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Review of guidelines and recommendations from 17 countries highlights the challenges that clinicians face caring for neonates born to mothers with COVID-19

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Abbreviations: AGREE II, appraisal of guidelines for research and evaluation 2; RT-PCR, reverse transcription polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

ABSTRACT

Aim: This review examined how applicable national and regional clinical practice guidelines and recommendations for managing neonates born to mothers with COVID-19 mothers were to the evolving pandemic.

Methods: A systematic search and review identified 20 guidelines and recommendations that had been published by 25 May 2020. We analysed documents from 17 countries: Australia, Brazil, Canada, China, France, India, Italy, Japan, Saudi Arabia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, the UK and the USA.

Results: The documents were based on expert consensus with limited evidence and were of variable, low methodological rigour. Most did not provide recommendations for delivery methods or managing symptomatic infants. None provided recommendations for post-discharge assimilation of potentially-infected infants into the community. The majority encouraged keeping mothers and infants together, subject to infection control measures, but one-third recommended separation. Although breastfeeding or using breastmilk were widely encouraged, two countries specifically prohibited this.

Conclusion: The guidelines and recommendations for managing infants affected by COVID-19 were of low, variable quality and may be unsustainable. It is important that

transmission risks are not increased when new information is incorporated into clinical recommendations. Practice guidelines should emphasise the extent of uncertainty and clearly define gaps in the evidence.

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

KEY NOTES

- A systematic search and review identified 20 guidelines and recommendations from 17 countries that had been published by 25 May 2020 on managing infants born mothers with COVID-19.
- All were based on expert consensus, with limited evidence, and were of variable, low methodological rigour.
- New information incorporated into clinical recommendations and guidelines should highlight any uncertainty, clearly define any gaps in the evidence and not increase transmission risks.

INTRODUCTION

The World Health Organization (WHO) has now recorded more than half a million deaths worldwide due to the COVID-19 pandemic (1). It has been widely reported that COVID-19 disproportionately affects older people with underlying medical conditions (2). In the initial stages of the pandemic, the effects of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) were thought to be relatively mild for pregnant women, newborn infants and children. However, there is now increasing evidence that this population can also be seriously affected, with some requiring high levels of medical care (3-6) and some dying (7).

Clinical practice guidelines and recommendations provide clinicians with management strategies for medical conditions that are based on the best available evidence (8). These guidelines and recommendations can decrease healthcare use and costs and improve consistency of practice, which can lead to better patient outcomes (9). Guidelines and recommendations should ideally be informed by the best available evidence, including well-designed randomised controlled trials. Acquiring robust and scientifically sound evidence takes time, often years, to generate (9), but this is not possible in a rapidly evolving situation like the COVID-19 pandemic.

Frontline action can have a significant impact on the outcome of infected patients in a pandemic. For example, several pressure points dictate the evolution of a successful pregnancy, including antenatal care, delivery management, postnatal care and discharge strategies. The initial recommendations during this pandemic were based on evidence gathered from areas with the highest infections levels, where social distancing and stringent lockdown procedures were paramount to containing the spread of the infection. However the impact of the pandemic has reduced in some countries and restrictions are being eased. This means that practices that were guided by the evidence on peak infections may not be applicable, or sustainable, in these populations.

The mother-infant dyad is a unique group, where infection has the potential to affect the mother and many others, including the newborn infant and other family members. The aim of this study was to critically evaluate the applicability of guidelines and recommendations from 17 countries that were developed during the initial stage of the COVID-19 pandemic. We wanted to see if those recommendations, based on clinical evidence, would continue to be applicable and sustainable as the pandemic moves into different phases across the world.

METHODS

Eligibility and search strategy

We evaluated guidelines and recommendations for managing newborn infants born to mothers with suspected and confirmed COVID-19, which were published between 31 Dec 2019 to 25 May 2020. In view of the rapidly evolving situation, the search protocol was not pre-registered. Full text guidelines and recommendations that were available from neonatal and paediatric societies, public health organisations and governments, at state and national levels, in any language were included. Neonatal and paediatric organisations were also contacted directly. Institutional documents were obtained for countries without national or regional guidelines and recommendations. We prioritised guidelines from countries that were affected early in the course of the pandemic and the countries with the highest incidence of infection from every major WHO region by 1 May 2020. The guidelines and recommendations were independently assessed for eligibility by three review team members (KTY, JLO, AS). Disagreements were resolved through discussions with a fourth reviewer (HYZ).

Risk of bias quality assessment

Two authors (KTY, AS) independently assessed the methodological quality of each of the guidelines and recommendations, excluding those from China, Singapore and South Africa, with the Appraisal of Guidelines for Research Evaluation II (AGREE II) instrument (10, 11). These three documents were not evaluated because two were institutional-based and the Chinese document was a summary of 10 different guidelines. The authors used a staged appraisal that initially evaluated Domain Three of the instrument, which covers the rigour of the development, for each of the guidelines and recommendations. Discrepancies of more than two points in the scores for the individual items were discussed and the scores adjusted, if necessary. Only guidelines and recommendations that had a quality score threshold of more than 70% for Domain Three were appraised for other domains. Scores for each domain were calculated by adding the scores from the individual reviewers and standardising them as a percentage of maximum possible scores, ranging from 0-100%.

Data extraction

A standardised approach was used to extract data from each of the guidelines and recommendations and this was based on four themes. The first was antenatal care: identifying and managing pregnant women. Second was delivery room management: where mothers and infant were placed, use of personal protective equipment and transporting neonates. Third was postnatal management: virus testing, isolation guidelines, breastfeeding and feeding using breastmilk, treatment of confirmed cases and visiting the neonate. Fourth

was discharge and follow up. Guidelines and recommendations in any languages other than English were translated by native speaking authors.

