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ORIGINAL ARTICLE

An initiative to evaluate the safety of maternal bonding in patients with SARS-CoV-2 infection

Liviu Cojocaru[a], Sarah Crimmins[a], Sripriya Sundararajan[b], Katherine Goetzinger[a], Emad Elsamadicy[a], Allison Lankford[a], Ozhan M. Turan[a] and Sifa Turan[a]

[a]Division of Maternal-Fetal Medicine. Department of Obstetrics, Gynecology and Reproductive Science, University of Maryland School of Medicine, Baltimore, MD, USA; [b]Department of Pediatrics. Division of Neonatology, University of Maryland School of Medicine, Baltimore, MD, USA

ABSTRACT

Background: In the last two decades, the world faced three epidemics caused by novel coronaviruses, namely, SARS-CoV in 2002, MERS-CoV in 2012, and the ongoing SARS-CoV-2 that started in late 2019. Despite a growing understanding of SARS-CoV-2 virology, epidemiology, and clinical management strategies, other aspects, such as mode of delivery, vertical transmission, and maternal bonding, remain controversial. The question we faced upon the decision to separate the neonates of SARS-CoV-2 positive mother is whether we follow the principle of "do no harm"?

Methods: This is a quality improvement project that analyzed all cases of SARS-CoV-2 positive pregnancies that delivered at a major health care system from March 1, 2020 to June, 1 2020. The article was prepared following Standards for Quality Improvement Reporting Excellence (SQUIRE) 2.0 guidelines. Data were prospectively collected and entered into the Research Electronic Data Capture (REDCap). Maternal bonding was defined by events such as rooming-in, skin to skin contact (STSC), and breastfeeding. Descriptive analysis was performed using the same software platform.

Intervention: We compared neonatal transmission rates between those neonates who experienced bonding versus those who were separated.

Results: A total of 1989 women were screened for SARS-CoV-2, from which 86 tested positive. Out of 31 analyzed pregnancies, five women (16%) were admitted to ICU and required mechanical ventilation. From the remaining 26 (84%), 17 (65%) opted for rooming-in, 12 (46%) for STSC, and 16 (61%) fed the infants with breastmilk (11 direct breastfeedings and five pumped the breast milk). All neonatal tests for SARS-CoV-2 returned negative.

Conclusion: Our results have illustrated that maternal bonding appears safe in neonates born to mothers that are SARS-CoV-2 positive.

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Maternal bonding; COVID-19; SARS-CoV-2; rooming-in; skin to skin contact; breastfeeding; do no harm

Introduction

In the last two decades, the world faced three epidemics caused by novel coronaviruses: SARS-CoV in 2002, MERS-CoV in 2012, and the ongoing SARS-CoV-2 that started in late 2019. While the first two viruses carried high mortality, the SARS-CoV-2 surpassed the absolute numbers of infection-related deaths due to higher contagiousness [1,2], and short incubation period [3]. Since the emergence of SARS-CoV-2 in December of 2019, it has resulted in over seven and a half million confirmed infections and over four hundred fifty thousand deaths [4], becoming one of the most overwhelming public health care challenges of our time. Despite a growing understanding of SARS-CoV-2 virology, epidemiology, and clinical management strategies [5], other aspects, such as mode of delivery, vertical transmission [6], and maternal bonding, remain controversial [7]. Currently, there is no clear evidence regarding optimal delivery timing and the route of delivery [8], as well as no evidence regarding the need for neonatal isolation from mother with SARS-CoV-2. Many guidelines recommend the neonate to be isolated in a designated COVID-19 neonatology unit until cleared [9], and early in the pandemic some even advised against breastfeeding [10]. At this time, most neonatal guidelines do not recommend against breastfeeding [9]. However, the basis for

CONTACT Sifa Turan sturan@som.umaryland.edu Division of Maternal-Fetal Medicine. Department of Obstetrics, Gynecology and Reproductive Science, University of Maryland School of Medicine, South Greene Street, Baltimore, MD 21230, USA

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such recommendations is a small case series, where breast milk from mothers with COVID-19, tested negative for SARS-CoV-2 [11].

We learned from previous SARS-CoV pandemic that antibodies against SARS-CoV could be found in breast milk, which can offer passive immunity [12]. The data during the MERS pandemic is almost non-existent. In a recent review of literature on MERS cases during pregnancy [13], there was only one case in which maternal milk was used to feed the neonate [14].

Although efforts have been made to establish the best practices around breastfeeding, there are many challenges to establish whether SARS-CoV-2 can be vertically transmitted through milk or during breastfeeding [15].

