CORRESPONDENCE

Favorable outcomes among neonates not separated from their symptomatic SARS-CoV-2-infected mothers

Pediatric Research (2021) 90:8–11; https://doi.org/10.1038/s41390-020-01226-3

INTRODUCTION
Coronavirus disease 2019 (COVID-19), resulting from infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), can affect pregnant women. Their newborns are at a higher risk of prematurity and early separation from their mothers, who may subsequently require intensive care for their own health.1,2 Although neonates born of mothers infected with SARS-CoV-2 during pregnancy are seemingly vulnerable to infection, studies have found that they were not at a high risk for severe infection and were very rarely affected by COVID-19.3–6 The presence of virus by real-time reverse transcriptase polymerase chain reaction (RT-PCR) has been reported in newborns before H 12 of life.7 In addition, antiviral immunoglobulin M has been detected in their last 2 weeks of pregnancy between March 15 and April 24, 2020. After birth, mothers and newborns were separated only when their medical status made this necessary. Skin-to-skin contact and breastfeeding required specific hygienic measures. Mothers had to wear surgical face masks, disinfect their hands, and wash their nipples with odorless soap. Direct breastfeeding, indirect breastfeeding through expressed breast milk, and formula feeding were at the mother’s preference. When mothers were sleeping, cradles had to be placed at least 2 m away from their beds. Visits from others were not permitted. Mothers were able to access their hospitalized neonates securely as soon as allowed by their medical status. Nasopharyngeal and anal swabs were obtained from each neonate at birth and on day 3, as well as weekly from neonates requiring a prolonged hospital stay, and breast milk samples were obtained on day 3 and/or day 7. The presence of SARS-CoV-2 RNA in these samples was assessed by in-house RT-PCR, with an assay sensitivity of about 10 copies/reaction (https://www.who.int/docs/default-source/coronaviruse/real-time-rt-pcr-assays-for-the-detection-of-sars-cov-2-institutepasteur-paris.pdf?sfvrsn=3662fcb6_2), using primers and probes targeting two regions on the RdRp gene and specific to SARS-CoV2.

Neonates were discharged after day 3 of life through hospital-assisted neonatal home care coordinated by a pediatrician. Home care included daily planned visits by a midwife until day 8 and every 2 days for breastfed infants or at days 10 and 14 for non-breastfed infants. At each visit, the newborn was weighed, and feeding methods and signs of illness were noted. Each newborn was examined in person by their pediatrician on day 14. Parents were able to call a neonatologist at any time, with systematic teleconsultation on days 8, 14, 21, and 28. The neonatologist provided advice, answered questions, and checked the medical status of the neonate, the mother, and the family. The study was approved on 14 May 2020 by the local ethics committee of the Strasbourg Faculty of Medicine (CE-2020-86), and all parents provided written informed consent.

RESULTS
Twenty-six mother–neonate dyads were included (Table 1). Only one preterm neonate required endotracheal intubation and surfactant administration. He was rapidly extubated after neonatal intensive care unit (NICU) admission and required no additional respiratory support. Three other neonates were admitted to the NICU, one of gestational age (GA) 34 weeks, one of GA 35 weeks with respiratory distress, and a full-term neonate with hemolytic anemia. Three neonates were never placed in the same room as their mothers, although all mothers had free access to their newborns. Most of the neonates were breastfed and were supplemented with artificial milk (formula) or pumped breast milk. Median hospital stay was 4 days (range, 3–18 days). RT-PCR showed that one anal swab, obtained on day 3 from a full-term, asymptomatic neonate, was positive for SARS-CoV-2 RNA. How-
obtained on day 3 were all negative. This infant developed no
ever, nasopharyngeal swabs obtained from this newborn on days
0 and 3, an anal swab obtained on day 0, and a stool sample
obtained on day 3 were all negative. This infant developed no

### DISCUSSION

We evaluated the risks and benefits of a strategy to deal with
newborns of mothers infected with SARS-CoV-2, mainly during
their last week of pregnancy. This strategy involved preservation
of continuous mother–infant proximity with specific hygienic
measures, breast milk as the main source of feeding, early
discharge with home isolation, and a structured follow-up with
hospital-assisted home care. Evaluation of 1-month outcomes in
these 26 neonates found that this strategy was feasible and safe.
Except for one infant, who was transiently positive for SARS-CoV-2
RNA but had no clinical signs, none of these newborns was
infected, had adverse outcomes, or presented with any virus-
related clinical symptoms until age 1 month, with none requiring
hospital readmission.

