

# Neonates Born to Mothers With COVID-19: Data From the Spanish Society of Neonatology Registry

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abstract

**OBJECTIVES:** To describe neonatal and maternal characteristics of the largest prospective cohort of newborns from mothers with coronavirus disease 2019 (COVID-19), the data of which were prospectively collected from the nationwide registry of the Spanish Society of Neonatology.

**METHODS:** Between March 8, 2020, and May 26, 2020, the data of 503 neonates born to 497 mothers diagnosed with COVID-19 during pregnancy or at the time of delivery were collected by 79 hospitals throughout Spain.

**RESULTS:** Maternal symptoms were similar to that of the general population, with 5% of severe forms. In 45.8% of asymptomatic women at the time of delivery, severe acute respiratory syndrome coronavirus 2 infection was detected because of recommendations established in Spain to perform COVID-19 screening in all women admitted to the hospital for labor. The rate of preterm deliveries was 15.7% and of cesarean deliveries, 33%. The most common diagnostic test was detection of viral RNA by polymerase chain reaction of nasopharyngeal swabs at a median age of 3 hours after delivery (1–12 hours). Almost one-half of neonates were left skin-to-skin after delivery, and delayed clamping of umbilical cords was performed in 43% of neonates. Also, 62.3% of asymptomatic neonates were managed with rooming-in. Maternal milk was received by 76.5% of neonates, 204 of them as exclusive breastfeeding.

**CONCLUSIONS:** The current study indicates that there is no need for separation of mothers from neonates, allowing delayed cord clamping and skin-to-skin contact along with maintenance of breastfeeding in a high percentage of newborns from mothers with COVID-19.



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**WHAT'S KNOWN ON THIS SUBJECT:** The characteristics of neonates born to mothers with coronavirus disease 2019 have been reported in small studies, according to which vertical transmission seems to be rare, and neonatal outcomes appear to be favorable. However, consistent data from nationwide registries are lacking.

**WHAT THIS STUDY ADDS:** On the basis of data from 503 neonates born to 497 coronavirus disease 2019–positive mothers, there is no need for separation of mothers from neonates, allowing delayed cord clamping and skin-to-skin contact along with maintenance of breastfeeding in a high percentage of newborns.

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A novel viral respiratory disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is responsible for a global pandemic of the coronavirus disease 2019 (COVID-19).<sup>1</sup> Despite information on COVID-19 in children,<sup>2-5</sup> limited data are available on COVID-19-positive pregnant women and their neonates.<sup>6-10</sup> Evidence that SARS-CoV-2 undergoes vertical transmission from infected pregnant women to their fetuses is still a controversial issue. Schwartz et al<sup>10</sup> propose that the occurrence of intrauterine transplacental SARS-CoV-2 among infected mother-infant dyads be based on identification of SARS-CoV-2 in chorionic villous cells by using immunohistochemistry or nucleic acid methods. Patanè et al<sup>11</sup> reported 2 neonates born from mothers with COVID-19, with polymerase chain reaction (PCR) positivity of nasopharyngeal swabs, in which the fetal side of the placenta showed chronic intervillitis with macrophages by immunohistochemistry and SARS-CoV-2 spike antigen in villous syncytiotrophoblasts by in-situ hybridization for SARS-CoV-2. In the case reported by Vivanti et al,<sup>12</sup> reverse transcriptase polymerase chain reaction (RT-PCR) on the placenta was positive for E and S genes of SARS-CoV-2, and placental histologic examination revealed diffuse perivillous fibrin deposition, with infarction and acute and chronic intervillitis, as well as an intense cytoplasmic positivity of perivillous trophoblastic cells performing immunostaining, with antibody against SARS-CoV-2 N protein.

