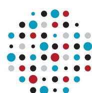

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2 **An Analysis of 38 Pregnant Women with COVID-19, Their Newborn Infants, and Maternal-**

3 **Fetal Transmission of SARS-CoV-2: Maternal Coronavirus Infections and Pregnancy Outcomes**

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Abstract

The emergence of a novel coronavirus, termed SARS-CoV-2, and the potentially life-threating respiratory disease that it can produce, COVID-19, has rapidly spread across the globe creating a massive public health problem. Previous epidemics of many emerging viral infections have typically resulted in poor obstetrical outcomes including maternal morbidity and mortality, maternal-fetal transmission of the virus, and perinatal infections and death. This communication reviews the effects of two previous coronavirus infections - severe acute respiratory syndrome (SARS) caused by SARS-CoV and Middle East respiratory syndrome (MERS) caused by MERS-CoV - on pregnancy outcomes. In addition, it analyzes literature describing 38 pregnant women with COVID-19 and their newborns in China to assess the effects of SARS-CoV-2 on the mothers and infants including clinical, laboratory and virologic data, and the transmissibility of the virus from mother to fetus. This analysis reveals that unlike coronavirus infections of pregnant women caused by SARS and MERS, in these 38 pregnant women COVID-19 did not lead to maternal deaths. Importantly, and similar to pregnancies with SARS and MERS, there were no confirmed cases of intrauterine transmission of SARS-CoV-2 from mothers with COVID-19 to their fetuses. All neonatal specimens tested, including in some cases placentas, were negative by rt-PCR for SARS-CoV-2. At this point in the global pandemic of COVID-19 infection there is no evidence that SARS-CoV-2 undergoes intrauterine or transplacental transmission from infected pregnant women to their fetuses. Analysis of additional cases is necessary to determine if this remains true.

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48 ## Introduction

49 The emergence of the novel coronavirus infection that occurred in Wuhan China in December
50 2019 has resulted in an epidemic that has rapidly expanded to become one of the most significant public
51 health threats in recent times.[1-5] This newly emergent coronavirus was isolated in China in early January
52 2020, initially referred to as 2019-nCoV and subsequently termed SARS-CoV-2 – the disease it produces
53 has been termed COVID-19.[6] Since then it has become an increasingly widespread and important cause
54 of respiratory infection which can progress to severe pneumonia and, in a small number of cases, death.
55 Since its initial identification in Wuhan, Hubei province, China, COVID-19 has now been reported from all
56 continents except for Antarctica, affecting 125,048 persons in 118 countries and resulting in 4613 deaths
57 as of March 12, 2020.[7] COVID-19 was declared a pandemic by the World Health Organization on March
58 11, 2020.[8]

59 There has been a rapid increase in knowledge of the genetic, virologic, epidemiologic and clinical
60 aspects of this emerging agent – the 7th coronavirus identified to cause human infection.[9] Recently the
61 initial description of the pulmonary pathology that occurs from fatal COVID-19 has been described.[10]

62 An important question that remains unanswered is whether SARS-CoV-2 can be transmitted
63 from a pregnant woman to her fetus, a process termed vertical transmission, and to determine the
64 mechanism(s) if it does occur.[9,11-17] Not only is this a significant public health issue, but also represents
65 an obstetrical management issue in determining the care received by pregnant women. The question is
66 especially relevant given the recent history of vertical maternal-fetal transmission of such emerging viral
67 infections as the Zika virus, Ebola virus, Marburg virus and other agents which can threaten the health
68 and survival of an infected mother and fetus.[18-21]

69 ## Previous Experiences with Coronavirus Infections During Pregnancy

70 Pregnancy increases the risk of adverse obstetrical and neonatal outcomes from many
71 respiratory viral infections. The physiologic and immunologic changes that occur as a normal component