This study had some limitations, including the relatively small
number of infants. In addition, repeated and systematic viral tests
were not performed, especially on breast milk, until the end of the
study period. However, this study included all newborns at two
institutions who met the inclusion criteria during the COVID-19
pandemic and with detailed clinical data on their hospital care
and full follow-up. These results are in accordance with the very
low incidence of infection in newborns of infected mothers in a
national cohort of the United Kingdom, in which guidelines for the
postnatal management of infants of infected mothers included
keeping the mother and infant together and encouraging
breastfeeding with strict infection control measures from birth.1
Our data add more information on the perinatal viral status and
clinical follow-up until the end of the neonatal period of neonates
cared for using a similar strategy. Our findings also support similar
guidelines of various countries and health care societies17 and
recently reported data.8 In our study, with a high proportion of
infants fed with breast milk, we found no evidence for horizontal
transmission. Breastfeeding may protect against the horizontal
transmission of SARS-CoV-2, as specific antibodies against this
virus have been found in the breast milk of a COVID-19-infected
mother.18 This hypothesis appears consistent with the protective
effect of breastfeeding against respiratory tract infections in
infancy.19

Our results support early postnatal proximity, despite many
mothers worldwide being separated from their newborn infants
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and
early separation is discouraged.20 Infant and family-centered care
can be maintained during the COVID-19 pandemic with preserva-
tion of the many benefits provided by early skin-to-skin contact,
including breastfeeding when desired.17 Lack of separation may
also reduce stresses on parents during the pandemic, especially
when fathers, in many settings, have restricted access to mothers
during the COVID-19 pandemic. Early separation strategies have
been reported to have deleterious mid- and long-term effects and

fully rule out the possibility of asymptomatic infection through postnatal contact, as we did not test these infants for SARS-CoV-2 infection at age 1 month. To date, however, no late postnatal mother–infant transmission has been reported after 1 month of age.

CONCLUSION

Even during the COVID-19 pandemic, safely maintaining family-centered perinatal care and continuing the promotion of bonding between neonates and their SARS-CoV-2-positive mothers appear possible, as these newborns are very rarely infected and, if infected, show only mild symptoms. Population-based studies, with longer postnatal follow-ups, are warranted to fully support this strategy. The impact of this approach should also be evaluated in preterm infants born to infected mothers.

ACKNOWLEDGEMENTS

We are very grateful to the participating neonates and their parents. This study was funded by the Strasbourg University Hospital.

AUTHOR CONTRIBUTIONS

A.M. collected and analyzed the perinatal data and the literature. He drafted the first version of the manuscript and contributed substantially to the revised version. I.L. organized the follow-up, collected and analyzed the neonatal and home care data, and revised the manuscript. A.D.-S., O.M., C.L., V.P.-K., and F.D.M. collected, organized the follow-up, collected and analyzed the neonatal and home care data, and revised the manuscript. I.L. and S.S.-S. interpreted the perinatal data and revised the manuscript. Philippe Deruelle6 and Pierre Kuhn1,6

1Department of Neonatology, University Hospital of Strasbourg, Strasbourg, France; 2Department of Neonatology, Hospital of Mulhouse, Mulhouse, France; 3Medical Virology Laboratory, University Hospital of Strasbourg, Strasbourg, France; 4Department of Obstetrics, University Hospital of Strasbourg, Strasbourg, France; 5Strasbourg University, INSERM, IRM UMR-S 1109, 67000 Strasbourg, France and 6Strasbourg University, Institut des Neurosciences Cellulaires et Intégratives, CNRS UPR 3212, Strasbourg, France

Correspondence: Pierre Kuhn (pierre.kuhn@chru-strasbourg.fr)

Correspondence: Pierre Kuhn (pierre.kuhn@chru-strasbourg.fr)

Table 2. Neonatal outcomes during home follow-up.

| Outcomes of discharged neonates                              | From day 4 to day 8 (n = 20) | From day 9 to day 14 (n = 25) | From day 14 to day 28 (n = 26) |
|---------------------------------------------------------------|------------------------------|------------------------------|-------------------------------|
| Absence of any clinical symptoms                              | 20 (100)                     | 24 (96)                      | 25 (96.2)                     |
| Nasal congestion                                              | 0 (0)                        | 1 (4.0)                      | 0 (0)                         |
| Diarrhea                                                      | 0 (0)                        | 0 (0)                        | 1 (3.8)                       |
| Weight gain, g/day, median (IQR)                              | 33 (39.3)                    | 40 (24.8)                    | —                             |
| Emergency consultation                                        | 0 (0)                        | 1 (4.0)                      | 0 (0)                         |
| Protocol-planned consultation                                 | 17 (85.0)                    | 25 (100)                     | 26 (100)                      |
| Parental calls                                                | 0 (0)                        | 0 (0)                        | 1 (3.8)                       |
| Exclusive breastfeeding                                       | 10 (50.0)                    | 9 (36.0)                     | 8 (30.7)                      |
| Breastfeeding and expressed breast milk or formula milk       | 8 (40.0)                     | 12 (48.0)                    | 12 (46.1)                     |
| Expressed breast milk and formula milk                        | 0 (0)                        | 1 (4.0)                      | 0 (0)                         |
| Exclusive formula milk                                        | 2 (10.0)                     | 3 (12.0)                     | 6 (23.0)                      |

Values are number (%) unless otherwise stated. IQR interquartile range.

