

**Original article**

**Title:** Clinical characteristics, management, and short term outcome of neonates born to mothers with COVID-19 in a tertiary care hospital in India

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20 **Lay summary:** The current pandemic of COVID-19 has affected all the countries globally.  
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22 However, the adverse impact of the pandemic is more seen in the low-income and middle-  
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24 income countries (LMICs). Although there is evidence on the adverse impact of the SARS-CoV-  
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26 2 on the health of mothers and neonates, the evidence is mainly from high-income countries. For  
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28 reducing the mortality and morbidity due to COVID-19 in LMICs, there is a need to generate  
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30 evidence from the LMICs. The present study is a part of the National Registry of pregnant  
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32 women with COVID-19 in India (PregCovid registry). Our study demonstrates a higher risk of  
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34 adverse outcomes such as neonatal sepsis and death in the SARS-CoV-2 infected as compared to  
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36 the non-infected neonates. The study also showed the risk of SARS-CoV-2 infection in 6.3 % of  
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38 neonates born to mothers with COVID-19.  
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**Abstract**

**Introduction:** We describe the clinical characteristics, management, and short-term outcomes of SARS-CoV-2 neonates born to mothers with COVID-19 in a tertiary care hospital in Mumbai, India.

**Methods:** The study is a retrospective analysis of 524 neonates born to mothers with COVID-19 admitted from 14<sup>th</sup> April 2020 to 31<sup>st</sup> July 2020.

**Results:** SARS-CoV-2 infection was detected in 6.3% of the newborns of the mothers with COVID-19. No significant differences were observed between maturity at gestation, birth weight and sex of SARS-CoV-2 infected and non-infected newborns. The risk of sepsis was 4.09 (95% CI, 1.28-13.00) fold higher in the neonates with SARS-CoV-2 as compared to the non-infected group ( $p=0.031$ ). Poor feeding was significantly more common among SARS-CoV-2 infected neonates (12.1%) as compared to the non-infected neonates (2.7%) ( $p=0.017$ ). There was a total of 13 neonatal deaths, of which 3 deaths occurred in SARS-CoV-2 infected neonates (9%) while 10 (3%) in the SARS-CoV-2 negative group. The risk of neonatal death was higher in SARS-CoV-2 infected newborns (OR 4.8; 95% CI 1.25-18.36).

**Conclusion:** Neonatal SARS-CoV-2 infection is observed in almost 6% of neonates born to mothers with perinatal COVID-19. There is a higher risk of adverse outcomes such as neonatal sepsis and death in the SARS-CoV-2 infected as compared to the non-infected neonates.

**Keywords:** SARS-CoV-2, COVID-19, newborns, neonatal outcome

## Introduction

The emergence of the outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in December 2019 has caused a global pandemic resulting in potentially lethal coronavirus disease 2019 (COVID-19). More than 167 million COVID-19 cases and more than 3.4 million deaths have been reported due to COVID-19 as of 27<sup>th</sup> May 2021[1]. Though it affects all age groups, there is growing evidence of its impact on pregnant women and their newborns [2]. India continues to be amongst the top countries having increasing numbers of COVID-19 cases affecting nearly 27 million people with more than 0.3 million deaths as of 27<sup>th</sup> May 2021 [3]. India accounts for nearly one-fifth of the world's annual childbirths thereby suggesting possibly large numbers of neonates affected with SARS-CoV-2 infection.

Current evidence indicates no major adverse neonatal outcomes of that maternal COVID-19 and a low risk of vertical transmission [4-6]. However, most of the data is accumulated from high-income countries [6-9]. There is very little information about clinical presentations and management of neonates born to COVID-19 mothers in low-income and middle-income countries (LMICs). There is a need to document the same in different populations.