72 of pregnancy can have systemic effects that increase the risk for complications from respiratory
73 infections. Changes in the cardiovascular and respiratory systems, including increased heart rate, stroke
74 volume, oxygen consumption, and decreased lung capacity, as well as the development of immunologic
75 adaptations that allow a mother to tolerate an antigenically distinctive fetus, increase the risk for
76 pregnant women to develop severe respiratory disease.[22] Outcomes data from multiple studies of
77 influenza have demonstrated an increased risk of maternal morbidity and mortality when compared
78 with non-pregnant women.[22,23] This association has also been previously demonstrated to occur when
79 pregnant women became infected with either of two pathogenic coronavirus infections – severe acute
80 respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).[9]

81 **Severe acute respiratory syndrome (SARS)**

82 The SARS epidemic occurred from November 2002 to July 2003, affecting greater than 8000
83 persons in 26 countries and resulting in 774 fatalities.[24] The causative agent, a coronavirus termed
84 SARS-CoV, was transmitted through close person-person contact, respiratory droplets, environmental
85 contamination, and potentially sewage.[9,25] There were 12 pregnant women reported who developed
86 SARS during the epidemic, of whom 3 died during pregnancy (case fatality rate of 25%).[9] Miscarriages
87 during the 1st trimester occurred in 4/7 women. Two of 5 women in the 2nd and 3rd trimester had a
88 neonate with intrauterine growth restriction (IUGR). In addition, 4/5 pregnancies resulted in preterm
89 birth – 1 spontaneous and 3 induction deliveries that were performed for maternal conditions.[26] Vertical
90 transmission of the SARS-CoV virus did not occur in any of the infants; however, the clinical outcomes of
91 pregnant women with SARS were worse than those occurring in infected women who were not
92 pregnant.[9,26-29]

93 **Middle East respiratory syndrome (MERS)**

94 MERS is another coronavirus infection that causes potentially severe respiratory disease. It was
95 first reported from Saudi Arabia in 2012, after which it spread to over 27 countries both within and

96 outside of the Arabian Peninsula.[9,30] MERS-CoV has been identified in camels, which have been
97 suggested as the primary source of human infections, as well as in bats, but more research is needed to
98 understand the role that these and other animals may play in transmission. MERS-CoV is characterized
99 by sporadic zoonotic transmission events as well as spread between infected patients and close contacts
100 (i.e., intra-familial transmission). Outbreaks of MERS in health care settings are characteristic of MERS,
101 and which result from poor infection control and preventative measures.[30,31]

102 MERS-CoV infection has been reported from 11 pregnant women, where it has been associated
103 with a variety of adverse clinical outcomes among 10 (91%) of them. These outcomes have included
104 maternal deaths, premature delivery, intensive care treatment for newborns, and perinatal death. There
105 have been no confirmed cases of vertical transmission of MERS-CoV.[9]

106 Current clinical features and obstetrical outcomes of pregnant women with 107 COVID-19

108 There has been a total of 38 pregnant women reported with COVID-19 originating from the
109 epicenter of the pandemic in China.[13-17] All women were in the 3rd trimester of pregnancy, and included
110 37 women whose SARS-CoV-2 positivity was confirmed by rt-PCR. These pregnancies resulted in 39
111 infants (one set of twins); detailed clinical information, obstetrical outcomes and SARS-CoV-2 status
112 were available for 30 neonates.

113 Zhongnan Hospital of Wuhan University, Wuhan, China

114 Nine pregnant women with COVID-19 have been described in a retrospective review of medical
115 records by Chen et al. (Table 1).[13] The women were tested for SARS-CoV-2 using rt-PCR kits
116 recommended by the Chinese Center for Disease Control and Prevention (BioGerm, Shanghai, China).
117 Samples were tested simultaneously using rt-PCR at the of Clinical Laboratory of Zhongnan Hospital and
118 State Key Laboratory of Virology/Institute of Medical Virology, School of Basic Medical Sciences, Wuhan
119 University. Positive confirmatory cases of SARS-CoV-2 infection were reported when a positive test