REFERENCES

1. Knight, M. et al. Characteristics and outcomes of pregnant women admitted to hospital with confirmed SARS-CoV-2 infection in UK: national population based cohort study. BMJ 369, m2107 (2020).
2. Sentilhes, L. et al. COVID-19 in pregnancy was associated with maternal morbidity and preterm birth. Am. J. Obstet. Gynecol. https://doi.org/10.1016/j.ajog.2020.06.022 (2020).
3. Ludvigsson, J. F. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. Acta Paediatr. 109, 1088–1095 (2020).
4. Perrone, S. et al. Report of a series of healthy term newborns from convalescent mothers with COVID-19. Acta Biomed. 91, 251–255 (2020).
5. Perlman, J., Oxford, C., Chang, C., Salvatore, C. & Di Pace, J. Delivery room preparedness and early neonatal outcomes during COVID-19 pandemic in New York City. Pediatrics 146, e20201567 (2020).
6. Salvatore, C. M. et al. Neonatal management and outcomes during the COVID-19 pandemic: an observation cohort study. Lancet Child Adolesc. Health 4, 721–727 (2020).
7. Dong, L. et al. Possible vertical transmission of SARS-CoV-2 from an infected mother to her newborn. JAMA 323, 1846–1848 (2020).
8. 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 395, 809–815 (2020).
9. Vivanti, A. J. et al. Transplacental transmission of SARS-CoV-2 infection. Nat. Commun. 11, 3572 (2020).
10. Buonsenso, D. et al. Neonatal late onset infection with severe acute respiratory syndrome coronavirus 2. Am. J. Perinatol. https://doi.org/10.1055/s-0040-1710541 (2020).
11. Gross, R. et al. Detection of SARS-CoV-2 in human breastmilk. Lancet 395, 1757–1758 (2020).
12. Chen, D. et al. Expert consensus for managing pregnant women and neonates born to mothers with suspected or confirmed novel coronavirus (COVID-19) infection. Int. J. Gynaecol. Obstet. 149, 130–136 (2020).
13. Puopolo, K. M., Hudak, M. L., Kimberlin, D. W. & Cummings, J. American Academy of Pediatrics. Management of infants born to mothers with COVID-19. https://downloads.aap.org/AAP/PDF/COVID%2019%20Initial%20Newborn%20Guidance.pdf (2020).
14. World Health Organization. Breastfeeding advice during the COVID-19 outbreak. http://www.emro.who.int/nutrition/nutrition-infocus/breastfeeding-advice-during-covid-19-outbreak.html (2020).
15. Vivanti, A. J. et al. Post-natal follow-up for women and neonates during the COVID-19 pandemic: French National Authority for Health recommendations. J. Gynecol. Obstet. Hum. Reprod. https://doi.org/10.1016/j.jogoh.2020.101805 (2020).
16. Société française de Néonatalogie. Société française de Pédiatrie. Propositions de la société française de néonatalogie et de la société française de pédiatrie concernant les nouveau-nés dans le contexte d’épidémie à covid-19. https://f4ed7074-25ed-461c-8cf3-ddd4393f43e2.filesusr.com/ugd/d8ff38_bc9913a3008a4cf7bd90f0e74832eb18.pdf (2020).
17. Tscherning, C., Sizun, J. & Kuhn, P. Promoting attachment between parents and neonates despite the COVID-19 pandemic. Acta Paediatr. https://doi.org/10.1111/apa.15455 (2020).
18. Dong, Y. et al. Antibodies in the breast milk of a maternal woman with COVID-19. Emerg. Microbes Infect. https://doi.org/10.1080/22221751.2020.1780952 (2020).
19. Duijts, L., Ramadhan, M. K. & Moll, H. A. Breastfeeding protects against infectious diseases during infancy in industrialized countries. A systematic review. Matern. Child Nutr. 5, 199–210 (2009).
20. Tomori, C., Gribble, K., Palmquist, A. E. L., Ververs, M. T. & Gross, M. S. When separation is not the answer: breastfeeding mothers and infants affected by COVID-19. Matern. Child Nutr. https://doi.org/10.1111/mcn.13033 (2020).
21. Stuebe, A. Should infants be separated from mothers with COVID-19? First, do no harm. Breastfeed. Med. 15, 351–352 (2020).
22. Lista, G. & Bresesti, I. Fatherhood during the COVID-19 pandemic: an unexpected turnaround. Early Hum. Dev. https://doi.org/10.1016/j.earlhumdev.2020.105048 (2020).