In the study by Zeng et al,<sup>13</sup> 3 of 33 (9%) infants were diagnosed with neonatal early-onset infection with SARS-CoV-2 on the basis of positive quantitative RT-PCR results of the nasopharyngeal and anal swabs in 2 consecutive tests at days 2 and 4 of age, but postpartum infections cannot be excluded because of the delay in

testing and the fact that all infants tested negative by days 6 to 7. In 2 reported cases of neonates infected with SARS-CoV-2 and elevated immunoglobulin M (IgM) antibody levels in blood samples drawn after birth,<sup>14,15</sup> the serological suggestion of vertical transmission did not prove in utero transmission in the absence of virological evidence in infants' specimens.<sup>16,17</sup> In a case of probable congenital SARS-CoV-2 infection in a neonate born to a woman with active infection, the presence of SARS-CoV-2 RNA was detected in breast milk, and maternal familial neutropenia may have contributed to antenatal acquisition of SARS-CoV-2 infection.<sup>18</sup> However, neonates should be tested for SARS-CoV-2 RNA in cord blood, placental specimens, and nasopharyngeal swabs without waiting the 24 hours indicated by the current American Academy of Pediatrics guidelines.<sup>19</sup> Also, obtaining 2 consecutive SARS-CoV-2 tests results (swabs) for the neonate may allow caregivers to discontinue droplet and contact precautions, although in some units, the infant will still be considered a contact of exposure for 14 days.<sup>18</sup>

Previous reports of pregnant women diagnosed with COVID-19 and their neonates were relatively small studies.<sup>20-23</sup> We have analyzed the largest series of 503 neonates born to 497 COVID-19-positive pregnant women, the data of which were prospectively collected in a nationwide registry of the Spanish Society of Neonatology.

## METHODS

The Spanish Society of Neonatology (*Sociedad Española de Neonatología*) (SENEO) developed a nationwide, prospective online case registration system, with the aim of collecting real-time data of neonates born to mothers diagnosed with COVID-19 during pregnancy or in the immediate postpartum period. SENEO executive

committee members reviewed the literature and designed the items that should be entered into the database, which was accessible from the SENE Web site to all neonatology services in Spain. Staff neonatologists at each service were responsible for entering data on different variables of the clinical characteristics of mothers (maternal age; previous morbidity; pathologic conditions during gestation; live births; mode of delivery; signs and symptoms of COVID-19 infection; intensity of symptoms, categorized as mild [upper respiratory tract infection], moderate [pneumonia], and severe [need of ICU admission]; diagnostic tests, and treatment) and neonates (gestational age, prematurity, birth weight, length and head circumference, Apgar test, resuscitation maneuvers, delayed clamping [ $>1$  minute, categorized as yes or no], skin-to-skin contact, type and mode of feeding, diagnostic tests, and outcome). The most common RT-PCR tests used in the laboratories of the largest participating hospitals included Allplex 2019nCoV Assay (Seegene, Seoul, South Korea), TaqMan 2019-nCoV Assay Kit v1 (Thermo Fisher Scientific, Waltham, MA), TaqPath COVID-19 Combo Kit (Applied Biosystems, Foster City, CA), and SARS-COV-2 Realtime PCR kit (Viracell, Granada, Spain).

The study was approved by the Clinical Research Ethics Committee of the Principality of Asturias. Written informed consent was obtained from the neonates' parents. The diagnosis and management of newborns with or at risk for COVID-19 were in accordance with clinical guidelines of the SENE.<sup>24</sup> The patients included in the registry between March 8, 2020, and May 26, 2020 form the basis of this report. Descriptive statistics are presented.

## RESULTS

During the study period, the data of 503 neonates born to COVID-19-

positive mothers ( $n = 497$ ) were collected by 79 hospitals throughout Spain. According to official data of the National Epidemiologic Surveillance Network from the Spanish Ministry of Health, data extracted on May 29, 2020, at 11 AM included a total of 250 273 cases of COVID-19 notified up to May 10, 2020, with 18 975 deaths, 86 488 hospital admissions, and 4735 admissions to the ICU.<sup>25</sup> A total of 0.2% of cases were diagnosed in infants aged <2 years.

### Clinical Features of Mothers With Perinatal COVID-19 Infection

Maternal characteristics are shown in Table 1. The median age of the 497 pregnant women was 33 years, and >70% had no previous pathologic conditions or diseases during pregnancy. Most women acquired COVID-19 infection during the third trimester of pregnancy and usually presented mild symptoms (eg, fever, cough, and malaise). Almost one-half of women (49.3%) were asymptomatic at the time of delivery, and COVID-19 infection was detected because of recommendations established in our country to make COVID-19 screening available to all women admitted to the hospital for labor. The percentage of asymptomatic women revealed an increase from 21.8% in March to 56.6% in April and up to 65.5% in May.