The question we faced upon the decision to separate the neonates of SARS-CoV-2 positive mother is whether we follow the principle of "do no harm"? It is essential to underline that maternal bonding is at the core of the mother and child relationship, and bonding problems are at the root of many dysfunctions of parenting such as child abuse, child neglect, and non-organic failure to thrive [16].

This quality improvement project was conducted to determine whether maternal bonding is safe for neonates whose mothers tested positive for SARS-CoV-2. To our knowledge, this is the first report focused on SARS-CoV-2 results in neonates that bonded with their mothers.

Materials and methods

In response to the rapidly evolving SARS-CoV-2 pandemic, a quality improvement initiative for surveillance of maternal, fetal, and neonatal outcomes was initiated at the University of Maryland Medical System. One of the objectives was to evaluate the safety of maternal bonding in all SARS-CoV-2 positive patients that were delivered between March, 1 2020 to June, 1 2020. The Institutional Review Board at the University of Maryland, Baltimore, approved this initiative as a quality improvement project (HP-00091259) on 22 April 2020. The article was prepared following Standards for Quality Improvement Reporting Excellence (SQUIRE) 2.0 guidelines [17].

Given multiple uncertainties at different levels in the prevention, management, and surveillance of outcomes during a rapidly evolving pandemic, we initiated a quality improvement project to monitor maternal, fetal, and neonatal outcomes.

Data management

We collaborated with clinical informatics to regularly generate EPIC EMR reports (Epic Systems Corporation) to identify all patients that are tested for SARS-CoV-2 and furthermore to identify those who tested positive. For optimal surveillance of maternal, fetal, and neonatal outcomes, data were prospectively collected and entered into the Research Electronic Data Capture (REDCap) [18,19], hosted at the University of Maryland, Baltimore. REDCap is a secure, web-based software platform designed to support data capture for research studies, providing (1) an intuitive interface for validated data capture; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical packages, and (4) procedures for data integration and interoperability with external sources.

We collected maternal demographics, the constellation of symptoms, signs, laboratory and imagistic findings at presentation; medical treatment, and hospital course complications. In addition, we collected fetal information and neonatal outcomes, including delivery details, neonatal disposition, breastfeeding rates, and hospital course. We performed a descriptive analysis using REDCap and Microsoft Excel (version 1908; Microsoft Excel 365 ProPlus, Microsoft Corporation). We compared neonatal transmission rates between those neonates who experienced bonding versus those who were separated.

Bonding

Maternal bonding was defined as one of the following events: skin to skin contact (STSC), rooming-in, and breastfeeding. Rooming-in and immediate STSC was allowed for mothers without severe or critical COVID-19 (designated based on Society for Maternal-Fetal Medicine Clinical Guidance) and whose neonates did not require admission to Neonatal Intensive Care Unit (NICU). Breast pumping was an option for mothers with critical COVID-19.

Diagnostic viral testing in the neonate immediate neonatal care this should be bolded at the "Bonding" and Data management" or the other way around

Neonates born to SARS-CoV-2 positive mothers were tested at 24 and then at 48 h of life if the neonates remained hospitalized. A swab from the neonate that sampled oropharynx and nasopharynx was sent for SARS-CoV-2 RNA testing by reverse transcription-polymerase chain reaction (RT-PCR) molecular assay. Repeat testing at seven days of life was performed for neonates admitted to the NICU.

According to the Centers for Disease Control and Prevention (CDC) guidelines, all neonates born to mothers with confirmed SARS-CoV-2 infection were considered as having suspected infection until testing results were available [20]. Temporary separation of the neonate from a mother with confirmed SARS-CoV-2 infection was considered in every case based on CDC recommendations [21]. The healthcare team discussed the risks and benefits of the temporary separation of the mother from her neonate. If the mother did not desire separation, the newborn roomed-in ≥6 feet apart in an isolette. The mother was encouraged to wear a cloth face covering and practice hand hygiene during all contact with the neonate. In the case of mother-neonate separation, a presumed healthy caregiver was identified by the parents to care for the neonate during the hospital stay and following discharge.

Breastfeeding

If the mother opted for breastfeeding, we gave instructions on how to take all possible precautions to avoid spreading the virus to the neonate. Instructions provided in accordance with the CDC and American Academy of Pediatrics (AAP) recommendations [21,22]. Some mothers chose to express breast milk with a pump and bottle feed rather than perform direct breastfeeding. When mothers declined breastfeeding, formula or pasteurized donor breast milk was offered to eligible neonates.