Statistical analysis

The AGREE II appraisal results were extracted and a descriptive statistical analysis of the means and standard deviations was undertaken using SPSS version 25.0 (IBM Corp, New York, USA).

Ethics review

The authors did not request an ethics committee review, because this study focused on official documentation and no patients were involved.

RESULTS

Characteristics of the guidelines and recommendations

We identified 20 guidelines and recommendations from 17 countries that had been published by 25 May 2020. They included those that were affected early in the course of the pandemic: China (12-21), Japan (22), Singapore, South Korea (23) and Italy (24). The review also included those with a high incidence of infection from every major WHO region: Australia (25), Brazil (26), Canada (27-29), France (30), India (31), Saudi Arabia (32), South Africa, Spain (33), Sweden (34), Switzerland (35, 36), the UK (37) and the USA (38, 39). There were two guidelines and recommendations from the USA, the Centers for Disease Control and Prevention and the American Academy of Pediatrics, and three from Canada, from Toronto, Edmonton and the Canadian Pediatric Society. The 10 different guidelines and recommendations from China were collated and summarised by two authors (HZ, YY). At the time of the review, at least nine guidelines and recommendations had been revised at least twice.

Risk of bias and quality of guidelines

The overall AGREE II Domain Three scores for rigour of development were low and highly variable, with a mean of 8 ±7% and a range of 2-33 (Table 1). India (33%), Italy (13%) and Spain (11%) had the highest scores in this category. The individual items that scored lowest focused on the lack of clear descriptions for: ‘methods for formulating the recommendations are clearly described’, ‘criteria for selecting the evidence are clearly described’ and ‘strengths and limitations of the body of evidence are clearly described’ (11).

Specific areas covered by the documents

Antenatal care

Seven guidelines provided specific recommendations for identifying and, or, managing pregnant women with suspected or confirmed COVID-19 during the antenatal period. These included recommendations for testing, according to established case definitions and risk profiles for COVID-19 (Table 2). China provided specific recommendations on using chest imaging and prescribing antenatal steroids.

Delivery room management

There were six guidelines and recommendations that recommended that delivery should be guided by the mother's obstetric needs: China, Toronto in Canada, India, Saudi Arabia, Sweden and Switzerland (Table 2). None of the documents provided specific recommendations for delivery methods, but China advocated a lower threshold for Caesarean deliveries if the women had severe COVID-19. Admission to a designated labour room or operating theatre was recommended by almost all of the guidelines and recommendations. Negative pressure rooms were recommended by five documents: Toronto in Canada, China, Singapore, South Korea and the American Academy of Pediatrics. N95 face masks, or equivalent, were recommended by 12 documents for aerosol generating procedures during newborn resuscitation, in addition to goggles, gowns and gloves. The postnatal recommendations varied considerably: 13 recommended rooming-in a healthy infant and infected mother, while six suggested separating the mother and infant until the mother tested negative.

Postnatal infant management

With regard to virologic testing, 14 documents recommended testing all infants born to COVID-19 mothers, regardless of maternal or infant symptoms. The testing methods for SARS-CoV-2 included nasopharyngeal, oropharyngeal and throat swabs and analysing them using reverse transcription polymerase chain reaction (RT-PCR) (Table 3). Four also recommended testing other specimens, such as placental swabs, cord blood, endotracheal aspirates, urine and stools. Recommendations for the timing of swabs were variable. Eight guidelines and recommendations suggested that swabs should be obtained between 0-72 hours and 10 suggested repeating swabs at 24-48 hours if the initial swabs were negative.

When it came to infection prevention and control practices, eight guidelines and recommendations suggested that infants should be cared for in negative pressure rooms, regardless of the symptoms and swab results (Table 3). Contact and droplet transmission-based precautions (40) were universally recommended, with the addition of N95 masks or equivalent (41) during aerosol generating procedures. Some suggested that a healthy infant and mother could be roomed-in together, but that the mother's bed and the infant's cradle or

cot should remain two metres apart. The recommended duration of maternal-infant isolation was variable and ranged from the results of the infant virus tests to an empirical 14 days.

We found that 17 guidelines and recommendations supported using expressed breast milk to feed infants from asymptomatic, but infected, mothers (Table 3) and 15 of these also recommended breastfeeding. Singapore and South Korea did not recommend any breastfeeding by asymptomatic mothers or the use of breast milk. China recommended pasteurising expressed milk prior to feeding.

We also looked at aspects of newborn management, including visiting policies. This showed that 12 guidelines and recommendations allowed healthy caregivers and parents to visit newborn infants in the first days after delivery (Table 3). There were no specific recommendations for treating symptomatic newborn infants, but four - China, India, Spain and Sweden - specifically recommended against the use of antiviral therapy in infants.

Discharge and follow up

The majority of the documents made provisions for follow up. Five suggested follow up via telehealth facilities using telephone and, or, video (Table 3). None provided suggestions about how potentially infected mother-infant dyads could be integrated into the community or with other infected member of the immediate family.

