidance to clinicians who care for infants born to mothers with suspected/confirmed COVID-19 during this current pandemic. We reviewed available literature and international guidelines based on the following themes: delivery room management; infection control and prevention strategies; neonatal severe acute respiratory syndrome coronavirus 2 testing; breastfeeding and breastmilk feeding; rooming-in of mother-infant; respiratory support precautions; visiting procedures; de-isolation and discharge of infant; outpatient clinic attendance; transport of infant; and training of healthcare staff. This guidance for clinical care was proposed and contextualised for the local setting via consensus by members of this workgroup and was based on evidence available as of 31 July 2020, and may change as new evidence emerges.

Keywords: COVID-19, neonate, perinatal care, practice guidelines, transmission

INTRODUCTION

On 11 March 2020, the World Health Organisation (WHO) declared COVID-19, an infection caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a global pandemic.⁽¹⁾ As of early August 2020, more than 17 million persons, including children and infants, have been infected worldwide.⁽²⁾ While postnatal infections have been well described,⁽³⁻⁸⁾ there are increasing reports to suggest that in-utero and intrapartum infection can occur.⁽⁹⁻¹³⁾ A recent meta-analysis reported an incidence of vertical transmission of 16 per 1,000 newborns (95% confidence interval 3–73).⁽¹⁴⁾ There are limited reports of SARS-CoV-2 virus detected in the amniotic fluid, placenta and breastmilk.^(5,11-13,15-18) In Singapore, the pregnancy outcomes of 16 women with COVID-19 was recently described, with no neonatal infections detected and no evidence of SARS-CoV-2 in the placenta or breastmilk specimens tested.⁽¹⁹⁾

Management strategies during delivery and the postpartum period may affect the SARS-CoV-2 transmission risk to newborns from infected mothers.⁽²⁰⁻²²⁾ Most infants with COVID-19 have been asymptomatic or have mild illness, although severe presentations have been recently reported.^(3,13) The long-term implications of this infection in the infant is currently unknown. With the limited evidence and rapidly evolving COVID-19 pandemic, this guideline aims to provide guidance to clinicians who are involved in the care of newborns born to mothers with confirmed or suspected COVID-19 in Singapore.

DEVELOPMENT OF CLINICAL GUIDELINE

This consensus guideline was prepared by neonatal care practitioners from three public hospitals and a private hospital to guide the clinical management of infants born to mothers with suspected/confirmed COVID-19 in Singapore. As all maternity hospitals in Singapore can potentially be expected to manage pregnant women (and their infants) with suspected COVID-

19, these guidelines have been developed, accounting for variations in infrastructure and resources available in the local setting.

Several workgroups were formed to review the available literature and published international guidelines based on the following themes: delivery room management; infection control and prevention strategies; neonatal SARS-CoV-2 testing; breastfeeding and breastmilk feeding; rooming-in of mother-infant; respiratory support precautions; visiting procedures, discharge of infant; and other considerations, including outpatient clinic attendance, transport of infant and training of healthcare staff. Guidance for the various themes was proposed by the individual workgroups, and all members had reached consensus for inclusion into this guideline. This clinical management guideline is based on evidence and other guidelines available as of 31 July 2020, and may change as new evidence emerges.

SECTION 1: DELIVERY ROOM MANAGEMENT OF INFANTS BORN TO MOTHERS WITH SUSPECTED OR CONFIRMED COVID-19 (FIG. 1)

1.1 Anticipation and pre-briefing

Structured, open communication between the obstetrics and neonatology team is important in the preparation for the delivery of a pregnant woman with suspected or confirmed COVID-19. Where possible, it is important for the neonatology team to discuss the expected resuscitation, postnatal care and disposition of the newborn infant with the obstetrics and infection control teams.⁽²³⁾ In addition, expectant parents should be briefed about resuscitation procedures, isolation policies, breastfeeding options and disposition in an anticipatory manner. This should be conducted as soon as possible after admission of the COVID-19 affected pregnant woman if she is clinically stable. The designated neonatal resuscitation team should conduct a pre-briefing before delivery to identify the risk factors, assign individual roles during resuscitation

and prepare equipment and personal protective equipment (PPE). A checklist can be used to familiarise the team with the workflow.