The most common diagnostic method was quantitative real-time PCR or dual fluorescence PCR in nasopharyngeal swabs. Other samples (eg, placenta, amniotic fluid, etc) for PCR testing were collected in a few cases, and results were negative. In 29 women, the diagnosis was made by using serological testing (particularly in women admitted to the hospital in May); and in 3 women, by highly suggestive clinical symptoms and history of direct contact with an individual with a confirmed case of COVID-19. In the 29 women in whom the diagnosis

was made by using serological testing, there were 19 women with positive IgM and immunoglobulin G (IgG) antibodies (PCR not performed in 7 and PCR results negative in 12) and 10 with negative IgM and positive IgG (PCR not performed in 3 and PCR results negative in 7) (Table 2). Of the 252 symptomatic pregnant women, symptoms developed before delivery in 246 and in the postpartum period in the remaining 6. In 63 of the 136 pregnant women diagnosed with COVID-19 infection more than a week before delivery, PCR testing of the nasopharyngeal swab on hospital admission to give birth revealed that viral RNA persisted detectable in 33 women, whereas 30 women were PCR-negative. In 26 of the 33 women who remained PCR-positive, >14 days had elapsed since the onset of symptoms (60 days in 1 case of a pregnant woman with viral pneumonia).

A total of 164 women (33%) had a cesarean delivery, one-half of them on an emergency basis and 76% because of obstetric factors. Maternal COVID-19 infection was the indication of cesarean delivery in 39 patients (23.8%), 81.5% of whom had moderate or severe COVID-19.

Other data collected included lymphopenia in 20.5% of the patients, increased liver enzymes in <20%, and elevated serum C-reactive protein levels in 58.4%. Anti-COVID-19 treatment included hydroxychloroquine in 113 women, antiviral agents in 122, and antimicrobial agents in 150. Hydroxychloroquine was administered as the only specific treatment in 50 women, whereas in the remaining women, it was given in combination with antiviral agents and/or antimicrobial agents. Doses and duration of treatments were not recorded.

### Clinical Features of Neonates

The clinical characteristics of neonates are shown in Table 2. One

newborn died in the delivery ward despite resuscitation maneuvers. The premature and very premature birth rates were 15.7% and 5.2%, respectively. One-half of newborns were left skin-to-skin after delivery (62% of infants born at term did not require resuscitation), and delayed clamping of umbilical cords was performed in 42.9% of neonates. PCR-positive mothers used facemasks when having skin-to-skin contact. Figure 1 shows the distribution of neonates according to the presence of symptoms and the need for admission to the NICU or the neonatal intermediate care unit, depending on isolation beds available at each hospital. Of the 502 neonates, 98 (19.5%) were admitted to the NICU because of clinical symptoms (including preterm infants). In the remaining 404 asymptomatic neonates, 264 (52.6%) were managed with rooming-in and breastfeeding in 90% of cases, whereas 41 infants were maintained with a healthy caregiver different from the mother. The median length of hospital stay for asymptomatic neonates was 48 hours (interquartile range [IQR] [25th–75th percentile] 48–56 hours). The remaining 99 neonates were admitted to the NICU or the neonatal intermediate care unit in relation to maternal COVID-19 infection because of severity of maternal clinical symptoms (20.2%) or hospital organization difficulties for rooming-in maintenance (79.8%). In this group, the median length of hospital stay was 2.5 days (IQR 2.5–7). Overall, 78.1% of neonates were fed with breast milk (alone or combined with formula). Exclusive breastfeeding was recorded in 272 (54.2%) neonates.

The diagnostic test most commonly used was detection of viral RNA by PCR of nasopharyngeal swabs at a median age of 3 hours after delivery (1–12 hours) (Table 2). Other samples, such as feces, urine, peripheral blood, or bronchoalveolar