DISCUSSION

At the beginning of the COVID-19 pandemic, there was little evidence that infants who were born to infected mothers were affected. However, by May 2020, several infants had positive RT-PCR virus results (42-47) and elevated SARS-CoV-2-specific immunoglobulin M (48, 49) within days of birth. This suggested *in utero* or intrapartum transmission. Indeed, the biological plausibility of perinatal infection has been underscored by the presence of the SARS-CoV-2 receptor, angiotensin-converting enzyme-2, in the placenta (50) and detection of the virus in amniotic fluid, placenta and breastmilk (4, 43, 47, 51-54). After the early postnatal period, late-onset infections of SARS-CoV-2 have also been increasingly reported in infants, as a result of household and community transmission (53, 55, 56).

Therefore, management during delivery and the postnatal period have the potential to have a significant impact on the risk of infection for newborn infants born to mothers with COVID-19. Such strategies are strongly driven by clinical practice guidelines and recommendations, but the overall methodological quality of those we reviewed was low. They did not take into account whether the recommendations could be assimilated into the changing face of the

pandemic, when social restrictions are lifted and the risk of a second wave emerges (57-59). The vagueness of the recommendations was probably inevitable, considering the speed and magnitude of the pandemic. However, at the time of this report, some countries were still experiencing huge numbers of infections that had not reached their peak. Synthesising recommendations from countries that were affected early in the course of the crisis, and comparing them with emerging evidence, will allow more newly affected countries to provide best management strategies and reduce the impact of the infection on mother-infant dyads. A summary of the recommendations is provided in Figure 1 and Table 4.

The most commonly used method to diagnose COVID-19 in infants is RT-PCR for SARS-CoV-2 in respiratory secretions from nasopharyngeal and oropharyngeal swabs. Most assays are based on detecting several SARS-CoV-2 gene targets (60). It should be noted that the performance of the different assays, which use different target genes, vary (61) and data on the performance of different assays in large populations of infants are lacking (62). Importantly, positive PCR results reflect the detection of viral ribonucleic acid and this does not indicate the viability of the virus (63). There are significant variations in the guidelines and recommendations with regards to the timing of initial infant testing. Recommendations to delay initial testing for the first 12-24 hours after birth are to account for potential contamination from maternal secretions. Earlier testing could be considered if there is an impact on where the newborn infant is placed and to establish whether the infection was *in utero*, intrapartum or postpartum (64). With increasing reports of late onset neonatal infections by the virus, any infant who presents with respiratory symptoms should trigger investigations for SARS-CoV-2 (53, 55, 56), especially in areas with ongoing community transmission. As the pandemic progresses, and antibody testing become more widely available, this may provide more evidence about the timing and routes of SARS-CoV-2 transmission and provide an alternative diagnostic method for neonatal COVID-19 (48, 49).

Delivery room practices are important during the pandemic. Emerging, but limited, reports of SARS-CoV-2 being detected in amniotic fluid, vaginal fluid and the placenta (43, 47) highlight the possibility of viral transmission and infection of the infant *in utero* and during delivery. Despite this, the vast majority of cases reported in the literature have indicated no substantial evidence for increased transmission risk during vaginal birth (65). Similarly, delayed cord clamping and provision of skin-to-skin contact with respiratory precautions have not been shown to increase the risk of viral transmission to the newborn infant. Having said that, there are significant variations in the guidelines and recommendations (52, 66). We can expect more evidence on the risks of viral transmission to emerge from systematic evaluations of specific COVID-19 clinical practices and infection control strategies in the

delivery room. Any strategies in the guidelines and recommendations would need to evolve in parallel to provide safe and patient-centered care, especially in view of constrained resources and facilities, such as personal protective equipment and negative pressure rooms.

With regards to post-delivery management, there has been limited evidence on the risk of the virus being transmitted by infected mothers during skin-to-skin contact and by rooming-in of mothers and infants. Recommendations for separating mothers and their newborn infants should be made after consulting the parents. In the early stages of the crisis, countries such as China, Singapore and South Korea isolated infants from their infected mothers for up to 14 days to prevent the virus being transmitted to the infant. Guidelines developed at a later stage in other countries have not supported separation, but these recommendations will need to be constantly reviewed in light of an increasing number of reports that suggest that infants have been infected after birth (45, 67-72). The availability of local resources, and the local situation, may also heavily influence rooming options. These could include keeping the mother and infant together in a room, but for the infant's cradle or cot to be kept more than two metres from the mother's bed (73).

Even though a number of studies have reported that SAR-CoV-2 has been detected in breastmilk by RT-PCR (43, 51, 53, 54), the risk that newborn infants face from viral transmission and infection remains unclear. The detection of the immunoglobulin A immune response in breast milk after SARS-CoV-2 infection suggests that it is possible that breastmilk could provide infants with passive protection against SARS-CoV-2 (74). The act of breastfeeding, in addition to the breastmilk itself, provides the mother and baby with multiple short-term and long-term health and psychological benefits (75). In uninfected infants, a balance between preventing infection and the benefits of breastfeeding need to be considered. Nearly all of the guidelines and recommendations say that breast milk should be used, with most allowing breastfeeding if suitable precautions are taken. The risks and benefits of this practice should be discussed with the parents, preferably before the infant is born.

The respiratory management and treatment of infants born to mothers with COVID-19 is another consideration. Antenatal steroids decrease the risk of adverse preterm infant outcomes (76-78), but may also pose a theoretical risk of worsening maternal viraemia (79, 80). Conversely. steroids reduce the cytokine storm, especially if maternal acute respiratory distress syndrome is evident (81). The use of antenatal steroids should be discussed in a multidisciplinary manner, on a case-by-case basis. Infants who need respiratory support

should be managed according to local protocols (82), bearing in mind that using a high-flow nasal cannula, continuous positive airway pressure and other non-invasive ventilation methods may increase the risk of viral aerosolization (83). Ventilatory circuits equipped with high-efficiency particulate aerosol viral filters on their expiratory limb (84) should be considered, but the evidence for this in newborn care has been limited.

