


# Longitudinal Survey of COVID-19 Burden and Related Policies in U.S. Neonatal Intensive Care Units

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## Abstract

**Objective** This study aimed to determine the prevalence of confirmed novel coronavirus disease 2019 (COVID-19) disease or infants under investigation among a cohort of U.S. neonatal intensive care units (NICUs). Secondly, to evaluate hospital policies regarding maternal COVID-19 screening and related to those infants born to mothers under investigation or confirmed to have COVID-19.

**Study Design** Serial cross-sectional surveys of MEDNAX-affiliated NICUs from March 26 to April 3, April 8 to April 19, May 4 to May 22, and July 13 to August 2, 2020. The surveys included questions regarding COVID-19 patient burden and policies regarding infant separation, feeding practices, and universal maternal screening.

**Results** Among 386 MEDNAX-affiliated NICUs, responses were received from 153 (42%), 160 (44%), 165 (45%), 148 (38%) across four rounds representing an active patient census of 3,465, 3,486, 3,452, and 3,442 NICU admitted patients on the day of survey completion. Confirmed COVID-19 disease in NICU admitted infants was rare, with the prevalence rising from 0.03 (1 patient) to 0.44% (15 patients) across the four survey rounds, while the prevalence of patients under investigation increased from 0.8 to 2.6%. Hospitals isolating infants from COVID-19-positive mothers fell from 46 to 20% between the second and fourth surveys, while centers permitting direct maternal breastfeeding increased 17 to 47% over the same period. Centers reporting universal severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) screening for all expectant mothers increased from 52 to 69%.

**Conclusion** Among a large cohort of NICU infants, the prevalence of infants under investigation or with confirmed neonatal COVID-19 disease was low. Policies regarding universal maternal screening for SARS-CoV-2, infant isolation from positive mothers, and direct maternal breastfeeding for infants born to positive mothers are rapidly evolving. As universal maternal screening for SARS-CoV-2 becomes more common, the impact of these policies requires further investigation.

## Keywords

- ▶ COVID-19
- ▶ NICU
- ▶ breastfeeding
- ▶ survey

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## Key Points

- In this cohort, neonatal COVID-19 is rare.
- Policies regarding isolation and breastfeeding for infants are rapidly evolving.
- Most hospitals are now providing universal screening for expectant mothers for SARS-CoV-2.

Pandemic novel coronavirus disease 2019 (COVID-19) has been rapidly spreading within the United States.<sup>1</sup> Symptomatic COVID-19 illness has been most common in adults. While severe pediatric and infant infection appear relatively uncommon,<sup>2,3</sup> pediatric illness has been more prevalent than previously recognized.<sup>4</sup> Studies have suggested children with COVID-19 typically have mild disease, but infants are more vulnerable to severe illness than older children. No documented cases of vertical transmission have been reported in prior coronavirus epidemics, such as severe acute respiratory syndrome (SARS) or Middle East respiratory syndrome (MERS),<sup>5</sup> suggesting the risk of vertical transmission with COVID-19 may be low. Early COVID-19-related data appears to confirm the scarcity of vertical transmission<sup>6–8</sup> but individual case reports confirm that vertical transmission is possible.<sup>9,10</sup>

There are no published data regarding the burden of COVID-19 within U.S. neonatal intensive care units (NICUs) or the breadth of NICU policies that have been introduced across the country in regard to infant isolation from mothers under investigation or positive for COVID-19, breastfeeding approaches in this situation, or universal screening of expectant mothers. We conducted a series of cross-sectional surveys to describe the burden of COVID-19 in U.S. NICUs and how policies have been implemented to approach the pandemic. We hypothesized that the burden of infant illness would be low.

## Materials and Methods

We performed a series of cross-sectional surveys of medical directors for NICUs managed by Pediatrix Medical Group (total NICUs = 368) to determine the active burden of COVID-19 and COVID-19-related policies. Surveys were distributed through the MEDNAX Neonatal Forum and through a listserv of MEDNAX/Pediatrix Medical Group practice medical directors. We requested NICU medical directors to fill out the survey during four periods: March 26 to April 3, April 8 to April 19, May 4 to May 22, and July 13 to August 2, 2020. Responses were collected through an internet-based tool (Survey Monkey).