The possibility of the maternal-fetal transmission of the SARS-CoV-2 is high due to various reasons such as the expression of ACE-2 receptor in the placenta [10]. However, the lower intracellular response induced by ACE-2 in the alveolar epithelial cells and the presence of alpha and gamma chains in fetal hemoglobin may exhibit a protective response in newborns [11]. Despite this hypothesis, severe course, and adverse outcomes are reported in neonates [12] and the occurrence of vertical transmission is demonstrated in some of the studies [13-15]. However, early neonatal infection due to horizontal transmission and/or environmental contamination cannot be excluded in some of the studies. There is evidence of SARS-CoV-2 detection in the

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3 breast milk of women with active infection [16,17]. Therefore, there is a reasonable possibility of  
4 vertical transmission of SARS-CoV-2 postnatally. Although some studies have refuted this  
5 possibility [7,18]. Further, SARS-CoV-2 infection perinatally affects maternal and placental  
6 health which can impact the clinical course of the newborns postnatally. The present study  
7 describes the clinical characteristics and management of neonates born to mothers with COVID-  
8 19. We also compared the clinical characteristics and short-term outcomes of the SARS-CoV-2  
9 infected and non-infected newborns of the mothers with COVID-19.

## 19 **Materials and Methods**

### 21 **Study design and procedures**

23 The study is a retrospective analysis of the neonates born to mothers with COVID-19 admitted  
24 and delivered at BYL Nair Charitable Hospital (NH). This study is a part of the National  
25 Registry of Pregnant women with COVID-19 in India [19]. Data on 524 neonates born at NH to  
26 mothers with COVID-19 from 14<sup>th</sup> April 2020 to 31<sup>st</sup> July 2020 was collected from the registry.  
27 The study was approved by the Ethics Committees of TNMC (No. ECARP/2020/63 dated  
28 27.05.2020) and ICMR-NIRRH (IEC no. D/ICEC/Sci-53/55/2020 dated 04.06.2020). The  
29 PregCovid registered with the clinical trial registry of India (CTRI/2020/05/025423).

### 41 **Labour room practices**

42 The obstetrics practices that were followed at NH are detailed earlier [20]. All healthcare workers  
43 involved in the deliveries of COVID-19 positive mothers used personal protective equipment  
44 including N-95 masks, face shields, and eye protection goggles to minimize virus spread during  
45 aerosol-generating procedures and followed the infection prevention and control principles  
46 meticulously. Pregnant mothers were delivered either vaginally, assisted delivery, or by cesarean  
47 section depending on their obstetric assessment. We practiced delayed cord clamping and  
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3 immediate skin-to-skin contact in vigorous babies was encouraged. Mothers performed hand  
4 hygiene and wore a mask. Those babies who required resuscitation were immediately shifted  
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6 under the pre-warmed radiant heat warmer in the designated newborn resuscitation room and  
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8 were appropriately managed as per the standard NRP 2015 resuscitation guidelines with a  
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10 minimum number of personnel attending (one doctor for low-risk cases and two for complicated  
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12 cases). COVID-19 status did not alter the indications for intubation.  
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### 16 17 **New-born testing strategies**

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19 The nasopharyngeal swab was sent for all babies for a real-time reverse-transcription–  
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21 polymerase chain reaction (RT-PCR) assay for SARS-CoV-2. From 14<sup>th</sup> April-May 2020 the  
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23 first swab was sent after 24 hours of birth and the second swab after 72 hours of birth as per  
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25 guidelines [21]. With the change of national policy, from June 2020 - till 31<sup>st</sup> July 2020 only the  
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27 first swab was sent at birth / within 12 hours of life. If the first swab was negative and the baby  
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29 was asymptomatic no further testing was done. In cases where the first swab was positive, a  
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31 repeat swab was collected 24-48 hours later and tested.  
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### 35 36 **Place of care, feeding, and management policies**

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38 All stable newborns were kept in the postnatal ward with mothers irrespective of their COVID-  
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40 19 status (Zero separation policy) [22,23]. All neonates born to COVID-19 positive mothers who  
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42 were roomed-in with their mothers in post-natal neonates were initiated into early and continued  
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44 exclusively breastfed as far as possible. Occasionally, in a few babies, pasteurized donor human  
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46 milk from Human Milk Bank or acceptable animal milk from pasteurized dairy milk with  
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48 standardized fat composition was given. All the newborns were managed as per guidelines by  
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50 expert group consensus. The antibiotics were given only if indicated in clinically suspected  
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52 sepsis or proven sepsis [22]. The antibiotics given were injectable cefotaxime and amikacin  
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3 which are then stepped up to piperacillin-tazobactam or meropenem and the duration ranged  
4 from 10-14 days. The resuscitation guidelines for newborns were followed [24]. Discharge of  
5 mother and baby was done as per the ICMR COVID-19 guidelines with adequate counseling.  
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7 Symptomatic SARS-CoV-2 infected neonates were shifted into a designated COVID-19 NICU  
8 having a dedicated separate team of health care workers where IPC control measures were  
9 strictly followed.