120 result from either laboratory was obtained. The mothers varied in age between 26 and 40 years of age,
121 had documented exposure to the novel coronavirus and were in the 3rd trimester of pregnancy when
122 they developed COVID-19 infection. Although none of the women had a preexisting chronic condition
123 such as diabetes, cardiovascular disease or hypertension, 3 women had co-morbid conditions that
124 developed during their pregnancy – influenza (Case 1), gestational hypertension occurring since 27
125 weeks gestation (Case 3), and preeclampsia developing at 31 weeks gestation (Case 4). Seven women
126 were febrile upon admission; additional findings included cough (4/9), myalgia (3/9), sore throat (2/9)
127 malaise (2/9), gastrointestinal symptoms (1/9) and shortness of breath (1/9). Laboratory findings
128 included elevated C-reactive protein (6/9), lymphopenia (5/9), and increased alanine aminotransferase
129 (ALT) and aspartate aminotransferase (AST)(3/9). Chest CT scans were abnormal in 8 of the 9 women,
130 demonstrating lungs with patchy ground-glass shadows. Four women had preterm labor, but none
131 occurring prior to 36 weeks gestation. Cases 5 and 8 had fetal distress, and cases 7 and 9 had premature
132 rupture of membranes (PROM). None of the women developed severe pneumonia, and there were no
133 maternal deaths.

134 All 9 women underwent cesarean sections. Two of the 4 preterm infants were delivered at 36
135 weeks 2 days and weighed less than 2500 grams (Cases 4 and 7) – one of the newborn infants (Case 4)
136 had a birthweight of 1880 grams and was delivered to a mother with preeclampsia. All of the infants had
137 good Apgar scores.

138 The presence of SARS-CoV-2 was evaluated in 6 of the 9 cases from amniotic fluid, breastmilk,
139 umbilical cord blood and neonatal throat swabs - all tests were negative. The specific cases that were
140 tested was not specified. All of the 6 neonatal samples tested were negative for SARS-CoV-2.

141 **Tongji Hospital of Tongji Medical College, Huazhong University, Wuhan, China**

142 Liu et al. reported 3 pregnant women from the Tongji Hospital who became infected with SARS-
143 CoV-2 during the 3rd trimester.[14] These 3 women were among a total of 17 pregnant women admitted to

144 the Obstetrics Ward during the study period - a COVID-19 prevalence of approximately 18 percent. The
145 women's ages ranged from 30 to 34 years (Table 2). COVID-19 testing was performed using the rt-PCR
146 assay with a SARS-CoV-2 ORF1ab/N gene detection kit (Shanghai Huirui Biotechnology Co.,Ltd, Shanghai,
147 China), a product based on the recommendation of the National Institute for Viral Disease Control and
148 Prevention, Chinese Center for Disease Control and Prevention.

149 Case 1 was a 34-year-old woman with hypothyroidism who was febrile prior to her hospital
150 admission. She had a chest CT that showed progressively worsening bilateral pulmonary infiltrates. The
151 mother had positive rt-PCR tests for SARS-CoV-2 from an oropharyngeal swab and feces; testing of
152 breast milk, vaginal mucus and placenta were negative. Her 3250-gram infant was delivered at 40 weeks
153 gestational age by cesarean section with chronic fetal distress, chorioamnionitis, meconium-stained
154 membranes but had good Apgar scores. Specimens from the infant including whole blood, plasma
155 serum, umbilical cord blood and an oropharyngeal swab were negative for SARS-CoV-2 by rt-PCR.

156 Case 2 was a 34-year-old woman with no significant obstetrical history or co-morbid conditions.
157 She developed a fever at 37 weeks of gestation, and a CT scan of the chest revealed bilateral ground
158 glass opacities and pulmonary consolidation, nodules in the left lower lobe and patchy consolidation in
159 the right middle lobe. A oropharyngeal swab taken one day prior to delivery was positive for SARS-CoV-2
160 by rt-PCR. A 3250-gram infant was delivered by cesarean section at 38 weeks 4 days gestation with good
161 Apgar scores. The newborn had slightly decreased muscle tone and responsiveness that had improved
162 the day after delivery. Testing for SARS-CoV-2 from whole blood, serum, oropharyngeal swabs, urine
163 and feces using rt-PCR were all negative for the novel coronavirus.

