

# International Journal of Gynecology and Obstetrics

## Delivery in SARS-CoV-2 infected women: a fast review.

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<b>Abstract:</b>	<p>Background. Few case reports and clinical series have reported cases of SARS-CoV-2 infected women who delivered.</p> <p>Objective. We reviewed the available evidences on mode of delivery, vertical/peripartum transmissions and neonatal outcome in SARS-CoV-2 infected women.</p> <p>Search strategy. Combination of the following key words: COVID-19 SARS-CoV-2 and pregnancy in EMBASE and PUBMED.</p> <p>Selection criteria. Papers reporting cases of SARS-CoV-2 infected women who delivered.</p> <p>Data Collection and analysis. The following information was extracted: author; country; number of women; design of the study; gestational age at delivery, selected clinical maternal data, mode of delivery, selected neonatal outcomes.</p> <p>Main results. In 13 studies, vaginal delivery was reported in six cases (9.4%, 95%CI=3.5-19.3). Indication to CS was worsening of maternal conditions in 31 (48.4%, 95%CI 35.8-61.3). Two cases of newborn positive to rRT-PCR assay for SARS-CoV-2 were reported. Four babies in which the SARS-CoV-2 IgG and IgM levels were elevated but the RT-PCR negative test was negative were reported.</p> <p>Conclusions. The rate vertical or peripartum transmission of SARS-CoV-2 is low, if any, in case of CS. No data are available in case of vaginal delivery. The observation of a low frequency of spontaneous preterm birth and of a general favorable immediate neonatal outcome are reassuring.</p>

Dear Editor,

We are now submitting for publication in your journal a paper of ours entitled  
Delivery in SARS-CoV-2 infected women: a fast review.

This paper offers an updated review of available information on delivery in women with SARS-CoV-2 infection

Word count 2485 excluding abstract and tables

The Authors have no conflict of interest to declare

Thanks in advance for your attention

Yours sincerely

Fabio Parazzini

A handwritten signature in black ink, appearing to read 'Fabio Parazzini', written in a cursive style.

Dear Editor, please find attached the short version of our paper. In order to quoted all considered papers we have included 13 references, but we can reduce them to 10.

Yours sincerely

Fabio Parazzini

**International Journal of Gynecology and Obstetrics (IJGO)**

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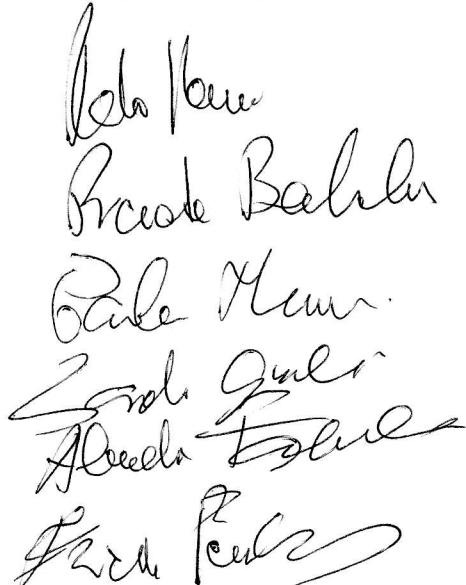
Delivery in SARS-CoV-2 infected women: a fast review

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Fabio Parazzini  
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Alessandro Favilli  
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The image shows six handwritten signatures in black ink, arranged vertically. From top to bottom, they correspond to the printed names: Fabio Parazzini, Renata Bortolus, Paola Mauri, Sandro Gerli, Alessandro Favilli, and Enrico Ferrazzi. The signatures are cursive and somewhat stylized.



***International Journal of Gynecology and Obstetrics***

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The CONSORT statement and checklist have been consulted: <http://www.consort-statement.org/consort-2010>. A CONSORT flow chart has been submitted as an editable figure in Word/PowerPoint format.

Systematic review/meta-analysis. The PRISMA guidelines have been consulted and followed: <http://www.prisma-statement.org/>.