### 16 **Data collection**

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18 New-born data was captured from the electronic database which included gestational age, mode  
19 of delivery, birth weight, sex, clinical symptoms, laboratory and radiological characteristics,  
20 diagnosis with SARS-CoV-2 infection, treatment, and neonatal outcomes.  
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### 26 **Statistical analysis**

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28 The categorical data were presented as frequencies and percentages. The odds ratio (OR) and the  
29 corresponding 95% confidence interval (95% CI) were calculated using binary logistic  
30 regression. To understand differences in outcomes of SARS-CoV-2 infected and non-infected  
31 neonates, the Pearson's Chi-square or Fisher's exact test was performed, as appropriate. A two-  
32 sided *p*-value of less than 0.05 was considered statistically significant. Statistical analysis was  
33 performed using IBM SPSS Statistics Base version 26.0 (SPSS South Asia Pvt Ltd, Bangalore).  
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### 42 **Results**

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44 Total 524 live births occurred during the study period of which 505 were singleton pregnancies  
45 and 8 were twin gestations with one triplet. Out of 524 newborns, the nasopharyngeal swab was  
46 collected in 523 newborns. Swab could not be collected in one newborn because of death  
47 resulting due to severe birth asphyxia. The information of this neonate was excluded for all  
48 further analysis.  
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### **SARS-CoV-2 testing in neonates**

Thirty-three of the 523 neonates (6.3%) were positive for SARS-CoV-2 by RT-PCR while the others were negative during the stay in the hospital. We compared the presentation and the outcomes of these 33 SARS-CoV-2 positive and 490 SARS-CoV-2 negative neonates born to mothers with COVID-19. The details of the 33 neonates are shown in Table 1. Amongst 33 COVID-19 positive neonates, 29 newborns were positive in their first swab itself collected within 12-24h of birth. There were four neonates whose initial RT-PCR test was negative; however, their repeat test at 72 hours of life was positive. In most neonates, the repeat RT-PCR test done after 48-72h of the first test was negative except for four neonates where the repeat test was also positive. Six of the 33 SARS-CoV-2 positive neonates were symptomatic (24%) while the others were asymptomatic. The profile and course of newborns of the mothers with COVID-19 are presented in Figure 1.

### **Presentations and outcomes in SARS-CoV-2 positive and negative neonates**

Out of 524 neonates, 53.6% (n=281) were males and 46.4% (n=243) were females (Table 2). The majority (95.2%, 499 out of 524) were born at full-term gestation and only 4.8% (25/524) were born as preterm. Amongst them, 88.5% (n=464) newborns were born appropriate for their gestation and 11.3% were born as small for their gestational age, one newborn was large for the gestational age. Nearly 76% new-borns had birth weight >2.5kg, 22.5% had 1.5 to 2.5kg and 1.1% had less than 1.5kg. Most of the babies (95.4%) cried immediately after birth. No significant differences were observed between maturity at gestation, birth weight, and sex of SARS-CoV-2 infected and non-infected babies.

Amongst 523 newborns, 19.9% (n=104) newborns develop complications such as fetal distress, hypoglycemia, hypocalcemia, meconium aspiration, sepsis, etc. during the neonatal period; 133