164 Case 3 was a 30-year-old woman who had developed gestational hypertension during her first
165 pregnancy. She developed cough at 37 weeks gestation, and upon admission to the hospital had a chest
166 CT scan that demonstrated ground glass opacities, subsolid patch and linear fibrosis in the left lung and
167 enlarged mediastinal lymph nodes. An rt-PCR test for SARS-CoV-2 performed on an oropharyngeal swab

168 was positive; follow-up testing of an anal swab, vaginal mucus and breast milk were all negative. She
169 delivered a 3670-gram infant by vaginal delivery at 39 weeks 5 days gestation with good Apgar scores.
170 Two rt-PCR tests for SARS-CoV-2 were performed on successive days using whole blood, plasma,
171 oropharyngeal swabs, urine and feces, and all were negative.

172 The mothers in this report all presented with either fever or cough accompanied by CT
173 abnormalities during the course of their COVID-19 disease. None of the women developed severe
174 pneumonia or died, and all 3 had successful perinatal outcomes with no evidence of intrauterine
175 transmission of SARS-CoV-2.

176 **Maternal and Child Health Hospital of Hubei Province, Union Hospital, Renmin Hospital, Tianmen First**
177 **People's Hospital, Jingzhou Municipal Hospital and Child Health Hospital, and Pediatric Hospital**
178 **affiliated with Fudan University, China**

179 Zhu et al. described in detail the pregnancies of 9 pregnant women with COVID-19 and their 10
180 infants (including one set of twins) from 5 hospitals in Hubei Province (Tables 2 and 3).[15] The women
181 ranged in age between 25 and 35 years of age, and had a 1 to 6 day interval between the onset of
182 symptoms and delivery. All women had a chest CT revealing ground glass opacities, patchy pulmonary
183 consolidation and blurred borders typical of viral pneumonia. Viral testing for SARS-CoV-2 nucleic acid
184 was performed on throat swab specimens from the 9 women, and results were positive for all patients
185 except the mother of the twins - her test was negative. She had typical clinical symptoms of COVID-19
186 and viral interstitial pneumonia by chest CT scan, and other diseases that could cause fever and lung
187 infection were excluded. The local Chinese Centers for Disease Control and Prevention then registered
188 her as a confirmed 2019-nCoV case, and she was included in the current study.

189 The initial symptoms among these women was fever and/or cough. Prenatal conditions included
190 fetal distress in 6 cases, premature rupture of membranes in 3 cases (5 to 7 hours prior to the onset of
191 labor), oligohydramnios and polyhydramnios in 1 case each, umbilical cord abnormalities in 2 cases, and

192 placenta previa in 1 case. Third trimester obstetrical ultrasounds were all normal. Seven of the mothers
193 underwent cesarean sections, and 2 had vaginal deliveries. There were no cases of severe pneumonia or
194 maternal death among the 9 women.

195 There were 8 singletons and 1 set of twins delivered to the mothers with COVID-19 – 4 were full-
196 term and 6 were premature. Two newborns were small for gestational age and one was large for
197 gestational age. The infants were evaluated for well-being using the Pediatric Critical Illness Score (PCIS),
198 the most widely used pediatric critical illness scoring method in China. Six of the newborns had a PCIS of
199 less than 90 – 6 infants had shortness of breath, 2 were febrile and 1 had a rapid heart rate.
200 Gastrointestinal symptoms were present in 4 infants – these included gastric bleeding, refusal of milk,
201 bloating and feeding intolerance. Chest radiographs revealed that 7 newborns had abnormalities at the
202 time of admission that included infection in 4, neonatal respiratory distress syndrome in 2, and
203 pneumothorax in 1 infant. Two infants had the onset of thrombocytopenia associated with liver
204 dysfunction. One premature infant developed shortness of breath and fluctuations of oxygenation and
205 decreased platelets treated with respiratory support and transfusions. There was one neonatal fatality
206 among the cohort (Case 4) – a premature newborn developed shortness of breath, refractory shock,
207 multiple organ failure and disseminated intravascular coagulation and died on the 9th day of life. Four
208 neonates remained hospitalized at the time of submission of the report. Pharyngeal swab specimens
209 were collected from 9 of the neonates between 1- and 9-days following delivery and tested for SARS-
210 CoV-2, and all were negative.