Meta-analysis of observational studies. The MOOSE guidelines have been consulted and followed: [http://www.consort-statement.org/mod\\_product/uploads/MOOSE%20Statement%202000.pdf](http://www.consort-statement.org/mod_product/uploads/MOOSE%20Statement%202000.pdf).

Other type of research.

We have shortened the paper as suggested



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# Delivery in SARS-CoV-2 infected women: a fast review.

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**Key words:** delivery, infection, SARS-CoV-2

**Synopsis:** the rate vertical/peripartum transmission of SARS-CoV-2 is low, if any, in case of CS, but no data are available in case of vaginal delivery.

**Word count** 2442

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**Background.** Few case reports and clinical series have reported cases of SARS-CoV-2 infected women who delivered.

**Objective.** We reviewed the available evidences on mode of delivery, vertical/peripartum transmissions and neonatal outcome in SARS-CoV-2 infected women.

**Search strategy.** Combination of the following key words: COVID-19 SARS-CoV-2 and pregnancy in EMBASE and PUBMED.

**Selection criteria.** Papers reporting cases of SARS-CoV-2 infected women who delivered.

**Data Collection and analysis.** The following information was extracted: author; country; number of women; design of the study; gestational age at delivery, selected clinical maternal data, mode of delivery, selected neonatal outcomes.

**Main results.** In 13 studies, vaginal delivery was reported in six cases (9.4%, 95%CI=3.5-19.3). Indication to CS was worsening of maternal conditions in 31 (48.4%, 95%CI 35.8-61.3).Two cases of newborn positive to rRT-PCR assay for SARS-CoV-2 were reported. Four babies in which the SARS-CoV-2 IgG and IgM levels were elevated but the RT-PCR negative test was negative were reported.

**Conclusions.** The rate vertical or peripartum transmission of SARS-CoV-2 is low, if any, in case of CS. No data are available in case of vaginal delivery. The observation of a low frequency of spontaneous preterm birth and of a general favorable immediate neonatal outcome are reassuring.

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The recent outbreak of COVID-19 infection has faced the midwiferies and the obstetricians with a new challenge.

In this early phase of the epidemic very few data are available on the effect of COVID-19 infection among pregnant women. The risk of intrauterine and peri-partum transmission of the virus to the fetus is also largely unknown.

Up to now, most of the guidelines are based on the previous experience with other highly pathogenic coronaviruses (i.e., severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS) (1-3).

A recent consensus stated that there is no clear evidence regarding optimal delivery timing, the safety of vaginal delivery, or whether caesarean section (CS) prevents vertical transmission at the time of delivery; therefore, route and timing of delivery should be individualized based on obstetrical indications and maternal-fetal status (2).

During the last weeks some case reports and clinical series have been published on the mode of delivery in pregnant infected women, immediate neonatal outcome, risk of infection of the newborn and breastfeeding (4-6).

These series, although including generally few cases, may offer initial information in order to direct clinical practice.

In this paper we have reviewed the available evidences with special focus on mode of delivery, vertical/peripartum transmission and immediate neonatal outcome.

**METHODS**

We searched the PubMed (National Library of Medicine, Washington, DC) and EMBASE databases from January up to 30th March 2020, using the combination of the following key words: COVID-19 SARS-CoV-2 and pregnancy (no limit).

Furthermore, we have reviewed reference lists of retrieved articles to search for other pertinent studies.

Two authors (FP and RB) reviewed the papers and independently selected the articles eligible for the systematic review.

Studies were selected for the review if they met all the following criteria: clinical studies, studies reporting original data, studies reporting SARS-CoV-2 infected women who delivered.