If we are to successfully adapt and cope with the changing phases of the pandemic, we need to exercise caution when interpreting and incorporating information into clinical recommendations. It is important that this process does not have a negative impact on infection prevention measures. The consensus and management strategies summarised in this review are drawn from the experiences of the countries that were affected early on in the current crisis and those with high burdens of disease. However, these will need to evolve with emerging evidence. To achieve this, we need to support international collaborations that acquire and collate data, to fill critical gaps and to support existing registries, databases and surveillance studies. Inadequately evidenced guidelines and recommendations may provide consistency, but they risk perpetuating practices that may be unhelpful or even harmful. If robust evidence is lacking, it would be beneficial for guidelines and recommendations to emphasise the extent of uncertainty and clearly define gaps in the evidence. They should also encourage healthcare practitioners and organisations to take part in national and international efforts to rapidly acquire and synthesise new information on the changing face of the COVID-19 pandemic.

CONCLUSION

This review covered 20 guidelines and recommendations from 17 countries for caring for neonates born to mothers with COVID-19. All were based on expert consensus and limited evidence and were of variable, low methodological rigour. The COVID-19 pandemic poses a real challenge for clinicians caring for newborn infants, as new evidence is constantly emerging. Caution need to be exercised when interpreting and incorporating any new information into clinical recommendations, so that they do not have a negative impact on infection prevention measures. These documents should also emphasise the extent of any uncertainty in the information provided and clearly define any gaps in the evidence.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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List of Tables/Figures

Table 1. Individual and overall standardised scores for rigour of development for 17 of the clinical practice guidelines and recommendations, using the AGREE II instrument

Rigour of development	Australia	Brazil	Canada			France	India	Italy	Japan
	Regional (%)	National (%)	Regional Edmonton (%)	Regional Toronto (%)	National (%)	National (%)	National (%)	National (%)	National (%)
Systematic methods were used to search for evidence	0	0	0	25	0	8	67	17	8
The criteria for selecting the evidence are clearly described	0	0	0	8	0	0	33	8	0
The strengths and limitations of the body of evidence are clearly described	0	0	0	0	0	0	17	17	8
The methods for formulating the recommendations are clearly described	0	0	0	8	0	0	17	0	0
The health benefits, side effects, and risks have been considered in formulating the recommendations	17	0	17	0	8	8	50	17	0
There is an explicit link between the recommendations and the supporting evidence	17	8	17	17	8	8	50	25	8

The guidelines has been externally reviewed by experts prior to its publication	8	17	0	17	0	0	17	17	17
A procedure for updating the guidelines is provided	8	0	8	0	0	0	17	0	8
Overall Domain Score	6	3	5	9	2	3	33	13	6

Organisations and institutions included – Australia: Victoria Neonatal Advisory Group; Brazil: Sociedade Brasileira de Pediatria; Canada: Edmonton Zone Section of Newborn Health, Toronto Region COVID-19 Hospital Operations Table, Canadian Paediatric Society; France: The French Society of Neonatology & French Pediatric Society; India: National Neonatology Forum; Italy: Italian Society of Neonatology; Japan: Japanese Society for Neonatal Health and Development; Saudi Arabia: Ministry of Health; South Korea: Korean Society of Neonatology; Spain: Spanish Society of Neonatoloy; Sweden: Swedish Perinatal Society; Switzerland: Swissnoso (Swiss National Center for Infection Prevention) and the Swiss Society of Obstetrics and Gynecology; UK: British Association of Perinatal Medicine; USA: Centers for Disease Control and Prevention, American Academy of Pediatrics.

Abbreviations: AAP-American Academy of Pediatrics; CDC-Centers for Disease Control and Prevention

Rigour of development	**Saudi Arabia**	**South Korea**	**Spain**	**Sweden**	**Switzerland**	**UK**	**USA**	
	National (%)	**National (%)**	**National (%)**	**National (%)**	**National (%)**	**National (%)**	**National CDC (%)**	**National AAP (%)**

Systematic methods were used to search for evidence	0	0	8	0	0	8	0	0
The criteria for selecting the evidence are clearly described	8	0	8	0	0	0	8	0
The strengths and limitations of the body of evidence are clearly described	8	17	17	0	0	17	17	0
The methods for formulating the recommendations are clearly described	0	0	0	0	0	0	0	0
The health benefits, side effects, and risks have been considered in formulating the recommendations	0	17	8	0	0	17	8	0
There is an explicit link between the recommendations and the supporting evidence	17	17	17	17	8	0	8	0
The guidelines has been externally reviewed by experts prior to its publication	0	17	17	8	8	8	17	8
A procedure for updating the guidelines is provided	42	17	17	0	0	25	17	8
Overall Domain Score	9	10	11	3	2	9	9	2

Organisations and institutions included – Australia: Victoria Neonatal Advisory Group; Brazil: Sociedade Brasileira de Pediatria; Canada: Edmonton Zone Section of Newborn Health, Toronto Region COVID-19 Hospital Operations Table, Canadian Paediatric Society; France: The French Society of Neonatology & French Pediatric Society; India: National Neonatology Forum; Italy: Italian Society of Neonatology; Japan: Japanese Society for Neonatal Health and Development; Saudi Arabia: Ministry of Health; South

Korea: Korean Society of Neonatology; Spain: Spanish Society of Neonatoloy; Sweden: Swedish Perinatal Society; Switzerland: Swissnoso (Swiss National Center for Infection Prevention) and the Swiss Society of Obstetrics and Gynecology; UK: British Association of Perinatal Medicine; USA: Centers for Disease Control and Prevention, American Academy of Pediatrics.