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3 (26%) required NICU admission (Figure 2). Of these majority were for reasons like  
4 hyperbilirubinemia, prematurity and low birth weight, respiratory distress, and other congenital  
5 anomalies like cleft lip & cleft palate, hydronephrosis, occipital encephalocele, and congenital  
6 diaphragmatic hernia. Nearly 8% of newborns were admitted for social reasons (baby admitted  
7 for care because of mother's illness). Out of 523 neonates, 97.1% (n=509) were either discharged  
8 or in a stable condition at the time of data extraction.  
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12 A comparison of the clinical presentations and complications is shown in Table 3. Sepsis was  
13 present in a greater proportion among SARS-COV-2 infected neonates as compared to  
14 uninfected neonates (12.1% vs 3.3%). The risk of sepsis was 4.09 folds (95% CI,1.28-13.00)  
15 higher in the neonates with SARS-CoV-2 infected group as compared to the non-infected group  
16 (p=0.031). Of the 33 SARS-CoV-2 infected newborns 3% had hypocalcemia, 6.1% had  
17 hypoglycemia and 15.2% had hyperbilirubinemia. The risk of hypocalcemia was 7.6 (95% CI,  
18 0.67-86.34) folds and hypoglycemia was 4.4 (95% CI, 0.89-22.33) folds higher amongst SARS-  
19 CoV-2 infected neonates as compared to uninfected neonates. Similarly, breathing difficulties  
20 (respiratory distress) were also reported significantly higher among SARS-CoV-2 infected  
21 neonates (12.1%) than non-infected (3.9%) (p=0.05).  
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40 The risk of developing fever in SARS-CoV-2 infected neonates was higher (OR 5.01, 95% CI,  
41 0.51-50.16) as compared to non-infected newborns, although this increase was not significant  
42 statistically (Table 4). Poor feeding was significantly more common among SARS-CoV-2  
43 infected neonates (12.1%) as compared to SARS-CoV-2 non-infected (2.7%) neonates  
44 (p=0.017). The risk of having poor feeding was 5.06 (1.55-16.49) times and respiratory distress  
45 was 3.42 folds (95% CI, 1.09-10.71) higher in SARS-CoV-2 infected neonates as compared to  
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3 their uninfected counterparts. Amongst the cohort of 33 infected neonates, one newborn had a  
4 patchy shadow suggestive of pneumonia.  
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8 The comparison of management strategies used for infected and non-infected neonates of  
9 mothers with COVID-19 is presented in Table 5. Nine out of 33 SARS-CoV-2 infected neonates  
10 required intensive care for management, while 123/490 non-infected neonates required NICU  
11 admission (OR 1.1, 95 % CI, 0.50-2.45). The need for bag and mask, CPAP, and the ventilator  
12 was, 1.91, 6.00, and 3.67 times higher in SARS-CoV-2 infected neonates than non-infected,  
13 however, the use of CPAP was only statistically significant.  
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21 As shown, in Table 6, out of nine neonates who were SARS-CoV-2 infected required NICU  
22 admission, two neonates required intensive care because of birth asphyxia and diabetes in the  
23 mother whereas three neonates had hyperbilirubinemia and required phototherapy. The  
24 remaining four neonates had clinically suspected sepsis and amongst them, two neonates were  
25 preterm and one was small for gestational age. Hemoglobin was decreased in case 4 and case 7.  
26 The leucocyte or white blood counts were decreased in case no 8. Low platelet count was seen in  
27 cases 4, 7, and 8. None of the neonates had grossly deranged liver function tests or renal function  
28 tests. However, C reactive protein (CRP) was elevated in cases 4, 6, 7, and 8. Other markers of  
29 inflammation like Interleukin 6 (IL-6) were elevated in case 6 and case 8. Blood culture was  
30 normal in cases 2, 4, and 8 whereas it grew Klebsiella Pneumonia in cases 6 and case 7. Thus, an  
31 increased risk of sepsis was observed in neonates with SARS-CoV-2 infection.  
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47 There was a total of 13 neonatal deaths, of which three deaths occurred in SARS-CoV-2 infected  
48 neonates (9%) who required intensive care while 10 (3%) were reported in the SAR-CoV-2  
49 negative group. The risk of neonatal death was higher in SARS-CoV-2 infected newborns [(OR  
50 (4.8, 95% CI1.25-18.36).  
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## Discussion

We analyzed the clinical characteristics of neonates born to COVID-19 mothers and found that the rate of SARS-CoV-2 infection in neonates was 6.3%. Compared to their uninfected counterparts, these neonates have a higher chance of developing clinical complications and required intense medical management. There is also a high risk of neonatal mortality amongst the SARS-CoV-2 infected neonates. The results of the study showed no significant difference between the proportion of males and females as predisposing factors to COVID-19. This observation was similar to the study reported by Dong et al showing that sex did not affect the incidence or severity of COVID-19 [25]. In our cohort, nearly 4.8% of the neonates were born as preterm which is lesser than that reported previously which has suggested high rates of preterm birth and stillbirths in SARS-CoV-2 infected women [5,26,27]. Factors like the appropriate implementation of protocols by the hospital for management of COVID-19 mothers may cause reduced rates of preterm births, improved air quality, home care, and reduced stress due to lockdown may also contribute to such reduced preterm birth rates. However, increased rates of home deliveries due to reduced access to the healthcare system could lead to under-reporting. Nevertheless, most neonates born to COVID-19 mothers were generally healthy and did not require special medical attention. Most newborns were in stable condition without any adverse outcome reiterating favorable course reported in newborns with lower fatality rates [28,29].