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6 *Data extraction*

7 A PICOS (Patient, Intervention, Comparator, Outcome, Study) design structure was used to  
8 develop the study questions and the inclusion/exclusion criteria. The question was, "Which  
9 is the mode of delivery and the obstetric and immediate neonatal outcome in SARS-CoV-2  
10 infected pregnant women?" (Table 1).  
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14 For each study, the following information was extracted: first author's last name; year;  
15 country; number of women who delivered; design of the study; gestational age at delivery,  
16 selected clinical maternal data (maternal age, comorbidity, diagnosis of pneumonia,  
17 treatment), mode of delivery, selected neonatal outcomes (birthweight, 5min-APGAR score,  
18 admission to Neonatal Intensive Care Unit (NICU), neonatal diseases, positivity to SARS-  
19 CoV-2).  
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30 *Data synthesis*

31 The primary outcomes assessed were frequency of preterm birth (<37weeks gestation),  
32 vaginal delivery, APGAR score 5min <7, newborn infection. For each study with binary  
33 outcomes, we calculated the 95% confidence intervals (CI) of the estimated proportion.  
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39 **RESULTS.**

40 The initial search retrieved 41 abstracts from Pubmed and 23 from Embase (1<sup>st</sup> April 2020).  
41 After exclusion of the bases of abstracts of review papers guideline and commentaries 17  
42 papers were selected for extensive read.  
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46 Two studies reported only data on maternal outcome (7,8). Another paper was published  
47 without peer review (9). Further one study was published in Chinese language (10). Thus a  
48 total of 13 studies have been identified (4-6, 11-20).  
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52 Their main methodological characteristics are presented in Table 2.

53 Six studies were case reports and seven retrospective clinical series.

54 A total of 64 women who delivered were reported (seven cases admitted in hospital but who  
55 did not delivered at the time of publication were also reported).  
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58 Table 3 considers the maternal characteristics and clinical conditions.

59 Pneumonia was present in most of cases (48 out of 61 cases for which the information was  
60 available, 78.7%, 95%CI 66.3-88.1). The 70.7% of reported cases for which the information  
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was available (29/41, 95%CI 54.5-83.9) needed oxygen support and the 5.4% (2/37, 95%CI 0.7-18.2) of admission to a Critical Care Unit (CCU).

Table 4 considers mode of delivery. Vaginal delivery was reported in six cases (9.4%, 95%CI=3.5-19.3). Indication to CS was worsening of maternal conditions in 31 (48.4%, 95%CI 35.8-61.3, cases by Liu et al (14) and Zeng et (19) al are not considered)

Preterm birth (<37weeks of gestation) was observed in 19 cases among the 48 for which the information on gestational age at delivery was available (39.6%, 95%CI=25.8-54.7). In only two cases, reported by Zhu et al. (5), the delivery was due to spontaneous preterm labour (1 twin pregnancy and 1 PROM).

Finally Table 5 considers the immediate neonatal outcome and the frequency of SARS-Cov-2 positivity in the newborns.

Low birthweight (<2500 g) was observed in 10 newborns (10/37 for which the information was available, 27.0%, 95%CI=13.8-44.1). In all cases 5-min-APGAR score was  $\geq 7$  (Table 4).

One neonatal death due to disseminated intravascular coagulation (DIC) syndrome was reported. The death occurred in a singleton male baby born by CS at 34+5 week of gestation and weighting 2200 g: the cause of death was multiple organ failure and DIC.

Considering respiratory disease, one pneumonia, one low grade fever and hazzines in both lung fields, one high density nodular shadow under the pleura of the right lung, 6 shortness of breath and two neonatal respiratory distress syndromes were reported (a detailed list is shown in Table 4).

Whang et al. (16) reported a case of neonatal COVID-19 infection with pharyngeal swabs tested positive by rRT-PCR assay 36 hours after cesarean birth, in which whether the case is a vertical transmission from mother to child remains to be confirmed.

Dong et al. (11) reported a case of a baby delivered by CS in which at two hours of age, the SARS-CoV-2 IgG and IgM levels were elevated. Results from 5 RT-PCR tests on nasopharyngeal swabs taken from 2 hours to 16 days of age were negative. Other three newborns delivered by CS with elevated IGM antibodies to SARS-COV-2 virus, but throat swab by RT-PCR negative test have been also reported (19).

Finally Yu et al (17) reported the case of a positive newborn at 36h after cesarean birth.