Abbreviations: AAP-American Academy of Pediatrics; CDC-Centers for Disease Control and Prevention

Table 2. Summary of reviewed guidelines for the antenatal and delivery room management of pregnant mothers with suspected or confirmed COVID-19

	Australia	Brazil		Canada		China	France	India	Italy	Japan	Saudi Arabia
Distribution	Regional	National	Regional (Edmonton)	Regional (Toronto)	National	Regional/national	National	National	National	National	National
Version number	5	Not specified	3	2	Not specified	Summary	2	2	3	3	Not specified
Date published	22 March	31 March	13 March	26 March	6 May	Feb/Mar	16 March	7 May	10 May	23 March	12 April
Antenatal Care											
Guidance for Identification & Management of Pregnant Women	None specified	None specified	None specified	Yes	None specific	Yes	None specified	Yes	None specified	None specified	Available in separate guideline
Delivery Room Management											
Mode of delivery	None specified	None specified	None specified	According to obstetric assessment	None specified	According to obstetric assessment	None specified	According to obstetric assessment	None specified	None specified	According to obstetric assessment
Site of delivery	Specific room	Specific labour room or operating theatre	Specific labour room or operating theatre	Specific labour room or operating theatre, prefer negative pressure	Specific room	Specific negative pressure labour room or operating theatre	None specified	Specific labour room or operating theatre	Specific labour room	None specified	Specific labour room or operating theatre
PPE Advice during delivery	Surgical face mask; for AGP-N95; mask, goggles, gown, gloves	N95 mask, goggles, gown, gloves	Surgical face mask; for AGP-N95; mask, goggles, gown, gloves	Droplet and contact precautions airborne for AGP	Droplet and Contact precautions, airborne if mother symptomatic	N95 mask, goggles, isolation suit, gloves	Surgical face mask; goggles, gown, gloves	N95 mask, goggles, gown, gloves	N95 mask, goggles, gown, gloves	Surgical face mask	Droplet and contract precautions

Separation of mother-infant after delivery	Room with mother unless infant unwell	Room with mother if mother and infant well	Room with mother, unless infant or mother unwell	Room with mother, unless mother or infant unwell	Room with mother	Separate from mother	Room with mother unless infant or mother unwell #	Room with mother unless infant or mother unwell *	Room with mother, unless infant or mother has symptoms of COVID-19	Room with mother, unless infant or mother unwell	Separate from mother
Provisions for internal transport of infant	Yes with incubator	Yes, with transport incubator	Yes, with incubator	Yes, with incubator	Yes, according to institutional practice	Yes, with transport incubator	None specified	None specified	None specified	None specified	Yes, with transport incubator

Organizations and institutions included: Australia: Victoria Neonatal Advisory Group; Brazil: Sociedade Brasileira de Pediatria; Canada: Edmonton Zone Section of Newborn Health, Toronto Region COVID-19 Hospital Operations Table, Canadian Paediatric Society; France: The French Society of Neonatology & French Pediatric Society; India: National Neonatology Forum; Italy: Italian Society of Neonatology; Japan: Japanese Society for Neonatal Health and Development; Saudi Arabia: Ministry of Health; Singapore: KK Women's & Children's Hospital; South Korea: Korean Society of Neonatology; South Africa: Groote Schuur Hospital; Spain: Spanish Society of Neonatoloy; Sweden: Swedish Perinatal Society; Switzerland: Swissnoso (Swiss National Center for Infection Prevention) and the Swiss Society of Obstetrics and Gynecology; UK: British Association of Perinatal Medicine; USA: Centers for Disease Control and Prevention, American Academy of Pediatrics.

* Provisions made according to resources: if resources available and no evidence of community spread, for separation of mother and her infant

** Separate guidelines endorsed by the Swiss Society of Neonatology

for infants with congenital anomalies that may be worsened by SARS-CoV-2 infection, the guideline suggests consideration for separation of mother-infant on a case-by-case basis.

Abbreviations: AAP-American Academy of Pediatrics; AGP- Aerosol generating procedures; CDC- Centers for Disease Control and Prevention; PAPR- personal powered air respirators; PPE-personal protective equipment

Table 2. Summary of reviewed guidelines for the antenatal and delivery room management of pregnant mothers with suspected or confirmed COVID-19

	Singapore	South Korea	South Africa	Spain	Sweden	Switzerland	UK	USA	
Distribution	Institutional	National	Institutional	National	National	National	National	National (CDC)	National (AAP)
Version no.	3	1	2	6	1	Not specified**	Not specified	Not specified	Not specified
Date published	8 May	6 March	1 April	13 April	17 March	20 March 24 March	13 May	20 May	21 May
Antenatal Care									