211 **The Second Affiliated Hospital and The Affiliated Infectious Hospital of Soochow University, Suzhou,**
212 **China**

213 In a case report Wang et al. described a 28-year-old pregnant woman who presented to the
214 hospital with a fever of one-week duration (Table 3).[16] She was at 30 weeks gestation at the time of her
215 admission and 2 throat swabs tested negative for SARS-CoV-2 using rt-PCR. Chest CT examination 2 days

216 later showed left-sided subpleural patchy consolidation and right-sided ground-glass opacities. A repeat
217 rt-PCR examination of sputum performed 4 days after admission was positive for SARS-CoV-2. She was
218 transferred to the Intensive Care Unit where she was placed in isolation. An obstetrical ultrasound
219 revealed a normal fetus of 30 weeks gestation. On hospital day 3 decreased fetal movement was
220 observed with absent variability of the fetal heart rate, and an emergence cesarean section was
221 performed. A preterm male infant was delivered that weighed 1.83 kg and with Apgar scores of 9 and 10
222 at 1 and 5 minutes, respectively. Samples were taken of placenta, amniotic fluid, umbilical cord blood,
223 gastric juice and throat swabs of the infant - all results tested negative for SARS-CoV-2 using rt-PCR.
224 Three days following delivery rt-PCR testing of the neonatal throat swab and stool samples were
225 negative. Seven and 9 days after birth throat swab and rt-PCR tests from the mother and the infant
226 remained negative for the novel coronavirus.

227 **Renmin Hospital of Wuhan University, Wuhan and the Central Hospital of Qianjiang City, Qianjiang,**
228 **China**

229 Zhang and colleagues retrospectively examined medical records of 16 pregnant women with rt-
230 PCR confirmed COVID-19 and their newborn infants, and compared these results with a cohort of 45
231 pregnant women who were not infected (translated from Simplified Chinese by DAS) – this constituted
232 the first comparison study between women with and without SARS-CoV-2 infection during pregnancy.[17]
233 Throughout this study testing for SARS-CoV-2 was performed using the New Coronavirus (2019) Nucleic
234 Acid Detection Kit (Dual Fluorescence PCR) provided by Jiangsu Shuo Shi Biotechnology Co., Ltd. All
235 women were in their 3rd trimester of pregnancy. Diagnosis of COVID-19 was based on the diagnostic
236 criteria of the New Coronavirus Infected Pneumonia Diagnosis and Treatment Plan (Trial Fifth Edition)
237 issued by the National Health and Health Commission.

238 In the COVID-19 cohort the women varied from 24 to 34 years of age, had previously been
239 pregnant between 1 and 4 times, and had parity varying from 0 to 1 (Table 4). The gestational age at the

240 time of delivery varied between 35 weeks 5 days up to 41 weeks, averaging 38.7 weeks. In the cohort of
241 women who were not infected with SARS-CoV-2 the maternal ages varied between 24 and 40 years, had
242 1 to 5 previous pregnancies and parity of 0 or 1, and delivered their infants between 35 weeks 2 days
243 and 41 weeks with an average of 37.9 weeks. The women with COVID-19 had infants weighing between
244 2300 and 3750 grams (average 3139 g), and the women without COVID -19 had infants weighing
245 between 2180 and 4100g (average 3260g). There were no significant differences between the 2 cohorts
246 in gravidity, parity, gestational age at delivery, birthweight or intraoperative blood loss. The maternal
247 ages were significantly different – mothers in the COVID-19 cohort were younger than those in the non-
248 COVID-19 cohort (*P*=.01).