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4 **DISCUSSION.**  
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6 The results of this fast systematic review of the available data on mode of delivery and  
7 immediate neonatal outcome in SARS-CoV-2 infected women suggest that the risk of  
8 vertical or peripartum transmission to the newborn of the virus is limited, if any.  
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11 We identified two cases of newborn infection, confirmed by pharyngeal swabs tested  
12 positive by rRT-PCR assay, out of 64 reported cases. At our knowledge, another case of  
13 SARS-CoV-2 infected newborn -not included in this review- has been reported from the  
14 National Health Commission of the People' Republic of China) (21-22) in which the  
15 diagnosis was made at 17 days of life. In all cases a postpartum neonatal infection acquired  
16 through an infected contact was impossible to be excluded.  
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19 IGM antibodies vs SARS-CoV-2 have been also found in four cases (11,19). Caution in  
20 interpreting these findings has been suggested including the possibility that IGM positivity  
21 could represent a laboratory artifact (23).  
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29 Otherwise these findings suggest that the transmission in utero can be possible. However,  
30 the SARS-CoV-2 was not found in amniotic fluid and cord blood. This latter finding is  
31 however based on very few cases (5).  
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37 The data on virus transmission are based substantially on women who delivered by CS. This  
38 aspect is relevant.  
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41 In fact, vertical transmission of infection usually occurs during intrauterine life via trans-  
42 placenta, or during delivery via ingestion or aspiration of cervicovaginal secretions, and in  
43 the postpartum period via breastfeeding (24).  
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46 The risk of ingestion or aspiration of cervicovaginal secretion or contact with perineal  
47 infected tissue is higher in case of vaginal delivery.  
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50 In this review we identified 19 cases who delivered preterm, but in only two cases  
51 spontaneous vaginal preterm birth was reported. Thus we have now reassuring evidence  
52 on the fact that COVID-19 infection of the mother did not markedly increase the risk of  
53 spontaneous preterm birth.  
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56 With regard to maternal conditions we have to note that COVID-19 infection in pregnancy  
57 seems to be less severe than other Coronavirus infections such SARS or MERS (2-3). We  
58 identified two cases who need intensive care.  
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62 The proportion of women requiring CCU admission seems to be similar to those reported in  
63 the general population affected by COVID 19 (25). However, the worsening of the maternal  
64 condition was the cause of emergency CS in about the 45% of women.  
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Diabetes and hypertension are considered determinants of worse prognosis in case of infection (25). We are not able to analyze in details this relation: the few cases reported with diabetes did not need CCU admission.

Finally, the newborn outcome deserves some consideration.

First of all we have to underline that in all the reported cases the 5min-APGAR score was higher than 7 and generally 9 or 10 (data not shown in table).

Also the frequency of NICU admission was low and due to medically induced preterm birth. However one neonatal death and several cases of respiratory symptoms or diseases were reported with pharyngeal or naso-pharyngeal swabs tested negative by rRT-PCR assay.

Unfortunately, very few reported cases provided information on the risk of newborn infection during breastfeeding. Guidelines suggest to allow breastfeeding to positive women with mask (26). Preliminary data suggest that the virus is not detectable in milk (4).

In conclusion, this review of the literature focused on delivery suggests that the rate of vertical or peripartum transmission of SARS-CoV-2 is low, if any, in case of CS. Substantially, no data are available in case of vaginal delivery. Likewise, breastfeeding was not generally reported, thus the risk of transmission during breastfeeding is unknown. The observation of a low frequency of spontaneous preterm birth and of a general favorable immediate neonatal outcome are reassuring.

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## 27 **Contributors**

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29 FP and EF designed the study  
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32 FP and RB reviewed the identified papers  
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35 FP and RB drafted the manuscript  
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38 PM and EF revised the manuscript.

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40 All authors reviewed and approved the final manuscript.  
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## 49 **Conflict of interests**

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51 No conflict of interest to declare  
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**Table 1.** PICOS criteria for inclusion and exclusion of studies.