Each survey queried sites regarding NICU patients confirmed positive for SARS-coronavirus-2 (SARS-CoV-2) and the number of patients under investigation (PUI) at the time of the survey response. For SARS-CoV-2-positive patients, we asked for the best clinical determination regarding horizontal versus vertical transmission. Although not part of the study, educational webinars (hosted by authors D.L.E. and R.H.C.) accessible to all MEDNAX-affiliated clinicians were provided throughout the study period. These presentations included summaries of the evolving Centers for Disease Control and Prevention (CDC)

and American Academy of Pediatrics (AAP) guidelines with regard to COVID-19, as well as a discussion of different types of transmissions, including the challenges of making a distinction between vertical and horizontal transmission.<sup>11</sup> After each webinar, the slide decks were e-mailed to MEDNAX clinicians to disseminate the information to those who could not attend the live events.

Starting with the second survey, we added questions to determine NICU policies with regard to breastfeeding and isolation of infants from maternal PUIs or confirmed positive SARS-CoV-2 mothers. Questions regarding expectant maternal screening practices were added for survey rounds 3 and 4 ([Supplementary Material](#), available in the online version).

For analysis, we utilized sample descriptive statistics including counts and percentages. This study was deemed exempt by the Methodist Healthcare System Institutional Review Board, San Antonio, TX.

## Results

Among 368 MEDNAX-affiliated NICUs, responses were received from 153 (42%), 160 (44%), 165 (45%), and 148 (38%) across four rounds representing an active patient census of 3,465, 3,486, 3,452, and 3,442 NICU admitted patients on the day of survey completion. In total, 266 unique NICUs responded to this survey with 69 responding to all four surveys, 50 to three, 53 to two, and 94 to one survey. Reporting NICUs included 36 states and Puerto Rico with the most highly represented states Texas, Florida, and California. Both the reported patient census across the four rounds (3,442–3,542 patients per round) and the state-level representation remained relatively stable. Using U.S. Census Bureau–designated statistical regions,<sup>12</sup> the South region represented 61 to 66%, West 22 to 25%, Midwest 9 to 14%, Northeast 1 to 2%, and Pacific 0 to 1% of reported NICU beds across the four survey rounds.

Confirmed COVID-19 disease in NICU admitted infants was rare, with the prevalence rising from 0.03% (1 patient) to 0.44% (15 patients) across the four survey rounds, while prevalence of patients under investigation increased from 0.8 to 2.6%. ([Table 1](#)). At the state level, the prevalence of confirmed COVID-19-positive infants increased between the first and fourth survey rounds within California (0–1.1%), Florida (0–0.9%), and Texas (0–0.7%). Similarly, the prevalence of infants under investigation for COVID-19 increased in Florida (1–2.3%) and Texas (0.6–4.4%), while decreasing in California (2.4–0.6%).

We added questions in rounds 2, 3, and 4 regarding infant isolation and feeding policies. We found only a minority of sites willing to allow direct maternal breastfeeding under investigation or COVID-19-positive mothers, 27 (17%) and 34 (21%) in rounds 2 and 3, respectively, but by round 4, this had