Guidance for Identification & Management of Pregnant Women	Yes	Yes	None specified	None specified	None specified	Yes	Available in separate guideline	Yes	None specified
Delivery Room Management									
Mode of delivery	None specified	None specified	None specified	None specified	According to obstetric assessment	According to obstetric assessment	None specified	None specified	None specified
Site of delivery	Specific negative pressure labour room or OT	Specific negative pressure labour room or operating theatre	None specified	Single room	Specific labour room or operating theatre	None specified	Specific labour room or operating theatre	None specified	Specific negative pressure labour room or operating theatre
PPE Advice during delivery	N95 mask, goggles, gown, gloves	N95 mask, goggles, gown, gloves	Surgical face mask; for AGP- N95; mask, eye protection, gown, gloves	None specified	Surgical face mask, goggles, gown, gloves	Surgical mask	Surgical face mask, goggles (if splash procedure), gown, gloves	None specified	N95 mask with eye protection or PAPR, gown, gloves
Separation of mother-infant after delivery	Separate from mother	Separate from mother	Room with mother, unless infant unwell	Room with mother if mother and infant well	Rooming with mother, unless infant or mother unwell	Case-by-case basis	Rooming with mother, unless infant unwell	Consider temporary separation	Consider temporary separation
Provisions for transport of infant	Yes, with incubator	Yes, with transport incubator	None specified	Yes, with transport incubator	None specified	None specified	Yes, with incubator	None specified	None specified

Organizations and institutions included: Australia: Victoria Neonatal Advisory Group; Brazil: Sociedade Brasileira de Pediatria; Canada: Edmonton Zone Section of Newborn Health, Toronto Region COVID-19 Hospital Operations Table, Canadian Paediatric Society; France: The French Society of Neonatology & French Pediatric Society; India: National Neonatology Forum; Italy: Italian Society of Neonatology; Japan: Japanese Society for Neonatal Health and Development; Saudi Arabia: Ministry of Health; Singapore: KK Women's & Children's Hospital; South Korea: Korean Society of Neonatology; South Africa:

Groote Schuur Hospital; Spain: Spanish Society of Neonatoloy; Sweden: Swedish Perinatal Society; Switzerland: Swissnoso (Swiss National Center for Infection Prevention) and the Swiss Society of Obstetrics and Gynecology; UK: British Association of Perinatal Medicine; USA: Centers for Disease Control and Prevention, American Academy of Pediatrics.

* Provisions made according to resources: if resources available and no evidence of community spread, for separation of mother-child

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for infants with congenital anomalies that may be worsesed by SARS-CoV-2 infection, the guideline suggests consideration for separation of mother-infant on a case-by-case basis.

Abbreviations: AAP-American Academy of Pediatrics; AGP- Aerosol generating procedures; CDC-Centers for Diseases Control and Prevention; PAPR- personal powered air respirators; PPE-personal protective equipment

Table 3. Summary of reviewed guidelines for the postnatal care of infants born to mothers with confirmed COVID-19

	Australia	Brazil	Canada			China	France	India	Italy	Japan	Saudi Arabia
	Regional	National	Regional (Edmonton)	Regional (Toronto)	National	Regional/National	National	National	National	National	National
Indications for testing of infant	If mother is positive and infant is symptomatic	None specified	If mother is positive or infant is symptomatic	If mother is positive or infant is symptomatic	If mother positive or infant is symptomatic	If mother is positive or infant is symptomatic and with contact history	None specified	If mother is positive or with exposure to persons with COVID-19	If mother is positive	If infant is symptomatic	If mother is positive
Method of testing	None specified*	None specified	NP/Throat swab PCR	NP swab, Placental swab, cord blood; placenta and rectal swab optional	NP swab	NP/OP swab, sputum, LR secretions, blood, rectal swabs, urine PCR	None specified	NP/OP swab; ET aspirate if mechanically ventilated	Pharyngeal swab	None specified	NP/OP swab
Timing of testing	None specified	None specified	When mother confirmed positive	If symptomatic or when mother confirmed positive	2h-24h and 24-48h of life	Second day of life, or at least >12h after delivery	None specified	At birth or when mother confirmed positive, Repeat after 5-14 days if initial test negative	None specified	If infant symptomatic	Two consecutive swabs
Isolation facility	Single room preferred; Negative pressure if moderate/ severe symptoms;	Single room	Single room; Negative pressure if severe symptoms	Single room; Negative pressure if require AGP	Single room; negative pressure if infant requires respiratory support	Separate isolation unit, negative pressure preferred	Single room	Separate isolation facility for symptomatic; negative pressure if require AGP	Single room	Single room, negative pressure preferred	Single room
Length of infant isolation	Depends on maternal and infant virologic testing, for 14 days	None specified	Depends on maternal and infant virologic testing;	Depends on infant and parent virologic testing	None specified	At least 14 days, 2 PCR tests 24h apart	None specified	Depends on initial rooming-in/separation, up to 48 hours of age	None specified	Length to be determined	Two negative PCR test

Transmission based precautions for infant care #	Contact and Droplet precaution; N95 mask for AGP; Airborne, Contact and Droplet if severe infection	Contact and Droplet precautions; N95 mask for AGP	Contact and Droplet precaution; N95 mask for AGP; Airborne, Contact and Droplet if severe infection	Contact and Droplet precaution; Airborne preferable if AGP	According to local infection prevention and control	Airborne, Contract and Droplet precaution,	Contact and Droplet precaution	Contact and Droplet precaution; N95 mask for AGP	Contact and Droplet precaution (only surgical mask for the mothers)	Contact and Droplet precaution	Contact and Droplet precaution
Breastfeeding / Expressed breastmilk	Allow BF, EBM	Allow BF, EBM	Allow BF, EBM	Allow BF, EBM	Allow BF, EBM	No BF, Allow pasteurised EBM	Allow BF, EBM	Allow BF, EBM (if mum symptomatic)	Allow BF, EBM (if mum symptomatic)	Allow EBM	Allow EBM
Visitation policy	Allow well and non-suspect mother and partner	Asymptomatic parents according to institution guidelines	None specified	Negative tested parents allowed in NICU	Asymptomatic and negative mother	No visitors	Father, mother/ legal caregiver if asymptomatic, with surgical mask	Family member not in contact with mother or other suspect /cases	No visitation by relatives or friends	Mother	No visitors
Treatment recommendation for newborn	None specified	None specified	Yes	None specified	None specified	Yes	None specified	Yes	None specified	None specified	None specified
Respiratory management recommendation	None specified	None specified	Yes	Yes	None specified	Yes	None specified	Yes	None specified	Monitoring of infant	None specified
Provision of antivirals	None specified	None specified	None specified	None specified	None specified	Not recommended	None specified	Not recommended	None specified	None specified	None specified
Discharge indications	Depends on symptoms and maternal and infant virologic test	None specified	Depends on symptoms and maternal and infant virologic test	If well	None specified	Improved symptoms, PCR test negative x 2 (1 day apart)	None specified	Depending on symptoms up to 10 days	After 5-7 days if PCR test negative	None specified	PCT test negative x 2
Home isolation	Discuss with Infection Prevention team	None specified	According to public health	According to public health	None specified	14 days	14 days	None specified	At least 14 days	None specified	None specified