Parameter	Inclusion criteria	Data extraction
Patient	Women treated with SARS-COV-2 infection	Location, age, clinical characteristics
Intervention	Delivery	Mode of delivery
Comparator	None	
Outcome	Neonatal outcome	Birth weight, APGAR score, neonatal disease NICU admission, SARS-COV-positivity
Study	Observational studies	Type of study design

**Table 2.** Study characteristics and sample size

Authors, year, country	Type of study	Aim	Assess	Cases (n)
Chen et al, 2020, China (4)	retrospective clinical series	IVT	AF, CB, ITS, M	9
Chen et al, 2020, China (20)	retrospective clinical series	-	-	5
Dong et al, 2020, China (11)	case report	IVT	IGM-IGG, INPS, VS, M	1
Fan et al, 2020, China(12)	case report	IVT	AF, CB, IGG, INPS, M, PT, VS,	2
Lee et al, 2020, Korea(18)	case report	IVT	AF, CB, INPS	1
Li et al, 2020, China(13)	case report	IVT	AF, CB, IOPS, IB, IS, IU, M, PT	1
Liu et al, 2020, China (14)	retrospective clinical series	IVT	nr	10/+3°
Liu, Li et al, 2020, China (15)	retrospective clinical series	-	-	11/+4°
Wang et al, 2020, China (16)	case report	IVT	CB, IOPS, M, PT	1
Wang et al, 2020, China (6)	case report	IVT	AF, CB, IGJ, IS, ITS, PT	1
Yu et al, 2020, China (17)	retrospective clinical series	-	-	7
Zeng et al, 2020, China (19)	retrospective clinical series	IVT	INPS	6
Zhu et al, 2020, China (5)	retrospective clinical series	IVT	IOPS	9*

IVT: intrauterine vertical transmission; AF: amniotic fluid; CB: cord blood; ITS: infant throat swab; M: milk; INPS: infant nasopharyngeal swab; PT: placenta tissues; VS: vaginal swab; IOPS: infant oropharyngeal swab; IB: infant blood; IS: infant stool; IU: infant urine; ° patients with pregnancy in progress; IGJ: infant gastric juice; \* 9 mothers and 10 neonates; nr: not reported;

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Table 3. Maternal characteristics and clinical conditions

Authors	Maternal age	Comorbidities	Antiviral therapy	Pneumonia	Oxygen support	CCU admission
Chen et al.	26-40	2 GH/9	6/9	9/9	9/9	0°/9
Chen, Liao et al.	25-31	2GD, 1GH/5	5*/5	5°°/5	0/5	nr
Dong et al.	29	0/1	1/1	1°°/1	1/1	nr
Fan et al.	29, 34	0/2	2/2	2/2	nr	nr
Lee et al.	28	0/1	0/1	0°/1	0/1	0/1
Li et al.	30	0/1	1/1	1°°/1	nr	nr
Liu, Chen et al.	22-36	0/13	Nr	1/13	nr	1/13
Liu, Li et al.	23-40 (32±5)	1 GD, 1VR/11	11*/11	11/11	11/11	nr
Wang, Guo et al.	34	0/1	1*/1	1°°/1	nr	nr
Whang, Zhou et al.	28	0/1	1/1	1/1	1/1	1/1
Yu et al.	29-34 (mean 32)	2**/7	7/7	7/7	7/7	0/7
Zen et al.	nr	Nr	Nr	nr	0/6	0/6
Zhu et al.	25-35 (mean 30)	0/9	3*/9	9/9	nr	nr

CCU: Critical Care Unit; GH: gestational hypertension; ° no mechanical ventilation; GD: gestational diabetes; °° computed tomography (CT) scan with typical images of viral pneumonia; VR: mitral and tricuspid valve replacement; \* after delivery; \*\* 1 hypothyroidism, 1 polycystic ovary syndrome; nr: not reported.

°Rx and CTscan: left lower/middle lobe consolidation

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Table 4. Mode of delivery and preterm birth

