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Clinical Characteristics of Covid-19 in Pregnancy and Newborn: A Retrospective Cohort Study

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Abstract

Objective: To describe the clinical characteristics of pregnant women infected with COVID-19, 4 weeks before delivery and their neonates, and to investigate the possibility of vertical transmission during pregnancy.

Design and Methods: A data review of all pregnant women who were positive for COVID-19, 4 weeks before delivery from 1st of April 2020 till 31st of March 2021 and their newborns. RtPCR tests were done for all pregnant women when they were admitted for delivery regardless if they had symptoms or not. RtPCR tests were done for the newborns whom delivered to positive mothers. 300 women and their newborns were included.

Results: 300 women were positive for COVID-19, 59.67% (179/300) were asymptomatic and 40.33% (121/300) were symptomatic. From symptomatic patients 90.09% (109/121) had mild symptoms and 9.91% (12/121) developed severe respiratory symptoms. Mortality rate was zero.

All mothers delivered live babies and no intrauterine fetal death, 55% (165/300) delivered by vaginal delivery while 45% (135/300) delivered by cesarean section. 84.67% (254/300) were term and 15.33% (46/300) were preterm. 46.34% (139/300) were separated from mother and 53.66% (161/300) were kept with mother in same room. 87.4% (262/300) of newborn were asymptomatic and 12.6% (38/300) were symptomatic. 295 newborn were negative (98.33%), 3 were inconclusive (1%) and 2 were positive (0.67%).

Conclusion: There was increase in the rate of premature deliveries. There is low risk of transmission of COVID-19 to newborn babies. None of the neonates developed sign and symptoms during rooming in, Covid 19 can cause serious complication during pregnancy.

Keywords: COVID 19; Neonate; NICU; PCR; SARS-CoV-19

Introduction

COVID-19 caused by severe acute respiratory syndrome has spread globally with significant consequences for public health [1]. Data have shown that females of reproductive age comprised almost 21% of all COVID-19 cases, of which 9% were pregnant [2]. In addition, data have portrayed that pregnant women with COVID-19 may develop severe or critical illness in 9–14% of cases [3,4] and are more prone for intensive care admission and adverse outcomes such as preterm birth and cesarean delivery [2]. Pregnant women experience physiologic changes and are known to have reduced

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immunity, which increases the risk of developing viral infections such as respiratory syncytial virus, influenza virus, and COVID-19 [5]. The concern has also increased due to the high number of pregnant women with confirmed COVID-19 [6]. While some studies showed that both COVID-19 and Middle East Respiratory Syndrome Coronavirus (MERS-CoV) posed severe complications in pregnant women [7,8] and this resulted in high rates of mortality, preterm birth, cesarean delivery, and intensive care unit admission [2,9-11] in pregnant women [5], other studies reported that pregnant women are not more susceptible to COVID-19 than non-pregnant women [12-15]. Also, few data suggest that pregnant women may present with severe symptoms such as hypoxia, hypotension, electrolyte disturbances, and placental hypo perfusion, which may trigger fetal distress, preterm labor, miscarriage, or fetal death [16-22].

Neonates are likely to be different from older patients in relation to their exposure to the virus. For example, they might catch the virus vertically before or at birth [23-25]. However, data in relation to neonatal disease and concerns about COVID-19 transmission from mother to newborn have resulted in a wide variation in guidance for the management of neonates at risk of COVID-19 [26]. For example in China at the beginning of the pandemic, the immediate routine separation of newborns from COVID-19 infected mothers was recommended, with no breastfeeding [27]. By contrast, the World Health Organization (WHO) recommends that mothers with suspected or confirmed COVID-19 should be encouraged to initiate or continue to breastfeed [28]. In addition, recommendations of the American Academy of Pediatrics (AAP) support keeping mother and newborn together and breastfeeding with hygiene precautions [29].