Summary of recommendation

Resuscitation of newborn infants born to mothers with COVID-19 require special considerations and workflows that are targeted toward the wellbeing of the newborn and healthcare workers. Pre-delivery discussions between the expectant parents and the obstetrician and neonatologist are necessary to manage expectations and facilitate appropriate steps of management.

1.2 Site of delivery

Designation and planning of facilities for delivery is necessary to minimise the risk of viral transmission to the newborn and healthcare teams. Pregnant women with suspected or confirmed COVID-19 who are in labour should be cared for in a pre-specified delivery room or operating theatre. If available, a negative pressure room should be designated, especially for high-risk cases where the pregnant woman is symptomatic. In the absence of a negative pressure room, increasing the air exchanges within the room could mitigate the risk of viral transmission.⁽²⁴⁾ Where facilities permit, the newborn should be moved to an adjacent room after delivery for initial assessment and any resuscitation, if required. If this arrangement is not possible, the resuscitation table should be located at least 2 metres away from the mother.⁽²⁵⁾

Summary of recommendation

A dedicated delivery room or operating theatre with isolation capabilities should be identified for the site of delivery for COVID-19 affected pregnant women. Neonatal evaluation or

resuscitation post-delivery should be conducted in an adjacent room or at a distance of at least 2 metres from the mother.

1.3 Post-delivery procedures

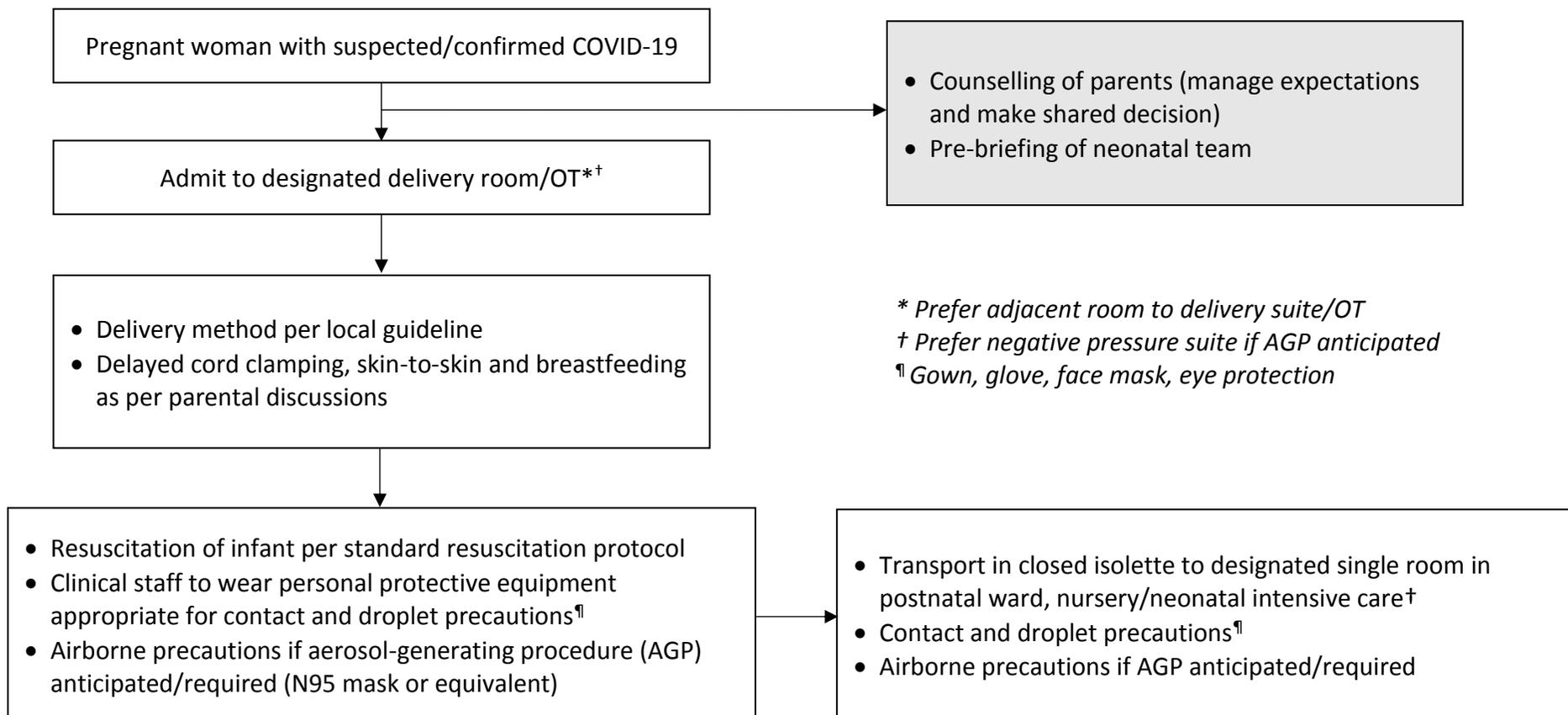
There is limited published evidence on the risk of COVID-19 transmission related to the routine practices of delayed cord clamping, skin-to-skin contact between infected mothers and their newborns, and maternal-infant rooming-in after birth.⁽²⁶⁾ If the pregnant woman's clinical condition is stable upon admission, a shared decision can be reached with the prospective parents after a discussion about the limited evidence on transmission risks related to delayed cord clamping, skin-to-skin contact, rooming-in (see section 4.2) and breastfeeding (see section 4.3).⁽²⁷⁾ As long as the potential risks are acknowledged by the parents, these practices can be allowed with strict adherence to infection control practices and PPE as described.