Infection of the newborn with SARS-CoV-2 is a controversial topic. Large systematic reviews have reported the incidence of SARS-CoV-2 infection in nearly 3-7% of neonates born to COVID-19 mothers [2,26,31]. Corroborating this data, herein we observed that nearly 6% of neonates were positive for SARS-CoV-2. Since we did not analyze the amniotic fluid or placenta, it is hard to comment if this virus was vertically transmitted or acquired postnatally. As

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3 per the current case definition of mother-to-child transmission, a neonate positive for SARS-  
4 CoV-2 at birth but not after 24 or 48h is a probable case of intrapartum transmission [32]. In our  
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6 study as most of the neonates that were positive for SARS-CoV-2 at birth, the repeat swab  
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8 collected at 48h was negative for the virus. Thus in most cases, the virus seems to be acquired  
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10 intrapartum in our cohort.  
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15 In a systematic review of 105 neonates which reported 8.8% of positivity [28], the rate of  
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17 premature was lower amongst the infected neonates. However, in our study, although the  
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19 numbers of premature neonates were higher in the infected group as compared to uninfected  
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21 controls, the difference was not statistically significant. Nevertheless, our analysis revealed that  
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23 the SARS-CoV-2 infected neonates are at increased risk of neonatal complications as compared  
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25 to their uninfected counterparts despite no difference in their maturity status or birthweight. This  
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27 observation is intriguing and warrants investigation as the current notion believes that SARS-  
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29 CoV-2 infection is rare and not deleterious to the newborn. Our study highlights that newborns  
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31 with SARS-CoV-2 infection are more susceptible to the adverse clinical course as respiratory  
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33 difficulties and poor feeding were more common among SARS-CoV-2 infected babies;  
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35 mechanical ventilation and CPAP were more commonly required in SARS-CoV-2 infected  
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37 babies. Whether respiratory distress and poor feeding can be predictors of severity of the  
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39 outcome in infected newborns needs further investigation. It is important to note that all the nine  
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41 SARS-CoV-2 infected neonates who required NICU admission had underlying medical  
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43 conditions warranting NICU stay. Characteristically, low platelet count decreased white blood  
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45 cells and elevated IL-6 were seen in neonates with clinical deterioration along with positive  
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47 septic screen in terms of elevated CRP and blood culture in a couple of cases. This suggests that  
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49 baseline investigations like complete blood count and CRP are essential and altered biochemical  
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3 parameters especially platelet count, CRP, IL6, and LDH are characteristically altered in SARS-  
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5 CoV-2 infected neonates with severe adverse outcome including death similar to findings  
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7 reported by McLaren et al [30].  
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10 An intriguing observation we made was a high risk of death amongst SARS-CoV-2 infected  
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12 newborns as compared to their non-infected counterparts. These neonates were not just positive  
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14 for SARS-CoV-2 but also developed sepsis. Previous studies have not reported deaths amongst  
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16 the SARS-CoV-2 infected neonates [7,33], however, the sample size is small in most studies, and  
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18 in many instances, it is unknown if the mother was also infected with COVID-19 [34].  
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20 Furthermore, most studies reported neonates in a wide age range, while in our study we analyzed  
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22 the death rates within the early neonatal period. As maternal COVID-19 would have some  
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24 pathophysiologic effects including that in the placenta [13,14], this may have affected the  
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26 newborn making them more susceptible to adverse outcomes. We believe that maternal COVID-  
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28 19 would compound the impact of SARS-CoV-2 on newborns and there is a need to address this  
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30 angle. It will be of clinical relevance to follow up with the non-infected neonates and investigate  
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32 their susceptibility to COVID-19 and other infections.  
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38 To summarize, this is probably the first large study describing the clinical profile of neonates  
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40 born to SARS-CoV-2 infected mothers and its significance with associated morbidities,  
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42 especially in the COVID-19 newborns. The strength of the study lies in the fact that this is a first  
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44 detailed study of a large cohort of newborns of COVID-19 mothers investigated uniformly. The  
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46 limitations include single-center data and lack of long-term follow-up of the neonates. In absence  
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48 of the data from uninfected mothers, we are unable to compare the outcomes and comment if  
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50 maternal COVID-19 is a major risk factor for neonatal health. Also in our cohort, most mothers  
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52 were infected with SARS-CoV-2 near term and hence the impact of early trimester infections on  
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3 newborn outcomes can not be judged. Nevertheless, our study highlights the need for further  
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5 research exploring the compounding health risk of a newborn in presence of maternal COVID-  
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## Figure legends