**TABLE 1** Clinical Characteristics of Pregnant Women With Confirmed COVID-19

Characteristics	All Women (N = 497)
Age, y, median (IQR)	33.0 (29–37)
≤35, n (%)	326 (65.6)
>35, n (%)	171 (34.4)
Previous morbidity, n (%) <sup>a</sup>	139 (28.0)
Obesity	36 (7.2)
Infertility	17 (3.4)
Hypothyroidism	13 (2.6)
Autoimmune disease	13 (2.6)
Respiratory disease	13 (2.6)
Coagulation disorder	11 (2.2)
Heart disease	7 (1.4)
Hypertension	4 (0.8)
Diabetes mellitus	3 (0.6)
Gestational pathology, n (%) <sup>a</sup>	99 (19.9)
Diabetes	23 (4.6)
Preeclampsia	20 (4.0)
Hypothyroidism	10 (2.0)
Cholestasis	8 (1.6)
Chorioamnionitis	4 (0.8)
Fetal maturation with corticosteroids < 35 wk, n (%)	25 of 41 (61.0)
Live births, n (%)	
Singleton	491 (98.8)
Twins	6 (1.2)
Mode of delivery, n (%)	
Vaginal	262 (52.7)
Cesarean delivery	164 (33.0)
Urgent	86 (52.4)
Obstetrical indication	125 (76.2)
Concern about COVID-19 infection	39 (23.8)
COVID-19 infection during gestation, n (%)	
Second trimester	8 (1.6)
Third trimester	489 (98.4)
Clinical manifestations, n (%) <sup>a</sup>	
Cough	166 (33.4)
Fever	159 (31.9)
General malaise or fatigue	58 (11.6)
Dyspnea	58 (11.6)
Myalgias	54 (10.9)
Anosmia and/or ageusia	51 (10.3)
Odynophagia	30 (6.0)
Headache	25 (5.0)
Diarrhea	19 (3.8)
Intensity of symptoms, n (%)	252 (50.7)
Mild	159 (32.0)
Moderate	72 (14.5)
Severe (ICU admission)	21 (4.2)
Asymptomatic, n (%)	245 (49.3)
Diagnostic tests, n (%)	
Positive PCR test results	
Nasopharyngeal swabs	464 (93.4)
Bronchoalveolar lavage fluid	1 (0.2)
Positive serological test results	
IgM antibodies	19 (3.8)
IgG antibodies	10 (2.0)
Highly suggestive clinical features	3 (0.6)
Other virological test results	
Placenta, n = 13	Negative
Amniotic fluid, n = 10	Negative
Feces, n = 4	1 positive, 3 negative
Breast milk, n = 3	Negative
Sputum, n = 2	1 positive, 1 negative

lavage fluid, were collected in a small percentage of newborns and, in all cases, had negative test results for SARS-CoV-2. In the first PCR tests, 14 of the 469 nasopharyngeal swabs were positive for COVID-19 (positive rate 3.0%). However, in the second PCR testing in these 14 cases, conducted 24 to 48 hours later, 12 samples gave negative results (a third PCR testing in nasopharyngeal swabs conducted in some of these cases also gave negative results). In all of these cases, the newborns were asymptomatic. One of the remaining 2 cases were in an infant born at term by cesarean delivery, without skin-to-skin contact and admitted separated from his mother (mild symptoms) immediately after delivery. The infant remained asymptomatic; the first PCR test was performed at 10 hours of age, and the second PCR performed at 8 days during outpatient follow-up gave negative results. The second case was also in a neonate born at term by vaginal delivery; the mother and the infant were both asymptomatic, and the first PCR testing was performed at 36 hours when rooming-in with the mother and breastfeeding. A second PCR test was not performed, and the patient was discharged at 60 hours of birth. The telephone follow-up confirmed that the clinical course was uneventful.

Four other patients had a negative PCR result at birth and a positive result in a second PCR test at 24–48 hours. In 1 case, the infant was rooming-in, and the second sample was taken when he had been with his mother for >24 hours. The remaining 3 cases were in neonates admitted to the neonatal unit from birth (1 because of prematurity and 2 because of maternal COVID-19). Except for the premature child who presented with transient respiratory distress, all were asymptomatic.

Of the 305 neonates who were not admitted to the hospital, 297 (97.4%) were managed by telephone calls and/or at the outpatient clinics of the hospital, and 248 (83.5%) were in

**TABLE 1** Continued

Characteristics	All Women (N = 497)
Vaginal exudate, n = 2	Negative
Other laboratory tests, n (%)	
Lymphocytopenia	102 (20.5)
Aspartate aminotransferase level >50 IU/L	45 of 278 (16.1)
Alanine aminotransferase level >50 IU/L	41 of 295 (13.9)
C-reactive protein level >2 mg/dL	170 of 291 (58.4)
Treatment, n (%) <sup>a</sup>	
None	294 (59.1)
Hydroxychloroquine	133 (22.7)
Antimicrobials	107 (21.5)
Antivirals	66 (13.3)
Low molecular-wt heparin	54 (10.9)
Interferon β-1b	4 (0.8)
Tocilizumab	1 (0.2)
Oxygen therapy	52 (10.5)
Respiratory support	23 (4.6)

<sup>a</sup> Concomitant presence of various characteristics in some women.

good health. Data of the remaining 57 infants were not available.