Internal transport of the newborn should occur in closed incubators (if available). Changing of PPE by the neonatal team prior to transport can be done according to institutional recommendations. All equipment used in the management and/or transfer of the newborn should be thoroughly cleaned and disinfected, and disposable equipment discarded appropriately (see section 3). Specific precautions are outlined for inter-hospital transfer of infants born to mothers with COVID-19 or infants who are suspected to have COVID-19 (see Section 5.2).

Summary of recommendation

A shared decision should be reached with the prospective parents about allowing delayed cord clamping, skin-to-skin contact, rooming-in and breastfeeding, preferably upon admission. Transport of the newborn should occur in a closed incubator, if available, with appropriate disinfection or disposal of equipment after transfer.

Fig. 1 Chart shows delivery room/operating theatre (OT) management of infants born to mothers with suspected/confirmed COVID-19.



SECTION 2: PERSONAL PROTECTIVE EQUIPMENT

Use of PPE to prevent transmission of SARS-CoV-2 to healthcare workers are based on consideration of the possible modes of virus spread: droplets, aerosol, body fluids and fomites.⁽²⁸⁾ For personal protection, we recommend the use (at a minimum) of surgical face mask, water-resistant gown, gloves and goggles/face shield for healthcare personnel caring for infants who are suspected of or confirmed with COVID-19. In addition, due to the potential for viral aerosolisation with aerosol-generating procedures (AGP, such as open suctioning, cardiopulmonary resuscitation, endotracheal intubation and extubation, non-invasive ventilation, manual ventilation), neonatal personnel performing such procedures should use N95 mask (or equivalent) or powered air purifying respirator (PAPR), if available, ensuring sufficient donning time.

Summary of recommendation

PPE guidelines are targeted at preventing SARS-CoV-2 transmission through contact, droplet and aerosol exposure. During AGP, the use of N95 (or PAPR) can limit aerosol transmission of the virus. We recommend utmost care and vigilance while donning and doffing PPE.