Follow-up appointments	Use telehealth facilities	None specified	None specified	48h-72h visit with precautions	None specified	Follow up by telephone 3,7,14 days or in person at 2 and 4 weeks	Follow up within 1 month	Telephone follow up or visiting nurse	Follow-up with PCR test at 20 and 30 days of life	None specified	Frequent follow up through 14 days

Organizations and institutions included: Australia: Victoria Neonatal Advisory Group; Brazil: Sociedade Brasileira de Pediatria; Canada: Edmonton Zone Section of Newborn Health, Toronto Region COVID-19 Hospital Operations Table, Canadian Paediatric Society; France: The French Society of Neonatology & French Pediatric Society; India: National Neonatology Forum; Italy: Italian Society of Neonatology; Japan: Japanese Society for Neonatal Health and Development; Saudi Arabia: Ministry of Health; Singapore: KK Women's & Children's Hospital; South Korea: Korean Society of Neonatology; South Africa: Groote Schuur Hospital; Spain: Spanish Society of Neonatoloy; Sweden: Swedish Perinatal Society; Switzerland: Swissnoso (Swiss National Center for Infection Prevention) and the Swiss Society of Obstetrics and Gynecology; UK: British Association of Perinatal Medicine; USA: Centers for Disease Control and Prevention, American Academy of Pediatrics.

* available in a separate associated guideline

** provisions made according to resources: if resources available and no evidence of community spread, for separation of mother and her infant

*** Separate guidelines endorsed by the Swiss Society of Neonatology

Appropriate PPE for following: contact precautions: use of gown, gloves, surgical mask; droplet precautions: addition of protective eyewear; airborne precautions: use of N95 mask or equivalent

Contact and droplet: use gown, gloves, surgical mask and eye protection. Contact and Droplet and Airborne: use gown, gloves, eye protection plus N95 mask or equivalent, and preferably in negative pressure room

Abbreviations: AAP-American Academy of Pediatrics; AGP-aerosol generating procedures; CDC- Centers for Disease Control and Prevention; BAL- bronchoalveolar lavage; BF-breastfeeding, EBM-expressed breastmilk; ET- endotracheal; LR- lower respiratory; NP-nasopharyngeal; OP-oropharyngeal; PCR-polymerase chain reaction

Table 3. Summary of reviewed guidelines for the postnatal care of infants born to mothers with confirmed COVID-19

	Singapore	**South Korea**	**South Africa**	**Spain**	**Sweden**	**Switzerland**	**UK**	**USA**	
	Institutional	National	Institutional	National	National	National ***	National	National (CDC)	National (AAP)
Indications for testing of infant	If mother is positive	If mother is positive	If mother is suspected or confirmed and infant symptomatic	If mother is positive	If mother is positive	None specified	If mother is confirmed and infant symptomatic	If mother is positive	If mother is positive

Method of testing	NP swab PCR	NP/OP swab PCR	NP/Throat swab PCR	NP/OP swab, BAL/ET aspirate, blood, stool, urine PCR	NP swab PCR	None specified	Nasal swab	NP/OP/Nasal swab PCR	NP/Throat swab PCR
Timing of testing	Two swabs on consecutive days	Two swabs 48h apart	When symptomatic or >72h and repeated on day 5	Two swabs, one at 24h and ≥48h	>4h after delivery	None specified	72 hours after birth and repeated on day 5	Two swabs, at 24h and 48h	Two swabs, one at 24h and 48h
Isolation facility	Single room, negative pressure	Single room	Single room	Single room, negative pressure if risk of aerosol generation	Single room; negative pressure for infected infant	Single room	Single room preferred	None specified	Single room; negative pressure preferred.
Length of infant isolation	Length to be determined	Depends on infant virologic testing	If positive, until resolution of symptoms and off respiratory support	Depends on maternal and infant virologic testing	None specified	10 days after symptoms and 48h asymptomatic	14 days and infant tests negative	None specified	None specified
Transmission based precautions for infant care #	Airborne, Contact and Droplet precaution	Contact and Droplet precaution; N95/P2 masks preferred	Contact and Droplet precaution; Airborne precaution and N95 mask if AGP	Contact and Droplet precaution	Contact and Droplet precaution	Contact and Droplet precaution; N95 for AGP	Contact and Droplet precaution; N95 mask for AGP if positive	Referral to IPC Guidance document; Contact and Droplet precaution	Contact and Droplet precaution; Airborne precaution if requires CPAP or mechanical ventilation
Breastfeeding / Expressed breastmilk	No BF,EBM	No BF,EBM	Allow BF, EBM	Allow BF, EBM	Allow BF, EBM	Allow BF, EBM	Allow BF, EBM	Allow BF, EBM	Allow BF, EBM
Visitation policy	No visitors	None specified	No visitation by positive mother	Allow parents or caregiver (if negative)	Healthy caregiver	Allow caregiver	Allow parents (if asymptomatic and/or negative)	Allow healthy parent/caregiver	Allow parents if not suspected with COVID-19