## DISCUSSION

This study reports data collected from a nationwide, prospective registry of COVID-19 in pregnant women and their neonates, with the support of the Spanish Society of Neonatology. The large number of cases analyzed with obstetrical and neonatal data is a salient feature of the study.

Clinical manifestations of COVID-19 in pregnant women appear to be similar to those in the general population (80% of patients being asymptomatic or showing mild symptoms). In the present series, 49% of pregnant women were asymptomatic at the time of delivery, which reinforces the need to screen pregnant women before delivery and implement strict infection control measures, to quarantine infected mothers, and to maintain close monitoring of neonates at risk for COVID-19.<sup>13</sup>

The 33% rate of cesarean deliveries was probably influenced by severe cases of COVID-19, which would decrease to 25% if these cases would have been excluded.

In other studies of SARS-CoV-2 infection in late pregnancy, all women had cesarean deliveries.<sup>23,26</sup> In a systematic review of 108 pregnancies with COVID-19, collected from 18 articles, cesarean delivery accounted for 91% of all deliveries.<sup>27</sup> Also, data of most reports describing women presenting in the third trimester with fever, coughing, lymphocytopenia, and elevated C-reactive protein levels are in agreement with the present findings.<sup>11,24</sup>

The 15.7% prematurity rate is higher than usual in our country, last estimated to be 7.54% in 2018, although a clear relationship with maternal COVID-19 cannot be established. However, 31 of the 39 cases of cesarean delivery performed because of SARS-CoV-2 infection were premature deliveries, and most of the cases were registered in large tertiary care hospitals in which the prematurity rate is greater than the national average. High rates of preterm delivery (47%) in COVID-19 pregnant women have been also reported in a review of 21 relevant studies, all of which were case reports or case series.<sup>28</sup>

Delivery was uneventful and neonatal resuscitation measures were required in a small percentage of newborns, and only one newborn died in the

delivery room. This was a case of severe maternal SARS-CoV-2 infection, in which the mother also died in the delivery room. On the other hand, the clinical course of neonates was generally favorable, and <40% of newborns required hospital admission, with the lack of hospital infrastructure for safe practice of rooming-in as the reason for admission in most of the cases, particularly during the first weeks of the COVID-19 pandemic. In these cases, however, the length of hospital stay was <3 days.

Testing for SARS-CoV-2 in nasopharyngeal swabs within the first 3 hours of life (1–12 hours) was performed in almost all neonates, with a second PCR test in only 28.6% of patients (most neonates admitted to the hospital). A total of 14 asymptomatic neonates tested positive for SARS-CoV-2 by PCR performed in nasopharyngeal samples taken 3 hours after birth. However, 12 of these 14 neonates were negative for COVID-19 in a second testing of nasopharyngeal swabs 24 to 48 hours later (some of them with a third negative result). In the remaining 2 cases, in 1 infant, the first PCR test was performed at 10 hours of life, and the second test was performed at the 8-day follow-up visit, with negative results. In the other infant, the first PCR was performed at 36 hours of life while rooming-in and breastfeeding, and a second PCR test was not performed, but the infant and his mother were asymptomatic, and follow-up was uneventful. The literature also contains case reports of neonates who were considered to be infected on 1 positive test result for COVID-19. Yu et al<sup>29</sup> reported 7 pregnant women with COVID-19, and the nucleic acid test result for the throat swab of 1 neonate was positive at 36 hours after birth; however, 2 consecutive negative nucleic acid test results were obtained 2 weeks later. Wang et al<sup>30</sup> published the case