Discharge disposition same here with discharge disposition, should be bolded

The discharge plan consisted of a well-informed decision-making discussion with a multi-specialty team from the NICU, pediatric infectious disease, social worker, and the neonate's family. The conversation took place through virtual video communication. The potential consequences of postnatal disease transmission were explained to the parents and identified caregivers when parents chose to separate from the neonate. Specific discharge instructions in line with CDC recommendations [21] were provided to caregivers. Close follow-up with the pediatrician was arranged. The caregivers were instructed to monitor for symptoms of possible COVID-19 infection in the neonate (nasal congestion, difficulty breathing, cough, turning blue around the mouth or lips, difficulty feeding, irritability, lethargy, or feeling warm to touch).

Results

We reviewed all pregnant women that were tested for SARS-CoV-2 and were managed at our health care institution. A total of 1989 women were screened for SARS-CoV-2, from which 86 (0.04%) tested positive. Mean maternal age at delivery in years was 30.4 (± 6.2) and mean gestational age at birth in weeks was 37.1 (± 3.4) (Table 1). We found a racial disparity in the population that tested positive, where 55% were Hispanic, 29% African American, 15% Caucasian, and 1% of other races. Out of all women who tested positive, 34 (39.5%) delivered during the study period. Three patients were excluded from the final analysis. One patient was transferred in a critical condition without the neonate. The second was considered "COVID recovered" as there had been more than six weeks from the first positive test. In the third case, the neonate was transferred due to respiratory distress at birth and the requirement for a higher level of care. The transfer to an outside facility was undertaken since it was substantially closer than the main facility within the system. Out of 31 pregnancies described in the results, eight

Table 1. Maternal characteristics at the time of delivery.

Variable	Mean	Standard deviation
Maternal age at delivery (in years)	30.4	±6.2
Gravity	3.4	±1.9
Parity	1.9	±1.8
BMI	31.5	±8

BMI: body mass index.

Table 2. Delivery details.

Variable	Numbers	Percentages
Vaginal delivery	23	74%
VBAC	2	40%*
Operative delivery	1	0.03%
Cesarean section	8	26%
Type of anesthesia**		
Regional	5	62%
GETA	3	38%

VBAC: vaginal birth after cesarean; GETA: general endotracheal anesthesia. *VBAC rate. **Type of anesthesia for cesarean section.

Table 3. Neonatal characteristics.

Variable	Mean or n	Standard deviation or %
Gender		
Male	15	48%
Female	16	52%
Gestational age at delivery (in weeks)	37.1	±3.4
Birth weight (in grams)	2834	±723
Apgar 1	7	±2.6
Apgar 5	8.4	±1.2
NICU admission	5	16%
Rule out sepsis	7	22%
Received antibiotics	5	16%
LOS*	3.5	±4

NICU: neonatal intensive care unit; LOS: length of stay. *For infants that were not admitted to NICU.

delivered *via* cesarean section, and 23 had a vaginal delivery. Delivery details are described in Table 2 and neonatal characteristics in Table 3.

Out of all women included in the final analysis, five (16%) were admitted to the ICU and required mechanical ventilation. From the remaining 26 (84%), 17 (65%) opted for rooming-in, 12 (46%) for STSC, and 16 (61%) fed the infants with breastmilk (11 direct breastfeedings and five pumped the breast milk) as depicted in the flowchart (Figure 1). In some neonates, the pumped breastmilk was administered through gavage ($n = 2$) and later on as tolerated *via* bottle ($n = 1$) or direct breastfeeding ($n = 1$). Bonding details are described in Table 4.

All neonatal tests for SARS-CoV-2 returned negative during hospitalization. (Figure 2) We describe the test results up to the day of discharge. From neonates that did not require NICU admission, 22 (95%) were negative at 24 h of life (one neonate did not have a SARS-CoV-2 test before discharge). Moreover, eight were negative at 48 h of life and one at seven days of life. From neonates that required NICU admission, all tested negative at 24 and 48 h of life and five at seven days of life. Details are described in Table 5.

The number of neonates that bonded with their mothers ($n = 17$) and the ones that were separated ($n = 14$) was similar. There was no difference in the transmission of the SARS-CoV-2 in the tested neonates ($p = 1$).