**Fig. 1.** A course of neonates born to mothers with COVID-19.

\*Roomed in with Mother: Exclusive breastfeeding ( EBF) and skin-to-skin care contact was followed for all stable mother-infant dyads. EBF was practiced by counseling the mother to take utmost precautions by ensuring strict respiratory (wearing a medical mask) and hand hygiene before and after feeding or touching the baby. Unstable, preterm babies and babies born to sick mothers were given expressed breast milk (EBM) / pasteurized donor human milk (PDHM) from Human Milk Bank with feeding cup / spoon-feeding /or gastric tube feeding as per needs of the baby.

**Fig. 2.** Indications for NICU admissions in newborns of mothers with COVID-19.

**Table 1: Details of the SARS-CoV-2 testing in neonates of mothers with COVID-19**

Tests	Number	NICU Admission	Symptomatic	Asymptomatic	Discharged	Died
Only 1 <sup>st</sup> RT-PCR Positive	25	6	6*	19	23	2
Only 2 <sup>nd</sup> RT-PCR Positive	4	1	2	2	4	0
Both 1 <sup>st</sup> & 2 <sup>nd</sup> RT-PCR Positive	4	2	2	2	3	1
Total	33	9	10	23	30	3

*\*One neonate in this category was managed in the postnatal wards for hyperbilirubinemia*

**Table 2: Demographic characteristics of neonates born to mothers with COVID-19**

Characteristics	Total neonates n=524 (%)	SARS-CoV-2 infected n=33 (%)	SARS-CoV-2 non- infected* n=491 (%)	OR (95% CI)	<i>p</i> value
Male	281 (53.6)	13 (39.4)	268 (54.6)	0.54 (0.26-1.11)	0.090
Female	243 (46.4)	20 (60.6)	223 (45.4)		
Preterm delivery	25 (4.8)	3 (9.1)	22 (4.5)	2.13 (0.60-7.53)	0.203
Term delivery	499 (95.2)	30 (90.9)	469 (95.5)		
AGA	464 (88.5)	28 (84.8)	436 (88.8)	0.71 (0.26-1.91)	0.568
SGA	59 (11.3)	5 (15.2)	54 (11.0)	1.45 (0.54-3.90)	0.403
Birthweight <1500 gm	6 (1.1)	1(3.0)	5 (1.0)		
Birthweight 1500-2500 gm	118 (22.5)	8 (24.2)	110 (22.4)		0.549
Birthweight >2500 gm	400 (76.3)	24 (72.7)	376 (76.6)		

AGA-Appropriate gestation age. SGA-Short for gestational age. OR-Odds ratio. CI-Confidence Interval.

\*Including a baby who died because of birth asphyxia and in whom nasopharyngeal swab collection was not possible.

**Table 3: Clinical characteristics and complications of neonates born to mothers with COVID-19**

Characteristics	Total neonates n=523 (%)	SARS-CoV-2 infected n=33 (%)	SARS-CoV-2 non-infected* n=490 (%)	OR (95% CI)	<i>p</i> value
Complications in neonatal period	104 (19.9)	9 (27.3)	95 (19.4)	1.56 (0.70-3.46)	0.272
Congenital anomalies	5 (1.0)	0 (0)	5 (1.0)	1.32 (0.07-24.33)	
Birth asphyxia	7 (1.3)	1 (3.0)	6 (1.2)	2.52 (0.29-21.58)	0.368
Meconium aspiration syndrome	4 (0.8)	0 (0)	4 (0.8)	1.61(0.08-30.61)	
Hypocalcemia	3 (0.6)	1 (3.0)	2 (0.4)	7.62 (0.67-86.34)	0.178
Hypoglycemia	9 (1.7)	2 (6.1)	7 (1.4)	4.45 (0.89-22.33)	0.105
Sepsis	20 (3.8)	4 (12.1)	16 (3.3)	4.09 (1.28-13.00)	0.031
Hyperbilirubinemia	59 (11.3)	5 (15.2)	54 (11.0)	1.44 (0.53-3.89)	0.404

NICU-Neonatal Intensive Care Unit. OR-Odds ratio. CI-Confidence interval.