Although there is a growing understanding of COVID-19, the consequences associated with SARS-CoV-19 infection during pregnancy remain limited and unclear. While previous evidence shows that infants who are less than one year are prone to COVID-19, especially when getting contact to positive cases (30), little is known in relation to neonates born to positive women. To date, there are limited data regarding the consequences of COVID-19 infection in pregnant women and infants and most recommendations come from small studies (31–33). Furthermore, vertical transmission potential of COVID-19 in pregnant women is not even well-known. There is also no local data on the outcomes of such pregnancies in Hamad Medical Corporation (HMC), Qatar. Therefore, we aimed to summarize the clinical characteristics of COVID-19 infected mothers and newborns born to infected mothers and to examine the vertical transmission potential of COVID-19 in pregnant women.

Methods

Design and setting

This is a retrospective study of electronic medical records including pregnant women with COVID-19 positive who were delivered at Women's Wellness and Research Center (WWRC), Cuban hospital (CH) and Al-Khor hospital (AKH) at HMC between April 1st, 2020 and 31st March, 2021. All hospitals were designated for the management of COVID-19 infected pregnant women and newborns born to COVID-19 infected mothers in Qatar. The neonatal intensive care unit (NICU) of WWRC is a specialized, advanced tertiary ward, and the largest NICU in the region that offers the greatest kind of care for critically ill newborns, while the NICU in AWH, CH is Level II units [34]. The Cuban hospital was set to be the main facility to manage the COVID-19 positive cases of pregnant women and their newborns and was equipped to receive deliveries of all gestational ages. According to Qatar's national COVID-19 policy, all pregnant women were tested for COVID-19 during the study period if they had symptoms or had been in contact with infected cases. All women were followed for at least 14 days after delivery.

Ethics approval

The study protocol (MRC-01-21-425) was approved by the local institution review body (IRB). As the data source was anonymized, the local IRB deemed that participant consent was neither feasible nor required.

Inclusion criteria

All pregnant with positive COVID-19 infection, confirmed by real-time reverse transcriptase-polymerase chain reaction (RT-PCR) assay of nasopharyngeal swab specimens four weeks before delivery. Newborns born to SARS-CoV-19 infection positive mothers were also included. We excluded all women who had equivocal or negative testing results.

Procedure

Rt-PCR test using a nasopharyngeal swab was performed for symptomatic pregnant women at the time of disease onset and for all pregnant women when they were admitted for delivery regardless if they had symptoms or not. According to Qatar's national policy, all newborns born to COVID-19 infected mothers were assessed by the neonatologist after birth and were isolated immediately and admitted to the NICU. This procedure was changed later during the data collection period and the asymptomatic newborns were allowed to stay in mother's room with restricted contact precaution. Neonates were admitted to a negative pressure isolated single room and received care by the neonatal team wearing proper personal protective equipment and received either expressed breast milk or artificial formula feeding. Rt-PCR test using a nasopharyngeal swab was performed for all newborns within 24 hours of delivery and repeated whenever there was a need to do so. Newborns were followed for 14 days after delivery for signs and symptoms of COVID-19 infection.

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Outcome measures

The main outcome of this study was to describe the clinical characteristics of pregnant women infected with COVID-19 four weeks before delivery and their newborns and to examine the vertical transmission potential of COVID-19 in pregnant women.

Data collection

Maternal demographic data included age, parity, antenatal risk factors such as diabetes, hypertesnion, chorioamnionatis, antenatal steroid status, antenatal ultrasound outcome. Clinical data included symptoms such as fever, headache, respiratory symptoms, interval time between PCR results and delivery time, need for respiratory support, and PCR result. Newborn data included gestational age, gender, type of delivery, birth weight in gram, APGAR score, need for resuscitation, seperatetion from mother, symptoms after delivery, result and time of of PCR.

Statistical analyses

Descriptive statistics were tabulated for all patient demographics and clinical characteristics. For continuous variables, findings were presented as mean and standard deviation (SD), whereas for categorical measures, data were presented as frequency and percentage. All statistical analyses were conducted using Microsoft office Excel 2016.

Results

Maternal outcomes

During the study period, a total of 300 pregnant with confirmed COVID-19 before delivery were included. The mean age of the women was 30.7 years (range 17-43). Majority of women were in their third trimester 237 (79%), and 165 (55%) underwent vaginal delivery versus 135 (45%) underwent cesarean delivery. A total of 69 (23%) women were primi mothers while 231 (77%) were multigravida.