**Table 1** Primary survey results

	Round 1	Round 2	Round 3	Round 4
Dates	3/26–4/8	4/8–4/19	5/4–5/22	7/13–8/2
Number of responding NICUs	153	160	165	148
Active NICU census	3,465	3,486	3,542	3,442
COVID-19 under investigation	26	38	42	90
COVID-19 positive—admitted	1	2	3	15
Vertical transmission	0	0	1	5
Horizontal transmission	1	2	2	8
Other family member	0	0	0	2
Isolation method policies		<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Admission to pediatric ward		2 (1)	1 (1)	0
Admission to pediatric ICU		2 (1)	4 (2)	2(2)
Isolation from mother for 14 days, discharge home with an alternate caregiver		74 (46)	66 (40)	25 (20)
Admission to NICU		4 (3)	4 (2)	3 (2)
Admission to NICU—negative pressure room		33 (21)	29 (18)	15 (12)
Room in with mother—no distancing		0	1 (1)	6 (5)
Room in with mother—physically distanced		6 (4)	5 (3)	12 (10)
Room in with mother—physically distanced and maternal PPE		17 (11)	36 (22)	56 (45)
Other		22 (14)	16 (10)	25 (20)
Feeding policies				
No breastmilk allowed		3 (2)	5 (3)	2 (1)
Donor breastmilk only		2 (1)	3 (2)	1 (1)
Expressed maternal breastmilk only		115 (72)	112 (68)	61 (41)
Breastfeeding with maternal precautions		27 (17)	34 (21)	69 (47)
Other		8 (5)	8 (5)	11 (7)
Screening practices for expectant mothers				
Screening for symptomatic women only			21 (13)	11 (7)
Screening for symptomatic women and those with known COVID-19 positive contacts			43 (26)	24 (16)
Universal screening for all women expecting to deliver			85 (52)	102 (69)
Other			14 (8)	8 (5)

Abbreviations: COVID-19, novel coronavirus disease 2019; ICU, intensive care unit; NICU, neonatal ICU; PPE, personal protective equipment.

more than doubled to 69 (47%). For the last three survey results, use of any maternal breastmilk (expressed and direct) was 88 to 89%. Sites reported a variety of policies regarding infant isolation after delivery to a COVID-19-positive mother, with physical isolation from the mother for 14 days and discharge to an alternate caregiver most common management plan. However, the number of facilities allowing infants to room in with mothers increased from 23 (14%) to 74 (50%; **Table 1**).

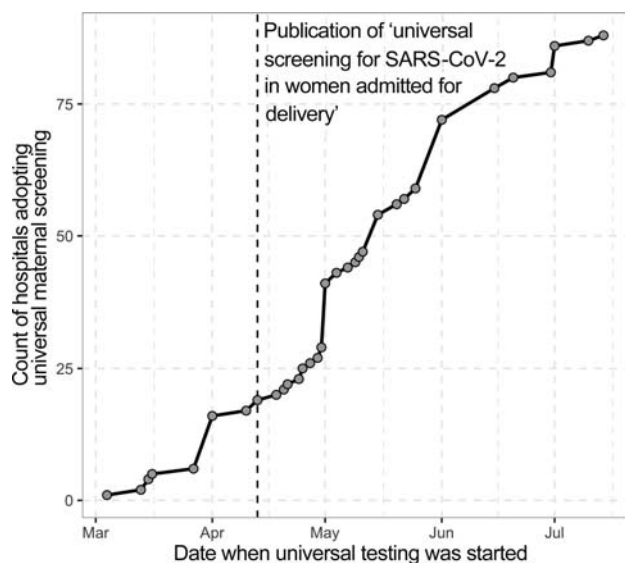
In rounds 3 and 4 of the survey, we added questions about hospital screening practices of expectant mothers. Data from survey 3 showed 85 hospital sites (52%) reported adoption of universal SARS-CoV-2 screening for all expectant mothers with only 21 (13%) restricting screening to symptomatic mothers (**Table 1**). Of these sites, 12 (14%) had begun universal maternal screening prior to the publication of a

report describing this practice in mid-April.<sup>9</sup> A progressive increase in sites adopting universal screening was noted in the following months (**Fig. 1**).