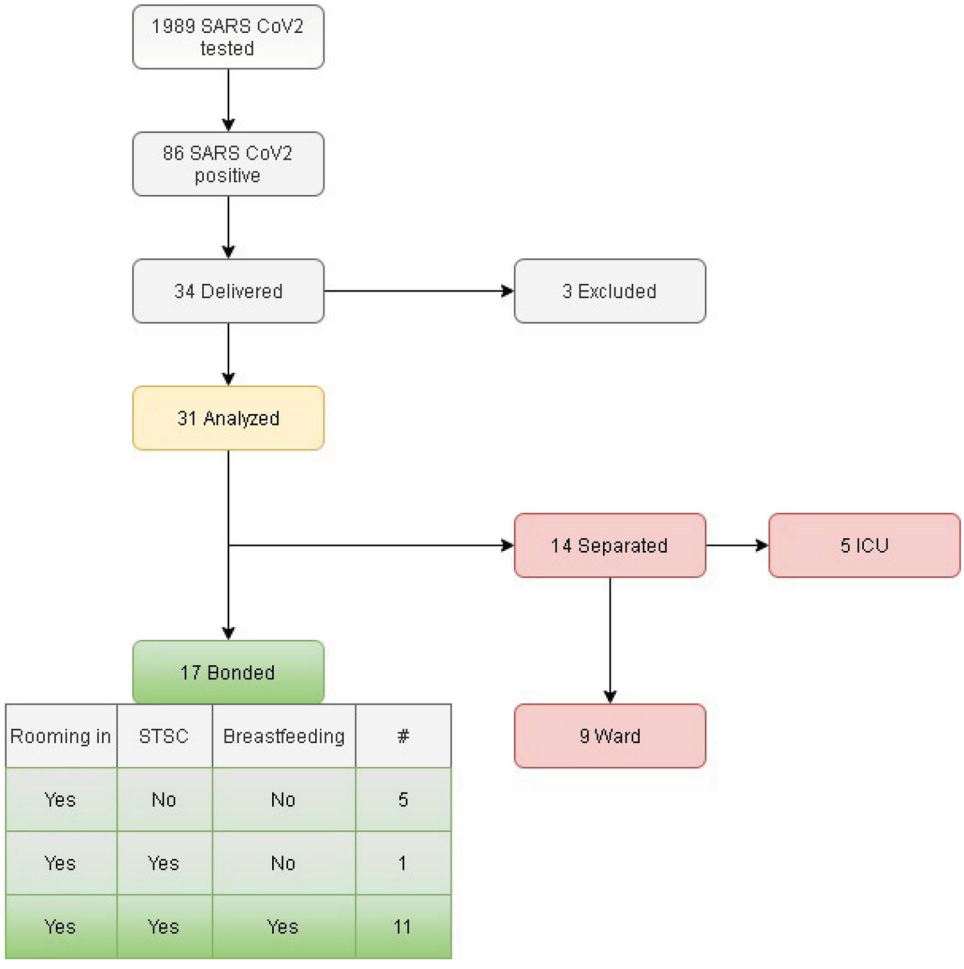

Figure 1. Flowchart depicting maternal bonding in patients with SARS-CoV-2 infection.

Table 4. Maternal bonding.

NICU admission	STSC	Rooming-in	Direct breastfeeding	Pumped breastmilk	Gavage
Yes	1	2	1	1	2
No	11	15	10	4	0

NICU, neonatal intensive care unit; STSC, skin to skin contact.

Discussion

Our quality improvement project demonstrated that maternal bonding, which included events such as rooming-in, STSC, and breastfeeding, appears safe in neonates born in SARS-CoV-2 positive mothers. None of the neonates who bonded with their mothers tested positive for SARS- CoV-2 during hospitalization.

A policy such as ours has allowed mothers and their neonates to benefit from maternal bonding. While we cannot address the rates of neonatal infection after discharge, it is essential to note that even strict isolation precautions do not entirely prevent neonatal infection [23]. Furthermore, few families have the resources to isolate the neonate at home [24].

On the other hand, separation results in a cascade of detrimental effects. It causes significant maternal [25] and fetal stress [26], and it interrupts neonatal physiology [27] on top of the ongoing affliction during the pandemic.

Rooming-in or keeping mothers and neonates together throughout the birth hospitalization increases breastfeeding initiation and duration [28]. Maintaining mothers and neonates together can also increase confidence and be protective against stress related to the parenting role change for some mothers [29]. Additionally, STSC improves mood, reduces stress and postpartum depression symptoms, encourages mothers to create a stimulating and caregiving environment, and promotes breastfeeding [30,31].

The benefits of breastfeeding are both maternal and neonatal. Maternal benefits of breastfeeding include decreased risk of breast cancer, ovarian cancer, postpartum depression, hypertension, cardiovascular disease, and type 2 diabetes mellitus. Neonates who are breastfed have a reduced risk of respiratory and gastrointestinal infections, asthma, childhood obesity, diabetes mellitus, and atopic dermatitis [32]. Neonates who are breastfed also have a higher IQ later in life [33].