<b>Authors</b>	<b>Gestational age (w)</b>	<b>Mode of delivery</b>			<b>Preterm birth</b>
		<i>CS for maternal COVID-19 infection</i>	<i>CS for obstetric indication</i>	<i>Vaginal delivery</i>	
Chen et al.	36-39	9 <sup>°</sup> /9	7 <sup>°</sup> /9	-	4/9
Chen, Liao et al.	38-40		2/5	3/5	0/5
Dong et al.	37	1/1	-	-	0/1
Fan et al.	36, 37	2/2	-	-	1/2
Lee et al.	36		1/1		1/1
Li et al.	35	-	1 <sup>°</sup> /1	-	1/1
Liu, Chen et al.	nr	5 <sup>°°°</sup> /10	5 <sup>*</sup> /10	-	6/10
Liu, Li et al.	nr	9/11	1/11	1/11	nr
Whang, Guo et al.	40	1/1	-	-	0/1
Wang, Zhou et al.	30	1/1	-	-	1/1
Yu et al.	37-41	7/7	-	-	0/7
Zen et al.	nr	6/6 <sup>°°</sup>			nr
Zhu et al.	31-39	1/9	6 <sup>**</sup> /9	2§/9	6 (2 twins)/10

CS: caesarean section; ° in 7 cases CS for maternal COVID-19 infection and obstetric indication: 1 history of caesarean section, 1 pre-eclampsia, 2 fetal distress, 1 history of stillbirth, 2 PROM; °° also fetal distress; °°° no obstetric indication; \*3 fetal distress, 1 PROM, 1 stillbirth; \*\* 1 PROM, 4 fetal distress, 1 cholecystitis and fever; § 2 PROM, 3 fetal distress, 2 twins; nr: not reported; °°unclear in the text.

Table 5. Newborn characteristics and breastfeeding

Authors	LBW	Apgar 5' ( $\geq 7$ )	NICU admission	COVID (+)	Neonatal diseases	Breastfeeding
Chen et al.	2/9	9/9	nr	0/6	0°/9	9/9
Chen, Liao et al.	0/5	5/5	nr	0°°/5	0/5	0/5
Dong et al.	0/1	1/1	1*/1	IGM+IGG+ INPS- M- VS-	-	nr
Fan et al.	0/2	2/2	nr	0/2	1 low grade fever, hazziness in both lung fields, abdominal distension/ 1pneumonia	nr
Lee et al, 2020	0/1	1/1	1°/1	0/1	0/1	0/1
Li et al.	nr	nr	nr	0/1	0/1	nr
Liu, Chen et al.	nr	nr	nr	0/9	0°/9	nr
Liu, Li et al.	nr	11/11	nr	nr	0°/11	nr
Whang, Guo et al.	0/1	1/1	nr	IOPS+ CB- M- PT-	Swallowing syndrome, lymphopenia, deranged liver function tests, elevated creatine kinase level, high density nodular shadow under the pleura right lung (CT)	0/1
Wang, Zhou et al.	1/1	1/1	1**/1	0/1	0/1	0/1
Yu et al.	0/7	7/7	nr	1 NAT-ITS+ /3	0/7	nr
Zen et al.	nr	6/6	nr	0/6°°	nr	nr
Zhu et al.	7 (2 twins)/10	10/10	nr	0/9	6 shortness of breath 3 cyanosis 2 DIC 1 death  Chest radiography: 4 infections 2 neonatal respiratory distress syndrome 1 pneumothorax	nr

LBW: low birthweight (< 2500g); NICU: Neonatal Intensive Care Unit; ° no neonatal asphyxia; °° neonatal SARS-CoV-2 quantitative RT-PCR; \* for quarantine; INPS: infant nasopharyngeal swab; M: milk; VS: vaginal swab; IOPS: infant oropharyngeal swab; CB: cord blood; PT: placenta tissues; \*\* for preterm delivery; NAT: nucleic acid test; ITS: infant throat swab; DIC: disseminated intravascular coagulation; nr: not reported. °to avoid SARS-CoV-2 exposure.  
°° see text results section

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# Delivery in SARS-CoV-2 infected women: a fast review.

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**Key words:** delivery, infection, SARS-CoV-2

**Synopsis:** the rate vertical/peripartum transmission of SARS-CoV-2 is low, if any, in case of CS, but no data are available in case of vaginal delivery.

**Word count:** 749

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In this phase of the SARS-CoV-2 infection epidemic, very few data are available on delivery and the risk of intrauterine and peri-partum transmission of the virus to the fetus among infected women.