Diabetes was found in 30.3% of the pregnant women, hypertension in 3.6%, anemia in 8%, hypothyroidism in 5.3%, chorioamnionitis in 1.6%, and antenatal steroid was given in 7.3%. Antenatal ultrasound was performed in 99% of women, of which, 272 (90.6%) women presented with normal findings while 4 (1.3%) women had polyhydramnios, 6 (3%) had oligohydramnios, 12 (4%) were small for gestational age and Intrauterine Growth Retardation (IUGR), 1 (0.3%) had renal anomalies, and 1 (0.3%) had Tetralogy of Fallot (TOF). All women were survived and discharged healthy from the hospital. Demo-graphical characteristics and antenatal US findings were summarized in Table 1.

Out of 300 women, 179 (59.7%) were asymptomatic and 121 (45.5%) were symptomatic. Symptoms included: cough (76%), headache (28.9%), upper respiratory infection (18.2%), anosmia and loss of taste (5.8%), leg pain (1.7%),

Table 1: Clinical characteristics of COVID 19 infected pregnant women.

Characteristic	N=300, presented as mean ± SD or N (%)
Age, years	30.8 ± 5.2
Gravida	
Primi	69 (23%)
Multigravida	231(77%)
Parity	
0	83 (27.7%)
1	87 (29%)
2 or more	130 (43.3%)
Gestational age at time of confirmed COVID-19	38.27 ± 1.99
28 weeks	8 (2.7%)
29-32 weeks	55 (18.3%)
33-37 weeks	237 (79%)
Interval between first COVID-19 positive and delivery (days)	6.62 ± 6.56
≤1 day	21 (7%)
2-7 days	128 (42.67%)
1-2 weeks	37 (12.33%)
2-3 weeks	16 (5.33%)
3-4 weeks	5 (1.67%)
Pre-existing medical disease:	
Chorioamnionitis	5 (1.6%)
Antenatal steroid	22 (7.3%)
Diabetes	91 (30.3%)
Hypertension	11 (3.6%)
Anemia	25 (8.3%)
Hypothyroidism	16 (5.3%)
Cholestasis	6 (2%)
Interstitial lung disease	1 (0.3%)
Protein S deficiency	1 (0.3%)
Thalassemia	1 (0.3%)
Multiple sclerosis	1 (0.3%)
Systemic lupus erythematosus	1 (0.3%)
Supraventricular tachycardia	1 (0.3%)
Hepatitis B	1 (0.3%)
Migraine	1 (0.3%)
Antenatal ultrasound findings	
Normal	272 (90.6%)
Abnormal	25 (8.3%)
Polyhydramnios	4 (1.3%)
Oligohydramnios	6 (3%)
Small for gestational age and intrauterine growth retardation	12 (4%)
Renal anomalies	1 (0.3%)
Tetralogy of fallot	1 (0.3%)
Not performed	3 (%)
Survival	
Yes	300 (100%)
No	0 (0%)
Length of hospital stay (days)	6.03 ± 6.20

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fatigue (2.5%), decreased fetal movement (0.8%), hemoptysis (0.8%), and abdominal pain (0.8%). symptoms are summarize in Table 2

From symptomatic patients 16.5% (20/121) developed severe respiratory symptoms required admission to intensive care unit, 7 needed mechanical ventilation (5.78%), 1 MV+ECMO (0.82%), 4 CPAP (3.3%), and 8 Nasal canula (6.6%), (Table 3) all were recovered, Table 3. Mortality rate was zero.

Neonatal Outcomes

RtPCR tests using a nasopharyngeal swab after delivery were performed for 300 newborns identified. Of which, 295 were negative (98.3%), 3 were inconclusive (1%) and came negative when they were repeated after 2-3 days, and 2 were positive (0.7%). Of the 300 newborns, 108 neonates had a repeat rtPCR at 1 to 21 days of life. The tests were not repeated for the remaining neonates because they were clinically well.