\*Excluding a baby who died because of birth asphyxia and in whom nasopharyngeal swab collection was not possible.

**Table 4: Clinical presentations in neonates born to mothers with COVID-19**

<b>Characteristics</b>	<b>Total neonates n=523 (%)</b>	<b>SARS-CoV-2 infected n=33 (%)</b>	<b>SARS-CoV-2 non-infected* n=490 (%)</b>	<b>OR (95% CI)</b>	<b>p value</b>
Fever	4 (0.8)	1 (3.0)	3 (0.6)	5.07 (0.51-50.16)	0.230
Poor feeding	17 (3.3)	3 (9.1)	3 (0.6)	16.23 (3.14-83.87)	0.017
Respiratory distress	23 (4.4)	4 (12.1)	13 (2.7)	5.06 (1.55-16.49)	0.050
<b>Oxygen saturation</b>					
≤95% saturation	14 (2.7)	4 (12.1)	10 (2.0)	6.62 (1.95-22.39)	0.008
>95% saturation	509 (97.3)	29 (87.9)	480 (98.0)		

OR-Odds ratio. CI-Confidence interval.

\*Excluding a baby who died because of birth asphyxia and in whom nasopharyngeal swab collection was not possible.

**Table 5: Management of neonates born to mothers with COVID-19**

Characteristics	Total neonates n=523 (%)	SARS-CoV-2 infected n=33 (%)	SARS-CoV-2 non-infected* n=490 (%)	OR (95% CI)	<i>p</i> value
Neonatal resuscitation	19 (3.6)	2 (6.1)	17 (3.5)	1.79 (0.39-8.12)	0.340
NICU admission	132 (25.2)	9 (27.3)	123 (25.1)	1.12 (0.51-2.47)	0.801
Bag and Mask	18 (3.4)	2 (6.1)	16 (3.3)	1.91 (0.42-8.68)	0.316
CPAP	15 (2.9)	4 (12.1)	11 (2.2)	6.00 (1.80-20.02)	0.011
Ventilator support	16 (3.1)	3 (9.1)	13 (2.7)	3.67 (0.99-13.58)	0.073
Treatments <sup>†</sup> (n=125)	125 (23.9)	9 (27.3)	116 (23.7)	1.21 (0.55-2.67)	0.639
Phototherapy	59 (11.3)	5 (15.1)	54 (11.0)		
Antibiotics	42 (8.0)	5 (15.1)	37 (7.6)		
Supportive therapy <sup>‡</sup>	66 (12.6)	3 (9.1)	63 (12.9)		

CPAP - Continuous positive airway pressure. OR-Odds ratio. CI-Confidence interval.

\*Excluding a baby who died because of birth asphyxia and in whom nasopharyngeal swab collection was not possible.

<sup>†</sup>Neonates required either one or combinations of treatment.

<sup>‡</sup>Supportive therapy includes intravenous fluid, warmer care, measured feed, Haemo Gluco Test monitoring (HGT).