A recent consensus stated that there is no clear evidence regarding optimal delivery timing, the safety of vaginal delivery, or whether caesarean section (CS) prevents vertical transmission at the time of delivery; therefore, route and timing of delivery should be individualized based on obstetrical indications and maternal-fetal status.

We have reviewed the available evidences with special focus on mode of delivery, vertical/peripartum transmission and immediate neonatal outcome. We searched the PubMed (National Library of Medicine, Washington, DC) and EMBASE databases from January up to 30th March 2020, using the combination of the following key words: COVID-19 SARS-CoV-2 and pregnancy (no limit). Studies were selected for the review if they met all the following criteria: clinical studies, studies reporting original data, studies reporting SARS-CoV-2 infected women who delivered.

The initial search retrieved 41 abstracts from Pubmed and 23 from Embase (1<sup>st</sup> April 2020). After exclusion of review papers, guidelines, commentaries, studies reporting only data on maternal outcome, published in the Chinese language and nor published in peer reviewed journals, a total of 13 studies have been identified (1-13).

Six studies were case reports and seven retrospective clinical series. A total of 64 women who delivered were reported (seven cases admitted in hospital, but who did not delivered at the time of publication were also reported).

Pneumonia was present in most of cases (48 out of 61 cases for which the information was available, 78.7%, 95%CI 66.3-88.1). The 70.7% of reported cases for which the information was available (29/41, 95%CI 54.5-83.9) needed oxygen support and the 5.4% (2/37, 95%CI 0.7-18.2) of admission to a Critical Care Unit (CCU).

Vaginal delivery was reported in six cases (9.4%, 95%CI=3.5-19.3). Indication to CS was worsening of maternal conditions in 31 (48.4%, 95%CI 35.8-61.3, cases by Liu et al (7) and Zeng et (12) are not considered) (Table 1).

Preterm birth (<37weeks of gestation) was observed in 19 cases among the 48 for which the information on gestational age at delivery was available (39.6%, 95%CI=25.8-54.7). In



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only two cases, reported by Zhu et al. (13), the delivery was due to spontaneous preterm labour (1 twin pregnancy and 1 PROM).

Low birthweight (<2500 g) was observed in 10 newborns (10/37 for which the information was available, 27.0%, 95%CI=13.8-44.1). In all cases 5-min-APGAR score was  $\geq 7$ .

One neonatal death due to disseminated intravascular coagulation (DIC) syndrome was reported. The death occurred in a singleton male baby born by CS at 34+5 week of gestation and weighting 2200 g: the cause of death was multiple organ failure and DIC.

Whang et al. (9) reported a case of neonatal COVID-19 infection with pharyngeal swabs tested positive by rRT-PCR assay 36 hours after cesarean birth, in which whether the case is a vertical transmission from mother to child remains to be confirmed.

Dong et al. (3) reported a case of a baby delivered by CS in which at two hours of age, the SARS-CoV-2 IgG and IgM levels were elevated. Results from 5 RT-PCR tests on nasopharyngeal swabs taken from 2 hours to 16 days of age were negative. Other three newborns delivered by CS with elevated IGM antibodies to SARS-CoV-2 virus, but throat swab by RT-PCR negative test have been also reported.

Finally Yu et al (11) reported the case of a positive newborn at 36h after cesarean birth. In all cases a postpartum neonatal infection acquired through an infected contact was impossible to be excluded.

IGM antibodies vs SARS-CoV-2 have been also found in four cases (12). Caution in interpreting these findings has been suggested including the possibility that IGM positivity could represent a laboratory artifact. Otherwise these findings suggest that the transmission in utero can be possible. However, the SARS-CoV-2 was not found in amniotic fluid and cord blood (1). The data on virus transmission are based substantially on women who delivered by CS. The risk of ingestion or aspiration of cervicovaginal secretion or contact with perineal infected tissue is higher in case of vaginal delivery.

In conclusion, this review of the literature focused on delivery suggests that the rate of vertical or peripartum transmission of SARS-CoV-2 is low, if any, in case of CS. Substantially, no data are available in case of vaginal delivery. The observation of a low frequency of spontaneous preterm birth and of a general favorable immediate neonatal outcome are reassuring.