Treatment recommendation for newborn	None specified	None specified	None specified	Yes	None specified	None specified	None specified	None specified	None specified
Respiratory management recommendation	None specified	None specified	Yes	Yes	None specified	None specified	Yes	None specified	None specified
Provision of antivirals	None specified	None specified	None specified	Not recommended	Not recommended	None specified	None specified	None specified	None specified
Discharge indications	None specified	Asymptomatic, PCR test negative x 2	None specified	Improved symptoms, PCR test negative over 3 days	Standard criteria	If well	If well	When well	According to unit criteria
Home isolation	None specified	None specified	None specified	None specified	According to public health	Not specified	None specified	Per local health dept	None specified
Follow-up appointments	None specified	None specified	Regular follow-up	In two weeks (telephone)	None specified	With midwife	Telephone or video follow-up	Close outpatient follow-up	Frequent follow up thought 14 days after birth

Organizations and institutions included: Australia: Victoria Neonatal Advisory Group; Brazil: Sociedade Brasileira de Pediatria; Canada: Edmonton Zone Section of Newborn Health, Toronto Region COVID-19 Hospital Operations Table, Canadian Paediatric Society; France: The French Society of Neonatology & French Pediatric Society; India: National Neonatology Forum; Italy: Italian Society of Neonatology; Japan: Japanese Society for Neonatal Health and Development; Saudi Arabia: Ministry of Health; Singapore: KK Women's & Children's Hospital; South Korea: Korean Society of Neonatology; South Africa: Groote Schuur Hospital; Spain: Spanish Society of Neonatoloy; Sweden: Swedish Perinatal Society; Switzerland: Swissnoso (Swiss National Center for Infection Prevention) and the Swiss Society of Obstetrics and Gynecology; UK: British Association of Perinatal Medicine; USA: Centers for Disease Control and Prevention, American Academy of Pediatrics.

* available in a separate associated guideline

** provisions made according to resources: if resources available and no evidence of community spread, for separation of mother-child

*** Separate guidelines endorsed by the Swiss Society of Neonatology

Appropriate PPE for following: Contact precautions: use of gown, gloves, surgical mask; Droplet precautions: addition of protective eyewear; Airborne precautions: use of N95 mask or equivalent

Contact and Droplet: use gown, gloves, surgical mask and eye protection. Contact and Droplet and Airborne: use gown, gloves, eye protection plus N95 mask or equivalent, and preferably in negative pressure room

Abbreviations: AAP-American Academy of Pediatrics; AGP-aerosol generating procedures; CDC-Centers for Diseases Control and Prevention; BAL- bronchoalveolar lavage; BF-breastfeeding, EBM-expressed breastmilk; ET- endotracheal; LR- lower respiratory; NP-nasopharyngeal; OP-oropharyngeal; PCR-polymerase chain reaction

Table 4. Summary of recommendations for the postnatal care of infants born to women with COVID-19

	Transmission-based precautions for clinical care	Separation of mother-infant	SARS-CoV-2 testing	Infant feeding	Respiratory management	Antiviral therapy
Asymptomatic newborn infant	Contact and droplet precautions	If mother well, room-in with strict hygiene practices * +	NP/OP swabs for PCR if mother is positive (12-48h after birth) **	Breastfeeding/ EBM feeding***	Not applicable	Not recommended
Symptomatic newborn infant	Contact and droplet precautions, consider airborne precautions if requiring AGP and, or, intubated	In a separate room, negative pressure room if infant requires AGP and, or, intubated	NP/OP swabs for PCR if mother is positive (12-48h after delivery) **	Breastfeeding/ EBM feeding***	Provision of respiratory support as clinically indicated Φ	Not recommended

* mother should have face mask on at all times and observe strict compliance to hand hygiene. Infant cradle/crib to be placed at a distance of ≥2m

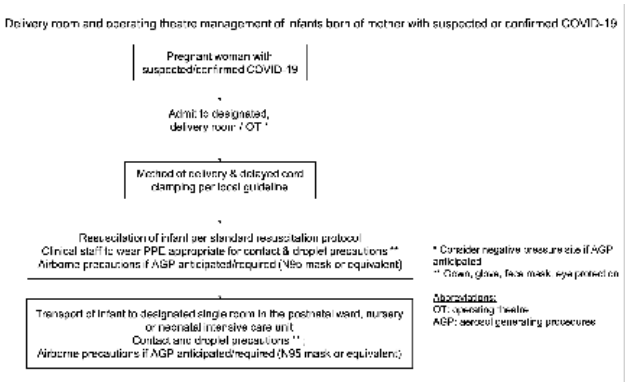
\+ separation of mother-child can be considered with parental consultation and availability of local resources.

** repeat testing 24-72h after first swab if negative

*** decision to breastfeed, feeding of expressed breastmilk should be done in discussion with the parents

Φ special care and considerations for potential aerosolization of secretions in infants on non-invasive support

Abbreviations: AGP: aerosol generating procedures; EBM: expressed breastmilk; NP: nasopharyngeal; OP: oropharyngeal; PCR: polymerase chain reaction



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