**Table 6:** Clinical and biochemical profile of nine neonates requiring NICU admission

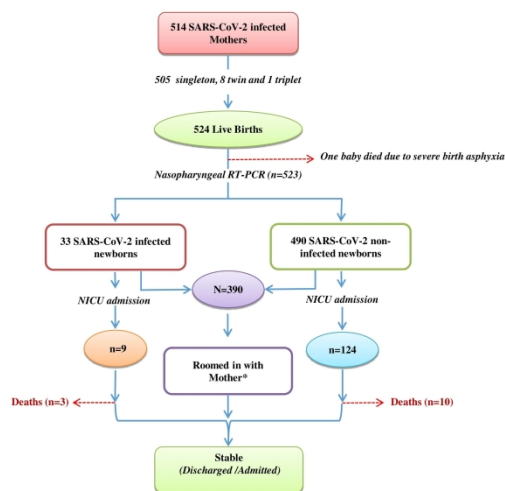
Case	1	2	3	4	5	6	7	8	9
<b>Hb gm/dl</b>	15	15.8	16	7.6 (↓)	16.6	13.6	10.3(↓)	13	14.2
<b>WBC (10<sup>3</sup>)</b>	8.9	14.8	11.5	12.3	10.15	17.4	6.0	3.88 (↓)	13.4
<b>Platelet Count (10<sup>5</sup>)</b>	4.2	2.08	2.5	0.23 (↓)	2.92	4.1	0.22 (↓)	0.06 (↓)	2.65
<b>LFT-Bilirubin/S GOT/SGPT</b>	4.2/27/ 24	4/28/21	8.4/31/1 0	0.8/45/17	17/ 38/24	16.5 (Direct 6.8) 577/909	10.9 / 221 / 17	9.8/35/34	18/48/18
<b>RFT-Na/ K/ BUN/Creatinine</b>	146/5.0 21/0.8	141 /4.5 22 /0.9	144/5.6 15/0.5	135/ 4.8/27/- 0.7	138/4.3/52/ 0.7	129/5.5 44/0.5	134/4.6 16/1.1	143/4.86 8/0.8	136/4.7
<b>Blood Culture</b>	*	No Growth	*	No Growth	*	<i>Klebsiella Pneumonia</i>	<i>Klebsiella Pneumonia</i>	No Growth	33/0.7
<b>X-ray Chest</b>	Normal	Normal	Normal	Pneumonia	Normal	Normal	Normal	Normal	Normal
<b>CRP</b>	*	5	*	78(↑)	*	51(↑)	37(↑)	73(↑)	*
<b>IL-6 / D-Dimer /LDH</b>	*	*	*	**	*	IL-6, 140 (↑) LDH-371.5. D-dimer14.6	**	IL-6, 5000(↑)	*
<b>CSF</b>	*	*	*	**	*	Normal	**	**	*
<b>Diagnosis</b>	IDM	Birth Asphyxia	Hyperbi lirubine mia	PT-RDS- Sepsis-	Hyperbiliru binemia	Sepsis with Cholestatic Jaundice	PT-Sepsis – Succumbed	SGA- Hypoglycemia -Sepsis- Succumbed	Hyperbiliru binemia

\* Not Indicated, \*\* - Could not be done, ↑-increased, ↓-decreased,

In case numbers-1, 2, 3, 5, 9 these investigations were not indicated. In case numbers 4,7,8—CSF examination could not be done due to very poor general condition or low platelet counts, in case of number4,7,8, the tests could not be done because of logistic issues.

Hb- Hemoglobin, WBC-White blood count, LFT-Liver function test, SGOT- serum glutamic-oxaloacetic transaminase, SGPT- Serum glutamic-pyruvate transaminase, RFT-Renal function test, BUN-Blood Urea Nitrogen, CRP-C Reactive Protein, IL 6-Interleukin 6, LDH- Lactate dehydrogenase, CSF-Cerebrospinal Fluid. IDM-Infant of Diabetic Mother, PT-Preterm, RDS-Respiratory Distress Syndrome, SGA-Short for Gestational Age

Figure 1: Course of neonates born to mothers with COVID-19



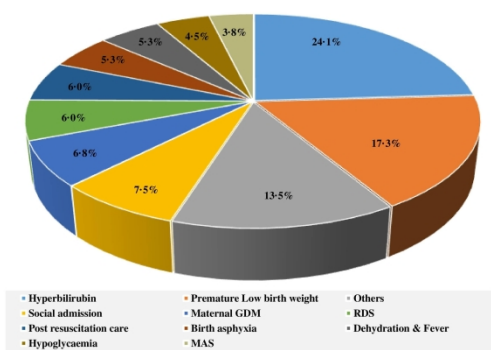
Roomed in with Mother\*: Exclusive breast feeding (EBF) and skin to skin care contact was followed for all stable mother-infant dyads. EBF was practiced by counselling the mother to take utmost precautions by ensuring strict respiratory (wearing a medical mask) and hand hygiene before and after feeding or touching the baby. Unstable, preterm babies and babies born to sick mothers were given expressed breast milk (EBM) / pasteurized donor human milk (PDHM) from Human Milk Bank with feeding cup / spoon feeding or gastric tube feeding as per needs of the baby.

Course of neonates born to mothers with COVID-19.

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Figure 2: Indications for NICU admissions in newborns of mothers with COVID-19



Indications for NICU admissions in newborns of mothers with COVID-19.

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