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## **Contributors**

FP and EF designed the study

FP and RB reviewed the identified papers

FP and RB drafted the manuscript

PM and EF revised the manuscript.

All authors reviewed and approved the final manuscript.

## **Conflict of interests**

No conflict of interest to declare

**Synopsis:** the rate vertical/peripartum transmission of SARS-CoV-2 is low, if any, in case of CS., but no data are available in case of vaginal delivery

Table 1. Mode of delivery, preterm birth and neonatal outcome.

Authors		Mode of delivery		Preterm birth	LBW	Apgar 5' ( $\geq 7$ )	NICU admission	COVID (+)	Neonatal diseases
				Yes/total series	Yes/total series	Yes/total series	Yes/total series	Yes/total series	Yes/total series
Chen et al, 2020, China (1)	9°/9	7°/9	-	4/9	2/9	9/9	Nr	0/6	0°°°°/9
Chen et al, 2020, China (2)		2/5	3/5	0/5	0/5	5/5	Nr	0°°°°°/5	0/5
Dong et al, 2020, China (3)	1/1	-	-	0/1	0/1	1/1	1***/1	IGM+IGG+ INPS- M- VS-	-
Fan et al, 2020, China(4)	2/2	-	-	1/2	0/2	2/2	nr	0/2	1 low grade fever, hazziness in both lung fields, abdominal distension/ 1 pneumonia
Lee et al, 2020, Korea(5)		1/1		1/1	0/1	1/1	1°°°°°°/1	0/1	0/1
Li et al, 2020, China(6)	-	1°°/1	-	1/1	nr	nr	Nr	0/1	0/1
Liu et al, 2020, China (7)	5°°°/10	5*/10	-	6/10	nr	nr	Nr	0/9	0°/9
Liu, Li et al, 2020, China (8)	9/11	1/11	1/11	nr	nr	11/11	Nr	Nr	0°/11
Wang et al, 2020, China (9)	1/1	-	-	0/1	0/1	1/1	Nr	IOPS+ CB- M- PT-	Swallowing syndrome, lymphopenia, deranged liver function tests, elevated creatine kinase level, high density nodular shadow under the pleura right lung (CT)
Wang et al, 2020, China (10)	1/1	-	-	1/1	1/1	1/1	1****/1	0/1	0/1
Yu et al, 2020, China (11)	7/7	-	-	0/7	0/7	7/7	Nr	1 NAT-ITS+ /3	0/7
Zeng et al, 2020, China (12)	6/6			nr	nr	6/6	Nr	0/6°°°°°°°°	Nr
Zhu et al, 2020, China (13)	1/9	6**/9	2§/9	6 (2 twins)/10	7 (2 twins)/10	10/10	Nr	0/9	6 shortness of breath 3 cyanosis 2 DIC 1 death  Chest radiography: 4 infections 2 neonatal respiratory distress syndrome 1 pneumothorax

CS: caesarean section; LBW: low birthweight (< 2500g); NICU: Neonatal Intensive Care Unit; NAT: nucleic acid test; ITS: infant throat swab; DIC: disseminated intravascular coagulation; nr: not reported. ° in 7 cases CS for maternal COVID-19 infection and obstetric indication: 1 history of caesarean section, 1 pre-eclampsia, 2 fetal distress, 1 history of stillbirth, 2 PROM; °° also fetal distress; °°° no obstetric indication; nr: not reported; °°°° no neonatal asphyxia; °°°°° neonatal SARS-CoV-2 quantitative RT-PCR; °°°°°° to avoid SARS-CoV-2 exposure. °°°°°°° see text results section

\*3 fetal distress, 1 PROM, 1 stillbirth; \*\* 1 PROM, 4 fetal distress, 1 cholecystitis and fever; § 2 PROM, 3 fetal distress, 2 twins \*\*\* for quarantine; INPS: infant nasopharyngeal swab; M: milk; VS: vaginal swab; IOPS: infant oropharyngeal swab; CB: cord blood; PT: placenta tissues; \*\*\*\*for preterm delivery