SECTION 3: INFECTION PREVENTION & CONTROL

Extensive contamination of the environment surrounding SARS-CoV-2 infected patients, including infants, have been reported.^(29,30) Studies have also shown the presence of viral RNA in the air, highlighting the possibility of airborne transmission in selected situations.^(31,32) Importantly, viral transmission has been documented from individuals before their onset of symptoms and from persons with asymptomatic infections.^(33,34) The contribution of viral transmission from infected paediatric and neonatal patients is currently unclear and thought to be limited.⁽³⁵⁾

The following infection prevention and control practices should be considered:

1. **Location:** Newborns from mothers with COVID-19 should be cared for in single rooms, if available. Negative pressure room should be considered for newborns who require respiratory support (continuous positive airway pressure/mechanical ventilation). If a negative pressure room is not available, the air exchanges per hour of the room may be adjusted accordingly.⁽²⁴⁾
2. **Skin cleansing:** There are emerging reports of the presence of SARS-CoV-2 in amniotic fluid.^(11,13,16,36) We recommend bathing or cleaning the baby as soon as reasonably possible, to mitigate the risk of viral transmission, after ensuring thermal and physiological stability. Healthcare staff cleaning the baby should wear appropriate PPE.
3. **Environmental cleaning and disinfection:** The length of time that SARS-CoV-2 survives on inanimate surfaces can vary depending on factors such as the amount of contaminated body fluid present and the environmental temperature and humidity.⁽³⁷⁾ Recent evidence showed significant viral contamination surrounding the infected patient, with greater contamination in the intensive care unit as compared to the general ward.⁽²⁹⁻³¹⁾ The virus is widely distributed on floors, computer mice, trash cans and handrails.⁽³¹⁾ The following should be considered with regard to environmental cleaning and disinfection:
 - Clean the transfer routes from delivery suite or operating theatre to the infant's room with virucidal solution.
 - Use disposable or dedicated medical equipment while minimising unnecessary contamination of other equipment. All non-dedicated, non-disposable medical equipment that is used for patient care should receive terminal cleaning and be disinfected.
 - Wipe down exposed surfaces, isolettes and non-disposable items with appropriate disinfectant wipes.

- Dispose of PPE in compliance with institutional procedures.

SECTION 4: POSTNATAL CARE OF INFANTS BORN TO MOTHERS WITH SUSPECTED OR CONFIRMED COVID-19 (Box 1)

4.1 Neonatal testing for SARS-CoV-2

The current basis for the diagnosis of COVID-19 is the detection of SARS-CoV-2 genes by reverse transcriptase polymerase chain reaction (RT-PCR) in respiratory secretions.⁽³⁸⁾ In newborns, nasopharyngeal/oropharyngeal swab or aspirate specimens are used for testing. Based on limited evidence, most guidelines recommend testing at least 12 to 24 hours after birth to prevent contamination of neonatal sample from maternal secretions immediately after birth.⁽²¹⁾ With potentially low viral loads obtained from upper respiratory tract samples, a repeat swab after 24 to 72 hours is also recommended to reduce the likelihood of a false-negative result. Specimens should be collected by trained healthcare personnel with appropriate infection control procedures, especially noting the possible risk of viral aerosolisation. The utility of testing perinatal samples, including cord blood, placental tissue and amniotic fluid, for diagnosis of congenital infection and vertical transmission is still unclear, although classification systems and case definitions have been proposed.^(11,13,39) The evidence for serological testing to diagnose neonatal infection and vertical transmission is still limited.^(9,10)

Summary of recommendation

Nasopharyngeal or oropharyngeal swabs or aspirates for RT-PCR detection of SARS-CoV-2 are to be obtained 12 to 24 hours after birth with a repeat test 24 to 72 hours after the initial swab on the newborn. Testing of other perinatal samples, such as cord blood, placental tissue, amniotic fluid, to determine vertical transmission should be performed according to institutional guidelines and testing capacity.