249 Among the 16 women with COVID-19 there were several mothers with co-morbid obstetrical
250 conditions – 3 women had gestational diabetes, 3 had premature rupture of membranes, 3 had preterm
251 deliveries, 2 had scarred uterus, 2 required B-Lynch suture procedure (a form of compression suture
252 used in obstetrics to mechanically compress an atonic uterus in the clinical setting of severe postpartum
253 hemorrhage). There was one incident of severe preeclampsia, meconium-stained amniotic fluid, fetal
254 distress and fetal asphyxia. Three of 16 women with COVID-19 had cough, chest tightness, shortness of
255 breath, and diarrhea that did not improve significantly with treatment. One of these mothers had
256 COVID-19 pneumonia – she was 35 weeks 6 days gestation with oxygen saturation of 93% accompanied
257 by chest tightness and shortness of breath, and with decreased fetal movement and abnormal fetal
258 heart monitoring. All of the women with COVID-19 underwent cesarean deliveries.

259 There were no significant differences between the groups of pregnant women with and without
260 COVID-19 in occurrence of severe preeclampsia, gestational diabetes, premature rupture of
261 membranes, fetal distress, meconium-stained amniotic fluid, premature delivery, neonatal asphyxia, B-
262 Lynch suture procedure or other compression sutures. The proportion of uterine scarring in the non-

263 COVID-19 group was statistically higher than that in COVID-19 group (p=0.032) – this abnormality
264 predated the development of COVID-19.
265 Among the cohort of 16 mothers with COVID-19 there were 10 infants for whom SARS-CoV-2
266 infection status was known – all were negative using rt-PCR analysis of throat swabs. Nine of these
267 newborns were full-term and 1 was preterm (36 weeks 2 days). Three of the neonates had bacterial
268 pneumonia based on their symptoms, laboratory testing, sputum culture, and imaging results – all of
269 them recovered following treatment. After discharge of the newborns from the hospital, follow-up
270 examinations demonstrated no neonatal illness or deaths.

271 Conclusions

272 Intrauterine transmission is one of the most serious complications of viral diseases occurring
273 during pregnancy. It can occur with maternal infection by congenitally-transmitted TORCH agents
274 (acronym for **T**oxoplasma, **O**ther, **R**ubella, **C**ytomegalovirus, **H**erpes) which also include Zika virus and
275 Ebola virus.[32] Maternal-fetal transmission of viral diseases (with the exception of herpes virus) is usually
276 through the hematogenous route in which the virus circulating in the maternal blood stream enters the
277 placenta, reaches the chorionic villous tree and fetal blood vessels, and is transmitted to the fetus.
278 Fortunately, this mechanism of transmission has been shown not to occur with infection of pregnant
279 women with 2 other pathogenic coronaviruses – SARS-CoV and MERS-CoV, although the clinical
280 infections caused by these coronaviruses has resulted in severe maternal pneumonia, maternal deaths
281 and early pregnancy losses.[12]
282 In this analysis of the detailed published reports of 38 pregnant women with COVID-19, of
283 whom 37 had rt-PCR-confirmed SARS-CoV-2 infection, there were no cases of either severe pneumonia
284 or maternal deaths. Although there were co-morbid conditions present in some of the women, some of
285 which were obstetrical in etiology, they apparently did not result in life-threatening maternal SARS-CoV-
286 2 disease. It is significant that these co-morbid maternal conditions, which included preeclampsia,

287 pregnancy-induced hypertension, uterine scarring, gestational diabetes, and uterine atony, did not
288 appear to be risk factors for intrauterine transmission of SARS-CoV-2 to the fetus. Gestational age
289 among these 22 mothers at the time of onset of COVID-19 varied between 30 and 40 weeks, and at least
290 in this range did not appear to be associated with heightened risk for maternal-fetal viral transmission

291 Among the 30 neonates delivered to these women who underwent testing, there were no cases
292 of rt-PCR-confirmed SARS-CoV-2 infection, despite the existence of perinatal complications in some of
293 the infants. An interesting observation is that in those cases where placentas were tested for SARS-CoV-
294 2, the results were negative. This lack of maternal-fetal transmission of SARS-CoV-2 is consistent with
295 past experiences with other coronavirus infections – SARS and MERS - occurring in pregnant women.