Of the 300 live births, 53% were males and 47% were females. 55% were delivered by normal vaginal delivery while 45% were delivered by cesarean section. Infant's age was between 29 and 41 weeks with a mean gestational age of 38.3 weeks. Eight patients had preterm labour, 55 had moderate or late preterm labour, 237 had term labour, and none were born extremely preterm. The majority of neonates (n=263) born with birth weight of at least 2500 g, 29 infants were <2500 g and ≥1500 g, one infant was <1500 g and ≥1000 g, and 7 were <1000 g. Neonates had 1-min and 5-min Apgar scores means of 8.7 and 9.8, respectively.

Of the 300 newborns, 46% (138) were separated from mothers and admitted to NICU in isolated rooms and 54% (162) were kept with mother in same room and restricted contact precaution was applied.

Table 2: Symptoms in COVID 19 infected pregnant women.

Symptoms	
Yes	121 (40.3%)
No	179 (59.7%)
Fever	55 (45.5%)
Headache	35 (28.9%)
Cough	92 (76%)
Upper respiratory infection	22 (18.2%)
Anosmia and loss of taste	7 (5.8%)
Leg pain	2 (1.7%)
Fatigue	3 (2.5%)
Decrease fetal movement	1 (0.8%)
Hemoptysis	1 (0.8%)
Abdominal pain	1 (0.8%)

Table 3: Respiratory support in symptomatic COVID 19 infected pregnant women.

Mechanical ventilation	7/121 5.78%	7/300 2.3%
MV+ECMO	1/121 0.82%	1/300 0.3%
CPAP	4/121 3.3%	4/300 1.3%
Nasal canula	8/121 6.6%	8/300 2.6%
Total	20/121 16.5%	20/300 6.6%

Of the 300 newborns, 262 infants were asymptomatic and 38 infants were symptomatic during the entire observation period and needed admission to NICU for respiratory support. Ten preterm newborns presented with Respiratory Distress Syndrome (RDS), 25 had transient tachypnea of the newborn which was managed by nasal canula for 1-2 days, one newborn had pneumonia and received non-invasive ventilation for 1-day, nasal cannula for 1 day, MV for 2 days, and antibiotics for 7 days. With regards to resuscitation, 20 (6.7%) newborns needed resuscitation. No neonatal death was reported.

All neonates were followed up by the neonatal team at 14 days life and parents were instructed to discontinue mask precautions at home when around the neonate. All parents were also educated in relation to the use of masks and hand hygiene practice measures at time of hospital discharge.

Mean length of hospital stay for all newborns was 6 days.

Description of neonatal characteristics born to infected mothers are shown in Table 4.

First neonate positive case:

The mother is 33 years old lady, gravida 2 para 0 +1. She was 37 weeks + 6 days pregnant with unremarkable regular antenatal care. She has a history of first trimester miscarriage. She was complaining of generalized body aches and joint pain with fever 5 days prior to delivery, and positive COVID-19 PCR and she was at home quarantine. At the day of delivery, she came to emergency complaining of decreased fetal movement, cardiotocography showed non-reassuring pattern, thus she was delivered by emergency cesarean section. Female baby was born vigorous, no resuscitation was needed, weight 3030g, Apgar score was 9 and 10 at 1 and 5 minutes, respectively. COVID-19 PCR was sent from resuscitation room after delivery and before any contact with the mother. After the mother was recovered, the baby was sent to her room with restrict contact precautions. At 16 hours of age, the baby was transferred to NICU as COVID-19 PCR result came positive and the baby remained asymptomatic in NICU for 5 days under close observation. The baby was sent back to mother room, and both were discharged home on day 19 after delivery, where the mother received treatment for wound cellulitis. COVID-19 PCR was repeated weekly for the baby and came negative on day 19.

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Table 4: Clinical characteristics of infants born to COVID-19 infected mothers.