### Discussion

We report results from a series of cross-sectional NICU surveys focusing on COVID-19 from March 2020 through early August 2020 during the first wave of the United States outbreak. Among a large cohort of NICU admitted infants, the burden of confirmed neonatal COVID-19 is minimal, with a maximum of 0.4% of the inpatient NICU population. Similarly, the burden of active PUI is low with 2.6% of NICU-admitted infants under investigation in the most recent survey. However, despite the low burden of SARS-CoV-2, most responding NICUs have defined policies regarding where to care for

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**Fig. 1** A total of 102 (69%) of responding NICUs adopted universal screening of expectant mothers. Of these, 88 provided dates when universal screening was adopted. In total, 17 adopted these universal screening practices in the 6-week prior to the initial U.S. report of universal maternal screening on April 13, 2020<sup>13</sup> and an additional 28 within 4 weeks of report publication.<sup>13</sup> NICU, neonatal intensive care unit; SARS-CoV-2, severe acute respiratory syndrome-coronavirus-2.

infants born to PUIs, breastfeeding approaches, and most hospitals have adopted maternal screening practices. The responses indicate that most NICUs have adopted policies weighing toward substantial caution regarding interaction between PUI and COVID-19-positive mothers with their infants, including a preponderance separating mother and baby for 14 days (40–46%) and a majority allowing only maternal expressed breastmilk (69–74%) based on surveys 2 and 3. The most recent survey shows an decrease in isolation of infants from their mothers and an increased numbers of NICUs allowing direct maternal breastfeeding.

These results indicate that secondary effects of maternal COVID-19, even when asymptomatic, may be substantial and could affect maternal–infant bonding and long-term breastfeeding success. The benefits of direct breastfeeding are well established<sup>14,15</sup> and may extend beyond the direct provision of maternal breast milk. Direct breastfeeding can be an important component of developing the maternal–infant bond<sup>14,15</sup> and exclusively breastfeeding mothers maintain provision of milk for greater durations than those who provide only expressed milk.<sup>16</sup> Guidance from the AAP has consistently supported the provision of maternal breast milk from mothers with COVID-19, as evidence suggests that SARS-CoV-2 is unlikely to be transmitted via maternal milk, however, also suggests caution with direct breastfeeding. However, while early AAP recommendations included isolating mothers and infants, at least temporarily,<sup>17</sup> this has since evolved to encourage rooming in healthy newborns with COVID-19-positive mothers while utilizing adequate personal protective equipment.<sup>18</sup> The adopted NICU policies we report are largely consistent with the AAP recommendations including maintaining support for the provision of breastmilk and isolating

mother and baby after birth. Further, we find that NICU policies regarding isolation of infants from mothers have evolved similarly to AAP guidance. Whereas 23 (14%) of responding facilities allowed rooming in of infants with COVID-19-positive mothers in April (survey round 2), 74 (50%) allowed this by July and early August (survey round 4). This indicates a rapid evolution of hospital policies in response to novel data and guideline development.

A May, 2020 report from New York City<sup>13</sup> found universal screening of expectant mothers in hospital delivery units frequently detected asymptomatic SARS-CoV-2 infection. We found that several sites had begun this practice prior to the widely publicized report from New York City<sup>13</sup> but that adoption of universal maternal screening increased in the following weeks and months. These policy changes may have occurred due to a combination of contributing factors. Potential reasons may include reactions to published research, local prevalence of COVID-19, improved testing capabilities, the desire to preserve personal protective equipment supplies for health care workers, and/or to optimize protection of health care workers and infants. Concurrent with this increase in universal maternal screening, we found a significant increase in infant PUI in round 4 of the survey. This may be reflective of both increases in universal maternal screening, as well as an increased incidence of COVID-19 infection throughout the Southern United States between the end of survey round 3 and initiation of survey round 4.

## Strengths and Limitations

The strengths of this work include the completion of four rounds of surveys over the course of 5 months, in the midst of the COVID-19 pandemic. We achieved a robust and consistent response across all three surveys. Limitations include those inherent to survey studies including inability to verify responses, incomplete responses, and inability to ask follow-up questions of respondents. Further, as questions were added in later survey rounds, we do not have full longitudinal results for all questions. Lastly, responding NICUs may not be representative of all NICUs in the United States.