296 Early in the epidemic there were two cases of neonatal SARS-CoV-19 infection reported. One
297 was an infant diagnosed at 17 days of life having a history of close contact with 2 confirmed cases of
298 SARS-CoV-2 infection (mother and nanny), and the other was a neonate who was found to be infected
299 36 hours following delivery. In both infants there was no direct evidence for vertical transmission, and
300 because viral testing was delayed, a postpartum neonatal infection acquired through an infected contact
301 could not be eliminated.[11,12]

302 A joint mission by the World Health Organization consisting of 25 national and international
303 experts travelled to the affected regions of China between 16 and 24 February 2020.[33] They investigated
304 147 pregnant women (64 confirmed, 82 suspected and 1 asymptomatic with COVID-19). Among these
305 women 8% had severe disease and 1% were critical. The joint mission concluded that pregnant women
306 were not at higher risk for developing severe disease due to COVID-19. This report did not examine
307 vertical transmission or neonatal outcomes.

308 As this global epidemic continues to expand there will be additional information available on the
309 effects of COVID-19 on pregnant women and their infants. In the unfortunate event of mortality
310 resulting from SARS-CoV-2 infection among pregnant women or neonates, pathological evaluation of

311 tissues together with molecular characterization of the virus would be useful in determining the
312 pathogenesis of the disease as it has in many cases of emerging infections.[34] There are currently updated
313 recommendations available on the obstetrical management of SARS-CoV-2 infection in pregnant
314 women.[35] In addition, it must be remembered that as vaccine development proceeds for COVID-19 that
315 pregnant women should be considered for inclusion in the clinical trials as well as the eventual
316 distribution of the vaccine unless the risks outweigh the potential benefits.[36]

317

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Table 1. Characteristics of 7 pregnant women with COVID-19 and their infants.

Case and 1st author	Case 1 Chen[13]	Case 2 Chen[13]	Case 3 Chen[13]	Case 4 Chen[13]	Case 5 Chen[13]	Case 6 Chen[13]	Case 7 Chen[13]
Maternal age (years)	33	27	40	26	26	26	29
Gestational age at delivery	37wk 2d	38wk 3d	36 wk	36wk 2d	38wk 1d	36wk 3d	36wk 2d
Comorbid events	Influenza	None	Gestational hypertension	Pre-eclampsia	Fetal distress	None	PROM
Maternal rt-PCR for SARS-CoV-2	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Symptom-to-delivery interval	1 day	6 days	4 days	3 days	1 day	4 days	2 days
C-section or vaginal	C-s	C-s	C-s	C-s	C-s	C-s	C-s
Birthweight	2870 g	3730 g	3820 g	1880 g	2970 g	3040 g	2460 g
Apgars at 1 & 5 mins	8, 9	9, 10	9, 10	8, 9	9, 10	9, 10	9, 10
Neonatal outcome	Normal	Normal	Normal	SGA	Normal	Normal	Normal
Neonatal rt-PCR for SARS-CoV-2	According to Chen et al. there were 6 of 9 neonates tested for SARS-CoV-2 and all 6 were found to be negative by rt-PCR, but which 6 neonates that were tested was not specified						

Abbreviations: SGA – small for gestational age; PROM – premature rupture of membranes

Table 2. Characteristics of additional 7 pregnant women with COVID-19 and their infants

Case and 1st author	**Case 8 Chen[13]**	**Case 9 Chen[13]**	**Case 1 Liu[14]**	**Case 2 Liu[14]**	**Case 3 Liu[14]**	**Case 1 Zhu[15]**	**Case 2 Zhu[15]**
Maternal age (years)	28	34	34	34	30	25	35
Gestational age at delivery	38wk	39wk 4d	40wk	38wk 4d	39wk 5d	38wk 4d	33w 6d
Comorbid events	Fetal distress	PROM	Hypothyroid	Placenta acreta	Gestational diabetes	Fetal distress, oligo	Scarred uterus
Maternal rt-PCR for SARS-CoV-2	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Symptom-to-delivery interval	2 days	7 days	~1 day	~7 days	~13 days	< 1 day	< 1day
C-section or vaginal	C-s	C-s	C-s	C-s	Vaginal	C-s	C-s
Birthweight	2800 g	3530 g	3250 g	3250 g	3670 g	2,450g	2,050 g
Apgars at 1 &5 mins	9, 10	8, 10	8, 9	8, 9	8, 9	9, 10	9, 10
Neonatal outcome	Normal	Normal	Normal	Normal	Normal	SGA	SOB
Neonatal rt-PCR for SARS-CoV-2	See Table 1	See Table 1	Negative	Negative	Negative	Negative	Negative