Characteristic	N=300, presented as mean ± SD or N (%)
Age, weeks	38.3 ± 2
Extremely preterm (<28 weeks)	0 (0%)
Very preterm (28≤32 weeks)	8 (2.7%)
Moderate or late preterm (32≤37 weeks)	55 (18.3%)
Term ≥37 weeks	237 (79%)
Gender	
Male	158 (52.7%)
Female	142 (47.3%)
Birth weight, g	
≥2500	263 (87.7%)
<2500 and ≥1500	29 (9.7%)
<1500 and ≥1000	1 (0.3%)
<1000	7 (2.3%)
Type of delivery	
Vaginal	165 (55%)
Caesarean	135 (45%)
Separated from mother	138 (46%)
Room in	162 (54%)
Need for resuscitation:	20 (6.7%)
Preterm	8 (40%)
Transient tachypnea of the newborn	10 (50%)
Hypoxic-ischemic encephalopathy	1 (5%)
Meconium aspiration syndrome	1 (5%)
Symptomatic	
Yes	38 (12.7%)
No	262 (87.3%)
Other symptoms	
Fever	0 (0%)
Cyanosis	1 (0.33%)
Respiratory distress:	38 (12.7%)
Preterm with respiratory distress syndrome RDS	10 (26.3%)
Transient tachypnea of the newborn	25 (65.8%)
Hypoxic-ischemic encephalopathy	1 (2.6%)
Meconium aspiration syndrome	1 (2.6%)
Pneumonia	1 (2.6%)
Timing of first PCR	
<24 hour	259 (86.3%)
1-6 days	38 (12.7%)
7-14 days	3 (1%)
First PCR results	
Negative	295 (98.3%)
Positive	2 (0.7%)
Inconclusive	3 (1%)
Timing of second PCR	
1-6 days	60 (20%)
7-14 days	35 (11.7%)
>14 days	12 (4%)
Second PCR results	
Negative	107 (35.7%)
Positive	1 (0.3%)
Not performed	192 (64%)
One- minute APGAR score	8.7 ± 1.2
Five- minute APGAR score	9.8 ± 0.9
Length of hospital stay	6.03 ± 6.20

Second neonate positive case:

The mother is 25 years old lady, 39 weeks gestational age, gravida 3 para, 2 with previous 2 cesarean sections, last cesarean section was done in 2019 due to placental abruption. The mother was asymptomatic but with positive COVID-19 test. Female baby was born vigorous, weight 2890g, and no resuscitation was needed, Apgar score was 9 and 10 at 1 and 5 minutes respectively. After the mother was recovered, the baby was sent to her room with restrict contact precautions, COVID-19 PCR was sent at age of 24 hour and came positive. Then, it repeated on day 4 of life and was negative. Both mother and baby were asymptomatic and discharge home on day 5 after delivery and remained asymptomatic for 14 days after delivery.

Discussion

To our knowledge, this is the first Qatari retrospective review of neonates born to mothers who tested positive for COVID-19 at time of delivery and who were subsequently followed up to 14 days of life. In our retrospective review, only two infants (0.6%) had COVID-19 virus detected by a nasopharyngeal swab in the first 24-hour postpartum period and remained asymptomatic during the study period. Furthermore, majority of infants remained asymptomatic during the study period.

Our study findings are consistent with previous studies which showed a low risk of perinatal transmission using strict infection control practices. The low risk of vertical transmission may be explained by three mechanisms. The first mechanism is the trans-placental transmission. Studies showed that the cell entry and the spread of COVID-19 depend on the angiotensin-converting enzyme 2 (ACE2) receptor [35,36] and the serine protease TMPRSS2 [52], which are minimally expressed by the human placenta throughout pregnancy [37]. The second mechanism is viremia which

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precedes placental infection, and none of pregnant women with confirmed COVID-19 infection developed viremia [38]. The third mechanism is exposure to vaginal fluid and the presence of the virus in vaginal secretion in pregnant women was not detectable [39-41].

In fact, our observation of few fetal infection caused by intrauterine vertical transmission could be affected by our small sample size and the stage of pregnancy at the onset of COVID-19 infection. All patients in the study were recruited in their third trimester, so we were unable to ascertain the possibility of intrauterine vertical transmission during the first or second trimester. For example, rubella infection in the first trimester can affect more than 50% of fetuses via intrauterine infection, whereas by the end of the second trimester the incidence rate is reduced by half [42]. We did not collect samples of vaginal mucosa or shedding in birth canals, which prevented us from analyzing whether COVID-19 could be transmitted during vaginal delivery.