4.2 Breastfeeding and breastmilk feeding by mothers with COVID-19

Breastfeeding is the gold standard for infant feeding and nutrition, providing optimal health benefits for infants and mothers. Based on available evidence, there is no clear link between breastfeeding and transmission of SARS-CoV-2 to the infant. Cases of neonatal infection associated with infected mothers breastfeeding without infection control precautions have been described.⁽⁴⁾ There have also been rare reports of positive SARS-CoV-2 RT-PCR^(5,11,15,18) and immunoglobulin A immune responses in the breastmilk of mothers with COVID-19.⁽⁴⁰⁾ Reassuringly, a recent article has reported that SARS-CoV-2 was non-viable in viral cultures of RT-PCR-positive breastmilk samples.⁽⁴¹⁾

The decision for the mother to breastfeed should be a joint discussion between the parents and the healthcare team, bearing in mind the benefits of breastmilk and the recommended precautionary measures to be taken.⁽⁴²⁾ Mothers who decide to breastfeed should practise respiratory hygiene and precautionary measures, including using a surgical mask, performing hand hygiene before and after contact with the infant, and routinely cleaning and disinfecting surfaces with which the mother has been in contact. WHO recommends a hierarchy of feeding options to be followed, which includes prioritising the use of the mother's own milk, followed by donor human milk from a human milk bank.⁽⁴³⁾ Pasteurisation has been shown to inactivate SARS-CoV-2,⁽⁴⁴⁾ and pasteurised donor human milk can be used to feed newborns who are unable to breastfeed or do not have access to their own mother's milk.⁽⁴⁵⁾

Summary of recommendation

A shared decision for breastfeeding between the parents and the healthcare team should be made on a case-by-case basis, taking into consideration various factors that may impact the health of the mother and her child. When breastfeeding or providing breastmilk, mothers must

practise appropriate infection control procedures. Pasteurised donor human milk can be made available to newborns with no access to their own mother's milk.

4.3 Infant rooming-in with mother

The option for infant rooming-in with the mother should take into consideration the medical status of both the mother and infant, availability of suitable hospital rooms, and the ability of nursing and medical staff to monitor such infants. The potential risks of horizontal transmission of COVID-19 to the newborn infant, should be discussed with each family prior to delivery, where possible. If the infant rooms in with the mother, the following added precautions should be considered to minimise the risk of transmission:

- Strict adherence to infection control precautions: hand hygiene, face masks for the mother and appropriate PPE for healthcare care workers.
- Physical barriers between the mother and infant (e.g. curtain/screen).
- More than 2 metres of distance separation between the mother and infant.

Summary of recommendation

A shared decision for infant rooming-in with the mother should be made on a case-by-case basis, with strict adherence to infection control precautions.

4.4 Respiratory support precautions for infants

Most of the reported respiratory conditions in newborns with COVID-19 are related to neonatal transition or prematurity, with few reports of severe respiratory failure in neonates secondary to COVID-19.⁽¹³⁾ Considerations should be given to protect healthcare workers from SARS-CoV-2 transmission during delivery and subsequent care. All staff caring for infants with

suspected or confirmed COVID-19 requiring respiratory support should wear N95 masks, goggles, gowns and gloves.

AGP should be avoided, where possible. Intubation should be performed with a video-laryngoscope, where available, and should be done by the most skilful person. Premedication for elective intubation can minimise cough and dispersion of respiratory secretions. Where available, high-efficiency particulate air (HEPA) filter should be fitted to disposable self-inflating bags, resuscitators and the expiratory limb of mechanical ventilators. For intubated infants, use of inline suctioning is recommended. High flow nasal cannula (flow > 2 L/min) and non-invasive ventilation may aerosolise viral particles and should be used with caution. Provision of exogenous surfactant should be as clinically indicated for neonatal respiratory conditions. It should be noted that none of these interventions have been extensively studied in the neonatal setting to prevent transmission of COVID-19 and should be applied judiciously.

Summary of recommendation

Infants requiring non-invasive respiratory support and mechanical ventilation should be cared for using appropriate infection prevention procedures. Additional interventions that may reduce the risk of transmission of SARS-CoV-2 to healthcare workers include the use of inline suctioning and HEPA filters to respiratory equipment.

4.5 Visiting the newborn

Postnatal transmission and infection of the neonate with SARS-CoV-2 through contact with infected parents or other sources have been reported.^(5,7,8) Any consideration for visiting the newborn needs to account for the potential risk of viral transmission to other vulnerable infants and healthcare workers. Many international guidelines recommend limiting visitors to the healthy, non-infected parents or caregiver. Visiting guidelines for the newborn nursery and

neonatal intensive care unit need to comply with prevailing national and institutional guidelines. Remote meetings using videoconferencing may be considered to allow for family contact.