Abbreviations: PROM – premature rupture of membranes; oligo-oligohydramnios; SGA-small for gestational age; SOB-shortness of breath

Table 3. Characteristics of additional 8 pregnant women with COVID-19 and their 9 infants including one set of twins

Case and 1st author	Case 3 Zhu[15]	Case 4 Zhu[15]	Case 5 Zhu[15]	Case 6 Zhu[15]	Case 7 Zhu[15]	Case 8 Zhu[15]	Case 9 Zhu[15]	Case 10 Zhu[15]
Maternal age (years)	35	30	30	30	30	29		34
Gestational age at delivery	34w 2d	34wk 5d	39w	37w	34w 6d	31w		39w
Comorbid events	Fetal distress	Vaginal bleeding, fetal distress	Cholecystitis	Placenta previa, fetal distress poly	Fetal distress	Twins, fetal distress, viral pneumonia c/w with COVID-19		None
Maternal rt-PCR for SARS-CoV-2	Positive	Positive	Positive	Positive	Positive	Negative		Positive
Symptom-to-delivery interval	2 days after delivery	3 days after delivery	6 days before delivery	4 days before delivery	4 days before delivery	3 days before delivery		1 day after delivery
C-section or vaginal	Vaginal	C-s	C-s	C-s	C/s	Vaginal twin		C-s
Birthweight	2350 g	2200 g	3030 g	3800 g	2300 g	1520 g	1720 g	2810 g
Apgars at 1 & 5 mins	8, 9	8, 8	8, 9	7, 8	9, 10	9, 10	9, 10	10, 10
Neonatal outcome	SOB	Multiple organ failure, shock, gastric bleeding, DIC, death	Diffuse scattered rashes, edema, facial skin lesions	LGA, in hospital	SOB, fever, GI bleeding DIC	SOB, in hospital	SOB, in hospital	SGA, SOB, cyanosis, in hospital
Neonatal rt-PCR for SARS-CoV-2	Neg	Neg	Not performed	Neg	Neg	Neg	Neg	Neg

Abbreviations: LGA – large for gestational age; poly-polyhydramnios; SGA-small for gestational age; SOB-shortness of breath; DIC-disseminated intravascular coagulation; c/w – consistent with

Table 4. Characteristics of an additional 17 pregnant women with COVID-19 and their infants

Case and 1st author	**Case 1 Wang[16]**	**Cases 1 to 16 Zhang et al.[17]**
Maternal age (years)	35	Varies from 24 to 34 years with mean of 29.3 ± 2.9
Gestational age at delivery	31 w	Varies from 35 weeks 5 days up to 41 weeks with mean of 38.7 ± 1.4
Comorbid events	Fetal distress	Gestational diabetes (3), PROM (3), preterm delivery (3), uterine scarring (2), B-Lynch/compression suture procedure (2), severe preeclampsia (1), fetal distress (1), fetal asphyxia (1), meconium staining (1), COVID-19 pneumonia (1)
Maternal rt-PCR for SARS-CoV-2	Positive	Positive in all 16 women
Symptom-to-delivery interval	13 days before delivery	Not stated
C-section or vaginal	C-s	C-s in all 16 women
Birthweight	1830 g	Varies from 2300 to 3750 grams with mean of 3139 g ± 437
Apgars at 1 & 5 mins	9, 10	Not stated
Neonatal outcome	Normal	Bacterial pneumonia in 3 neonates, 1 preterm infant
Neonatal rt-PCR for SARS-CoV-2	Neg	Viral testing results available for 10 of 16 neonates, all of whom were negative for infection

Abbreviations: PROM – premature rupture of membranes