To date, data with regards to transplacental, perinatal, intrapartum, and postnatal routes and risks of transmission of COVID-19 to newborns is based on case series only [43]. Considering that COVID-19 is a respiratory virus, the risk of vertical transmission is likely to be very small or absent. This supposition is supported by the evidence that no vertical transmission was detected in other members of the coronavirus family (SARS and MERS) [44].

Currently, there is limited number of studies describing the outcomes of neonates born to COVID-19 positive mothers. Zeng et al. [45] for example have shown that three of 33 neonates, born to COVID-19-positive mothers, tested positive through the nasopharyngeal and anal swabs on days 2 and 4 of life. Also, Zamaniyan et al. [46] reported a positive case of preterm neonate born to a mother with severe COVID-19 who were tested positive using nasopharyngeal swab and amniotic fluid at 48 hours of life. Kirtsman et al. [47] reported a term neonate born to a mother tested positive for COVID-19 via the parenchymal and chorionic sides and tested positive by nasopharyngeal swab at time of birth. The neonate had 1 day of fever and cough at time of delivery. In a United Kingdom (UK) based study [48], six neonates were positive within 12 hours after birth, however, this seemed to be a false positive from maternal contamination as the testing was obtained very soon after birth and was not repeated at a later time to confirm. In two reports from China [49,50], three neonates born to mothers with COVID-19 pneumonia were positive for IgG and IgM. However, presence of IgM solely is not a reliable indication for vertical transmission and its significance is still unclear [51].

Many case series have been published but none followed the neonates with serial rtPCR testing until the first two weeks of life [2,37-41]. In our study, 54% neonates were allowed to stay in the same room with mothers (neonate was kept in a closed isolette, 6 feet (1•83 m) apart from their mother unless feeding. In these cases, mothers were allowed to directly breastfeed following appropriate infection control precautions which included frequent hand hygiene, use of surgical masks at all times, and breast cleansing. These precautions, however, are controversial in relation to COVID-19 transmission.

Indeed, there are case reports of neonates who became clinically symptomatic after hospital discharge, such as a study by Coronado et al. [53] which included a neonate with respiratory symptoms at 5 days of life and tested positive for COVID-19. This finding further supports the need for scrupulous precautions to prevent horizontal spread of infection. There is evidence that asymptomatic carriers are common, as reported by Wang et al. [54] and confirmed in our cohort of mothers, with 59.7% of cases being entirely asymptomatic. Because 121 mothers in our study were symptomatic before or during delivery, acquisition of protective maternal antibodies in all infants is unlikely. Whether infants in our cohort were less likely to acquire infection due to inherent physiological reasons or by early infection control measures remains to be clarified.

Since the risk of perinatal transmission of COVID-19 is uncertain, it is questionable whether the neonate should be separated from the infected mother [55]. A study conducted by Yan et al. [11] and included 7 neonates found that COVID-19 positive mother does not result in adverse events in their neonates, but it is important to separate newborns from mothers to prevent potential risks of COVID-19 infection. In contract, a study by Coronado et al. [53] suggested that separation may not prevent infection, and early separation might increase the risk of pneumonia among newborns. A case series of 10 newborns born to COVID-19 positive mothers showed no risk of vertical transmission of COVID-19 to the newborns but perinatal. In our study, separation was not performed in 162 newborns. There are some factors that favor our approach. First, the well-known benefits of early mother–neonate bonding and breastfeeding should be prioritized during the perinatal period if the risks seem low. Secondly, most neonates were discharged within 5 days to home, where in most cases the mother continued breastfeeding. We have shown that keeping the neonates with the mother in the same room and breastfeeding are safe taking into consideration giving full education of safe infection control practices, such as use of surgical masks at all times and frequent hand hygiene.