Summary of recommendation

Visiting of the mother and infant should be limited and adhere to prevailing national and institutional guidelines.

4.6 De-isolation and discharge procedures

For infants born to mothers with COVID-19, we recommend adoption of a test-based strategy for de-isolation in the hospital setting. This is based on very limited case reports suggesting infants may have prolonged, albeit intermittent, viral shedding.⁽⁴⁶⁻⁴⁸⁾ Upon testing positive for SARS-CoV-2, the infant should remain in isolation. He/she may be deisolated after two documented negative RT-PCR tests 24 to 48 hours apart, and is asymptomatic without respiratory support. Any consideration for de-isolation of infants should comply with national and institutional infection control guidelines.

An infant who screens negative for two SARS-CoV-2 tests following birth may leave the hospital but will, however, need to be monitored and isolated at home for up to 14 days during the incubation period, and the infant should not be cared for by vulnerable persons. Routine newborn screening (national newborn screening and universal hearing screen) and vaccinations should be completed prior to discharge.⁽⁴⁹⁾ Provisions should be made for follow-up visits, including neonatal jaundice monitoring (see Section 5.1), and clear anticipatory guidance should be provided to caregivers (see Appendix 1).

Summary of recommendation

De-isolation of infants born to mothers with COVID-19 should be based on virologic testing. Any consideration for de-isolation and discharge should comply with prevailing national and institutional infection control guidelines. All routine newborn screening, vaccinations and follow-up should be planned.

Box 1. Summary of postnatal management of infants born to mothers with COVID-19:	
Transmission-based precautions	<ul style="list-style-type: none"> Contact and droplet precautions Consider airborne precautions if requiring AGP and/or intubated
Separation of mother-infant	1. In a separate room, consider negative pressure room, especially if infant requires AGP and/or intubated*
SARS-CoV-2 Testing	<ul style="list-style-type: none"> Nasopharyngeal/oropharyngeal swabs for polymerase chain reaction test at 12–24 hr if mother is positive 2. Consider sending earlier sample and placenta, amniotic fluid, cord blood[†]
Breastfeeding/breastmilk feeding	1. Shared decision with the parents about breastfeeding or feeding of breastmilk from a well mother to a well infant
Respiratory precautions	<ul style="list-style-type: none"> Special care for infants on non-invasive support Appropriate PPE, including N95 mask 2. Use of inline suctioning/HEPA filters
Discharge	<ul style="list-style-type: none"> Depend on infant virologic testing and symptomatology Require 14 days of monitoring and quarantine Routine vaccinations and screenings 3. Provisions for outpatient follow-up (e.g. jaundice)
*If rooming-in with mother, consider physical barriers (i.e. isolette), distancing (> 2 m), face mask and strict hand hygiene of mother. [†] Repeat testing 24–72 hr after first swab if negative. AGP: aerosol-generating procedure; HEPA: high-efficiency particulate air; PPE: personal protective equipment	

SECTION 5: OTHER CONSIDERATIONS

5.1 Outpatient clinic attendance

Infants born to mothers with confirmed COVID-19, who are discharged within the 14-day incubation period and require outpatient clinic attendance, must abide by prevailing hospital and national guidelines. Outpatient clinic visits in the neonatal period are typically indicated for jaundice monitoring. In order to minimise the need to return to the outpatient clinic for jaundice reviews, infants at high risk of significant hyperbilirubinaemia may be considered to

remain for a longer in-hospital period of observation, including newborns who require jaundice checks following cessation of phototherapy. Caregivers and infants should attend the clinic at a specific, agreed time after coordination with the hospital and the necessary public health agencies

- Infant who are within the 14-day incubation period are to be reviewed in a dedicated clinic room by staff in full PPE. A transcutaneous bilirubin check can be performed. If serum bilirubin is performed, the appropriate biohazard precautions should be taken and the results expedited. The infant and caregiver should wait in the room until the results are known.
- Infants who are within the 14-day isolation period who require re-admission for phototherapy should be admitted to a single isolation room.