**TABLE 2** Clinical Characteristics of Neonates Born to Mothers With COVID-19

Characteristics	All Neonates (N = 503) <sup>a</sup>
Anthropometric data, mean (SD)	
Birth wt, g	3097 (667)
Length, cm	49 (3.7)
Head circumference, cm	34.0 (2.4)
Gestational age, wk, mean (SD)	38.2 (2.7)
Prematurity, wk, n (%)	
<37	79 (15.7)
≤32	26 (5.2)
Apgar score, median (IQR)	
At 1 min	9 (9–9)
At 5 min	10 (10–10)
Neonatal resuscitation maneuvers, n (%)	
Nasopharyngeal suctioning	17 (3.4)
Intermittent positive pressure with mask	44 (8.7)
Endotracheal intubation, cardiac massage	13 (2.6)
Immediate skin-to-skin contact, n (%)	260 (51.8)
Delayed cord clamping, n (%)	216 (43.0)
Type of feeding, n (%)	
Mother's milk	245 (48.8)
Donated maternal milk	54 (10.7)
Mixed	93 (18.5)
Adapted formula	110 (21.9)
Mode of feeding, n (%)	
Breastfeeding	272 (54.2)
Bottle-feeding	179 (35.6)
Nasogastric catheter	39 (7.8)
Various modes	12 (2.4)
PCR diagnostic test, n (%)	
Samples	
Nasopharyngeal swab	469 (93.2)
Feces <sup>b</sup>	15 (3.0)
Bronchoalveolar lavage fluid <sup>b</sup>	5 (1.0)
Peripheral blood <sup>b</sup>	3 (0.6)
Urine <sup>b</sup>	1 (0.2)
Results of nasopharyngeal swab PCR test, n (%)	
First test	
Positive	14 of 469 (3.0)
Negative	455 of 469 (97.0)
Second test, performed in 157 neonates	
Positive, previous negative	4 of 144 (2.7)
Negative, previous positive	13 of 14 (2.8)
Age, h, median (IQR)	
At first PCR in nasopharyngeal swabs	4 (1–12)
At second PCR in nasopharyngeal swabs	48 (30–48)
Admission to the NICU or intermediate care unit	197 (39.2)

IQR is in 25th to 75th percentile.

<sup>a</sup> One neonate died in the delivery room (negative PCR result in the pharyngeal swab).

<sup>b</sup> Negative results.

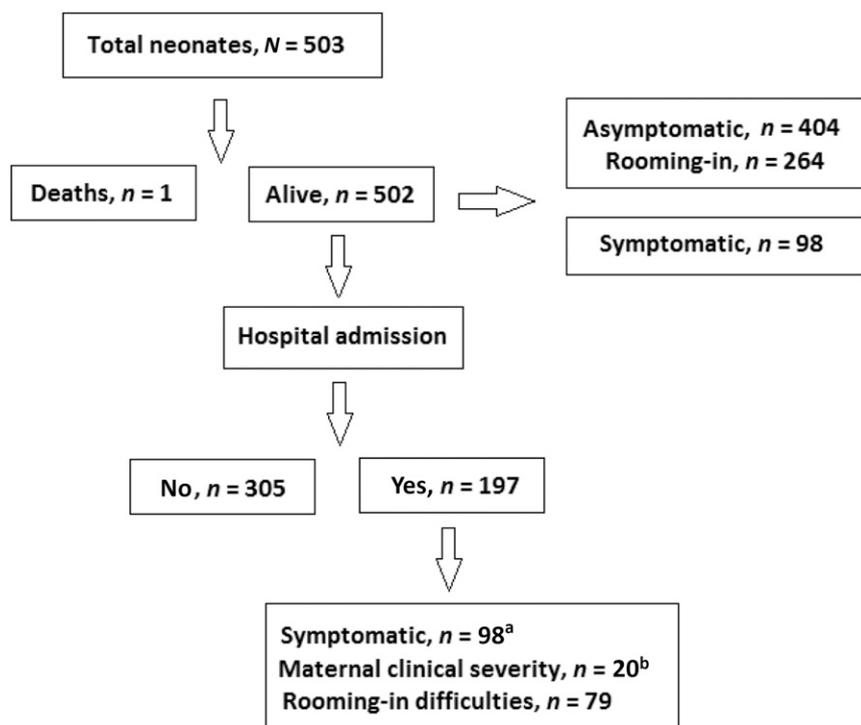
report of a neonate born by cesarean delivery with pharyngeal swab positive for SARS-CoV-2 36 hours after birth, but nucleic acid tests for SARS-CoV-2 on cord blood and placenta specimens that we retained during the operation gave negative results. In a retrospective cohort study of 19 neonates with positive test results for COVID-19 from 10 hospitals throughout Iran, there was

significant variability in the results of neonatal testing for the virus, including neonates with only 1 positive test result (from 1 hour after birth to day 35), neonates with initial positive results and negative results in a second testing between day 4 and day 20 after birth, and initial negative results (between 1 and 4 hours after birth) and positive results in a second testing between 3 and 8 days after birth.<sup>31</sup>