The recommendations of international medical authorities support our findings. In our study we found that the protocol released by HMC Corporate Infection Prevention and Control initially included the isolation of the newborn for 14 days after delivery. Therefore, 138 newborn (46%) were separated from mothers and admitted to the NICU in isolated

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rooms. With releasing new recommendations from WHO [28], the AAP [56], the US CDC [57], and UK RCOG [58], which encourage breastfeeding and initiation of mother–infant relationship after delivery, HMC Corporate Infection Prevention and Control changed the protocol and neonates were allowed to stay in the same room with mothers (i.e. neonate was kept in a closed isolette, 1-2 meters apart from their mother unless feeding), and mothers were allowed to directly breastfeed following appropriate infection control precautions which included frequent hand hygiene, use of surgical masks at all times, and breast cleansing. A total of 162 newborns (54%) were kept with mother in same room and none of them developed sign and symptoms of COVID-19 infection during breast feeding and rooming in.

Our study results suggest that other safe methods exist to ensure safety of neonates in the immediate postnatal period in addition to the recommendations released by the AAP [56], the US CDC [57], and the Chinese expert consensus [27]. To reduce the risk of perinatal transmission, isolation of the neonates immediately after delivery, use of formula or expressed breast milk feeding, and avoiding direct contact, if possible, with the mother for 14 days or at least 7 days from symptoms onset are recommended. This however contradicts the WHO recommendation [28], UK Royal College of Obstetricians and Gynecologists [58], and the Italian Society of Neonatology recommendations on management of neonates born to COVID-19-positive mothers, endorsed by the Union of European Neonatal and Perinatal Societies, which encourage breastfeeding and the importance of initial mother–infant relationship after delivery.

Despite, none of our neonates developed severe pneumonia or died of COVID-19 infection, we should be cautious in relation to the possibility that the disease course and prognosis of infection could follow the same trend as SARS in pregnant women.

Our findings found that 18.2% of women needed ICU admission and respiratory support with a zero-morality rate. In contrast, a previous study [30] included 1,922 pregnant women with positive COVID-19, of which 11% were admitted to NICU, 8% required MV, and 1% died. Indeed, pregnancy alters the body's immune system and generally affects the woman's response to viral infections. However, pregnant and non-pregnant women with COVID-19 infection had similar epidemiological characteristics [59,60]. While a prior study indicated that the risk of poor clinical and pregnancy outcomes was greater among pregnant women with COVID-19 compared with pregnant women without a COVID-19 [61], we could not measure this outcome as it was beyond the objective of this study.

To date, there is no evidence to suggest that development of COVID-19 in the third trimester of pregnancy could cause serious consequences in neonates and whether fetal infection is due to intrauterine vertical transmission. In fact, pregnant women are particularly prone to respiratory pathogens and severe pneumonia, because they are at an immunosuppressive state, and physiological adaptive changes during pregnancy such as diaphragm elevation, increased oxygen consumption, and oedema of respiratory tract mucosa can render them intolerant to hypoxia.

Our study is without limitations. First, the study is limited by the sample size and a short follow-up period of 14 days. A larger cohort and longer follow-up with repeat testing and serology might be necessary to confirm that perinatal transmission is impossible to develop even following correct protective strategies are used. Second, screening for presence of the virus in blood, urine, or stool was not conducted due to absence of approved testing for these samples during the study period. Hence, it remains possible that the virus might be detectable only in the blood and urine rather than in the respiratory tract in congenitally infected neonates. However, neonates tested positive for COVID-19 was based on nasopharyngeal swab at birth in previous studies. Third, we relied solely on parental report regarding hand hygiene and mask usage at home, therefore there is the possibility for recall bias. Forth, we used a retrospective design which is associated with some bias; therefore several considerations should be taken into account when interpreting the results.

Conclusion

Our data suggest that there is a low risk of transmission of COVID-19 to newborn babies when infection control measures are followed. However, none of the neonates developed sign and symptoms of COVID-19 infection during breast feeding and rooming in.

Author contributions

M. Alkhateeb and F. AbouNahia were the main investigators, conceptualized and designed the study, coordinated and supervised data collection. M. Alkhateeb and D. Abushanab drafted the initial manuscript, and reviewed and revised the subsequent manuscript versions. A. Albaridi, M. Mahmah, L. Dominques collected, cleaned and anonymized the data. M. Alkhateeb and M.AL Qubaisi designed and performed the data analysis. All authors reviewed and revised the manuscript, and approved the final submitted manuscript.

Conflict of interest

All authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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