Centered on available data, breast milk is unlikely to be a source of SARS-CoV-2 transmission [34]. On the contrary, the presence of targeted antibodies in human milk after maternal viral infections has been established [35,36] including in the case of SARS-CoV [12] and SARS-CoV-2 infection [37], supporting the plausibility of passive immunity against coronaviruses.

At the same time, it is essential to recognize some of the limitations of the breastfeeding literature, such as self-selection and residual confounding in the observational studies or heterogeneity of the studies included in the metanalysis [38,39]. Also, many studies are derived from high-income settings where breastfeeding is more common among highly educated mothers who are more health-conscious, and whose offspring may be less likely to suffer certain adverse outcomes [39].

Based on our findings, we recommend maternal bonding in mothers with SARS-CoV-2 infection, assuming that appropriate precautions are followed. Certainly, all risks and benefits should be discussed with families. However, the benefits from maternal bonding that were discussed above should be part of the counseling. Also, while not extensively studied at

Table 5. Neonatal negative SARS-CoV-2 results.

NICU admission	Total number	24 h	48 h	Seven days
Yes	8	8 (100%)	8 (100%)	5* (83%)
No	23	22* (96%)	7** (54%)	1 (100%)

SARS-CoV-2: novel coronavirus; NICU: neonatal intensive care unit. Data represented as n (%) from total number of the neonates that remained hospitalized. *One neonate had no testing. **One neonate had no testing. Four neonates discharged on day of life 2 before the 48 h mark.

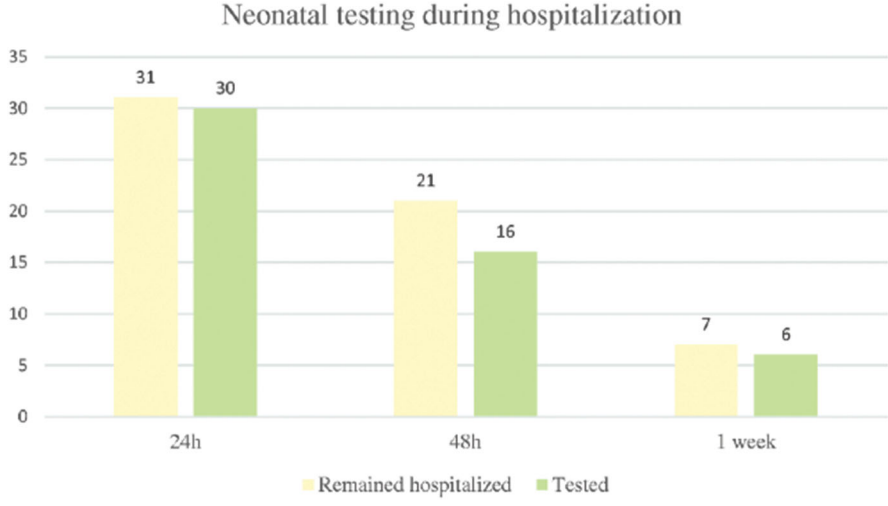

Figure 2. The chart depicts the proportion of the neonates that had SARS-CoV-2 testing during hospitalization.

this time, there is no evidence that maternal bonding will increase the risk of neonatal SARS-CoV-2 infection.

This project's major strengths were a prospective collection of the data points into a secure, web-based software platform designed to support data capture for research studies. Maternal and neonatal charts were reviewed by both an obstetrician and a neonatologist to ensure the accuracy of the data. This is also the first reported data focused on maternal bonding during COVID 19 pandemic. Furthermore, all patients are from a single health care system leading to less variability to the approach toward maternal bonding.

The main limitation of this project is that being a Quality Improvement within our health care system, it has not been applied to other institutions. Multidisciplinary counseling of the families, compliance with a well-established protocol, and adequate resources to provide the necessary supplies must be assured before such an approach is undertaken at other institutions. Also, we could not follow all neonates in outpatient settings to determine if they remained SARS-CoV-2 negative after discharge. None the less, our project demonstrated that maternal bonding is safe in neonates born to mothers that are SARS-CoV-2 positive when a well-established protocol is followed. While transmission during maternal bonding remains a potential risk, it is essential to remember that strict isolation does not prevent neonatal infection [23], and we yet have to come with an operational solution for transmission prevention once the neonate is discharged. Based on CDC[21] this reference did not come through and AAP [22] recommendations, as well as on the results of our quality improvement project, we find it hard to justify neonatal separation at birth beyond the circumstances of medical necessity.

Author contributions

Dr. Liviu Cojocaru and Dr. Sripriya Sundararajan reviewed medical records and wrote the first draft. Each of us was involved in the writing and revision of the manuscript, read and approved the final version.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Liviu Cojocaru http://orcid.org/0000-0003-1558-702X

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