## Conclusion

In conclusion, this survey of MEDNAX managed U.S. NICUs finds the burden of COVID-19 in the NICU environment to be low but rising. For mothers under investigation or positive for COVID 19, policies had been commonly enacted to restrict maternal–infant exposures and to limit direct breastfeeding, but we found these policies to be rapidly evolving. With the rapid adoption of universal screening for expecting mothers, the numbers of infants born to asymptomatic mothers and impacted by these policies are expected to rise. As a result, the short- and long-term impact of these clinical care policies require further investigation.

## Conflict of Interest

None declared.

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### References

- 1 Centers for Disease Control and Prevention (CDC), National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases. United States COVID-19 Cases and Deaths by State. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html>. Accessed May 31, 2020
- 2 CDC COVID-19 Response Team. Coronavirus disease 2019 in children - United States, February 12-April 2, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(14):422-426
- 3 Dong Y, Mo X, Hu Y, et al. Epidemiology of COVID-19 among children in China. *Pediatrics* 2020;145(06):e20200702
- 4 American Academy of Pediatrics. Children and COVID-19: State-Level Data Report. Available at: <https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-state-level-data-report/>. Accessed October 6, 2020
- 5 Schwartz DA, Graham AL. Potential maternal and infant outcomes from (Wuhan) coronavirus 2019-nCoV infecting pregnant women: lessons from SARS, MERS, and other human coronavirus infections. *Viruses* 2020;12(02):194
- 6 Zeng L, Xia S, Yuan W, et al. Neonatal early-onset infection with SARS-CoV-2 in 33 neonates born to mothers with COVID-19 in Wuhan, China. *JAMA Pediatr* 2020;174(07):722-725
- 7 Chen H, Guo J, Wang C, et al. Clinical characteristics and intra-uterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. *Lancet* 2020;395(10226):809-815
- 8 Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Disease (NCIRD), Division of Viral Diseases. Evaluation and management considerations for neonates at risk for COVID-19. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/caring-for-newborns.html>. Accessed October 6, 2020
- 9 Vivanti AJ, Vauloup-Fellous C, Prevot S, et al. Transplacental transmission of SARS-CoV-2 infection. *Nat Commun* 2020;11(01):3572
- 10 Sisman J, Jaleel MA, Moreno W, et al. Intrauterine transmission of SARS-COV-2 infection in a preterm infant. *Pediatr Infect Dis J* 2020;39(09):e265-e267
- 11 Kimberlin DW, Stagno S. Can SARS-CoV-2 infection be acquired in utero?: More definitive evidence is needed *JAMA* 2020;323(18):1788-1789
- 12 United States Census Bureau. Census Regions and Divisions of the United States. Available at: [https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us\\_regdiv.pdf](https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf). Accessed April 8, 2020
- 13 Sutton D, Fuchs K, D'Alton M, Goffman D. Universal screening for SARS-CoV-2 in women admitted for delivery. *N Engl J Med* 2020;382(22):2163-2164
- 14 Section on Breastfeeding. Breastfeeding and the use of human milk. *Pediatrics* 2012;129(03):e827-e841
- 15 Chantry CJ, Eglash A, Labbok M. ABM position on breastfeeding-revised 2015. *Breastfeed Med* 2015;10(09):407-411
- 16 Centers for Disease Control and Prevention, Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion. Breastfeeding Report Card. Available at: <https://www.cdc.gov/breastfeeding/data/reportcard.htm>. Accessed October 6, 2020
- 17 American Academy of Pediatrics. FAQs: Management of Infants Born to Mothers with Suspected or Confirmed COVID-19. Available at: <https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/faqs-management-of-infants-born-to-covid-19-mothers/> [updated April 2, 2020]. Accessed May 31, 2020
- 18 American Academy of Pediatrics. FAQs: Management of Infants Born to Mothers with Suspected or Confirmed COVID-19. Available at: <https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/faqs-management-of-infants-born-to-covid-19-mothers/> [updated July 22, 2020]. Accessed August 18, 2020