On the other hand, in some published case reports of vertical transmission, researchers report persistently positive PCR results,<sup>32</sup> with 1 patient with PCR-positive results up to 14 days of life<sup>33</sup> and another up to 18 days of life.<sup>12</sup> Other studies in amniotic fluid, cord blood, or placental immunochemistry or RT-PCR analysis<sup>10–12</sup> were not performed.

However, positive test results shortly after birth should be cautiously interpreted given the paucity of studies at this time, the absence of knowledge of the mechanism(s) for perinatal acquisition of the infection in the majority of cases reported, the lack of data regarding the sensitivity of nasopharyngeal testing for SARS-CoV-2 in neonates, no available data on specificity and sensitivity of RT-PCR testing in neonates for COVID-19, and little understanding of the patterns of test positivity for the coronavirus in nasopharyngeal and oropharyngeal specimens in neonates.

The current study reveals that delayed cord clamping, skin-to-skin contact, and breastfeeding were achievable in approximately one-half of the cases, which is clinically important because they impact health and early child development. The World Health Organization<sup>34</sup> recommends that infants born to mothers with suspected, probable, or confirmed COVID-19 infection should be fed according to standard infant-feeding guidelines while applying necessary precautions for infection prevention control. The results of this review do not discourage delayed cord clamping when the newborn's clinical condition would allow it. The determination of whether to separate a mother with known or suspected COVID-19 and her infant should be made on a case-by-case basis, according to virological results in the mother and the infant as well as recommendations of the epidemiological surveillance team of the hospital.<sup>24</sup> Skin-to-skin contact and breastfeeding can be recommended,



**FIGURE 1** Distribution of neonates according to symptoms and the need for hospital admission (NICU or neonatal intermediate care unit, depending on isolation beds available at each hospital). <sup>a</sup> Includes prematurity. <sup>b</sup> Neonates were asymptomatic.

but it is critical to screen pregnant women, implement prevention and control measures, and closely monitor newborns at risk for COVID-19.

This study has several strengths. First, this is the first nationwide study, to date, with a major focus on the epidemiological characteristics of COVID-19 during pregnancy. Second, the large number of women with confirmed SARS-CoV-2 infection and their neonates presents comprehensive data of pregnant women with COVID-19 in one of the European countries that have experienced especially high infection rates. This study also has a number of limitations, particularly problems with pregnancy and neonatal registries restricted to a core data set to simplify participation, promote complete reporting, and avoid information bias. In this respect, data on the threshold cycle values for PCR-positive patients were not recorded, which would be more illustrative to

reflect viral load and may be used to justify the low rate of neonatal infection. A potential variability of results may be considered because specific information regarding performance details of the laboratory techniques used at each participating hospital were not recorded.

### CONCLUSIONS

Maternal symptoms of COVID-19 in pregnancy are similar to those of the general population, with a low percentage of severe forms. SARS-CoV-2 infection was detected in almost one-half of asymptomatic women because of recommendations established in Spain to perform COVID-19 screening in all women admitted for labor: Universal PCR testing before labor should be recommended. The rate of preterm deliveries was almost threefold higher than that usually recorded in our country. Skin-to-skin contact after delivery, delayed cord clamping, rooming-in with the mother,

and breastfeeding were recorded in a high percentage of neonates, with no adverse events. Most neonates did not require hospitalization and were managed on an outpatient basis. No case of readmission due to COVID-19 has been registered. The present results are in line with the fact that, as of today, most mothers are found not to be contagious at the time of delivery.

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#### ABBREVIATIONS

COVID-19: coronavirus disease 2019  
IgG: immunoglobulin G  
IgM: immunoglobulin M  
IQR: interquartile range  
PCR: polymerase chain reaction  
RT-PCR: reverse transcriptase polymerase chain reaction  
SARS-CoV-2: severe acute respiratory syndrome coronavirus 2  
SENEO: Spanish Society of Neonatology (*Sociedad Española de Neonatología*)

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