5.2 Neonatal inter-hospital transport

There is currently limited evidence to guide the practice of the out-born transport of an infant born to a mother with confirmed COVID-19. The following should be considered when transporting an infant with suspected or confirmed COVID-19:

1. Inter-hospital transfers of neonates with suspected/confirmed COVID-19, or those under observation during the incubation period, should be minimised. Considerations for inter-hospital transfer should be based on the neonate's escalating clinical needs, which are not available at the referring hospital.
2. Staff should institute the necessary infection prevention and control measures, including the use of appropriate PPE during the entire transfer process.
3. Pre-transfer:
 - Keep the number of staff to a minimum.
 - All members of the transport team are to don appropriate PPE.

- Consider removing non-essential equipment from the ambulance or moving non-essential equipment to a closed compartment in the ambulance.
- The receiving unit is to prepare the bed and PPE, and coordinate a transfer route into the unit.

4. During stabilisation and transfer:

- Consider early intubation, if appropriate, as prolonged bag and mask ventilation or non-invasive ventilation may increase the risk of viral aerosolisation.
- Respiratory care as described in Section 4.4.
- Avoid AGP during transport, if possible; consider inline suction devices to minimise aerosol particles and use closed ventilation systems.
- Neonates are routinely transported in a transport incubator. However, incubators are not closed units and therefore do not fully prevent contamination of the air outside the incubator.
- Retrieval service should have a protocol for decontamination of the transport equipment and ambulance after transport.

Summary of recommendation

To minimise unnecessary exposure risks, inter-hospital transfer of neonates should only be for clinical care needs not available at the referring hospital. Inter-hospital transfer of a neonate with suspected or confirmed COVID-19 requires a carefully coordinated and planned process with specific infection prevention and control measures at each step of the transfer.

5.3 Training of healthcare workers in COVID-19 workflows

Healthcare workers should be made aware of the transmission-based precautions and the proper usage of appropriate PPE to reduce contamination of self and the environment. Electronic-

learning is an essential component of training and can be in the form of presentation slides and videos, interactive video-conferencing with didactic teaching or scenario-based discussions, as well as circulation of newsletters and infographics. Important topics to cover include hand hygiene techniques, types of PPE, correct PPE usage and disinfection procedures. Maintaining staff morale while instilling a sense of personal responsibility for self-learning is equally important in view of the anticipated protracted duration of the situation and the need for frequent modifications to protocols and policies.

Training is best performed in progressive levels with examples of potential scenarios. Different institutions will require individual modification and adaptation of simulation training depending on the available resources in terms of manpower, equipment and space. To ensure effective and constructive simulation, trainers and ‘spotters’ can be assigned to identify gaps. They can provide on-the-spot feedback or raise their observations for discussion during debriefing post-simulation. Spotters can be members outside of the care providing team, i.e. an infection control officer or a patient safety lead who focuses on adherence to infection control measures. Clear instructions should be provided on access to equipment (bundling of items for ease of procedural preparation) and PPE (marking or labelling of specific area designated for donning and doffing). Online modules should be easily accessible to staff at their convenience to aid reinforcement of knowledge pertaining to disease updates as well as changes in policies and guidelines. Debriefing following the simulation sessions will also assess and identify gaps, in order to make important adjustments to existing workflow while preparing for the changing status of the pandemic.

Summary of recommendation

Individual institutions should ensure adequate training of staff in infection prevention and control measures for specific neonatal situations. The dissemination of conceptual knowledge

and skills competency training in anticipation and preparation for the management of a baby exposed to COVID-19 will ensure optimal patient care and safety of staff. Training can be performed in progressive levels, from individual tasks and integrated skills to intra- and inter-departmental simulation, with debriefing to identify gaps in processes.

CONCLUSION

The rapidly evolving COVID-19 pandemic has posed significant challenges in the care of pregnant women and their newborns affected by COVID-19. The guidelines and recommendations described here for the care of such infants are based on current, available evidence and contextualised to our local setting.

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