Failure to Detect SARS-CoV-2 RNA in the Air During Active Labor in Mothers Who Recently Tested Positive

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The risk of potential SARS-CoV-2 transmission by infected mothers during labor and delivery has not been investigated in-depth. This work collected air samples close to (respiratory droplets) and more distant from (aerosol generation) unvaccinated patients who had previously tested positive for SARS-CoV-2 during labor within 5 days of a positive test. All but one of the patients wore masks during the delivery, and delivery was carried out in either birthing or negative pressure isolation rooms. Our work failed to detect SARS-CoV-2 RNA in any air samples for all of the six patients who gave birth vaginally, despite validation of the limit of detection of the samplers. In sum, this brief report provides initial evidence that the risk of airborne transmission of SARS-CoV-2 during labor may be mitigated by the use of masks and high ventilation rates common in many modern U.S. medical facilities; however more work is needed to fully evaluate the risk of SARS-CoV-2 transmission during labor and maternal pushing.

Keywords: SARS-CoV-2, COVID, vaginal delivery, labor and delivery, transmission, coronavirus, viral transmission

INTRODUCTION

About 2 years since the beginning of the SARS-CoV-2 pandemic, questions remain regarding transmission of this rapidly spreading viral infection. Implementing appropriate infection control measures is crucial to protecting health care workers and to limit nosocomial and community spread (1). SARS-CoV-2 is primarily thought to be transmitted via the airborne route, but the proportion of larger respiratory droplets vs. aerosols and the distance over which transmission can occur is hotly debated (2, 3). During the first stage of labor, the cervix dilates from 0 to 10 cm. There is no active pushing during that time period. Specifically, active labor is the time from 6 cm through 10 cm cervical dilation. The second stage of labor occurs from 10 cm dilation through delivery of the neonate. At this point there is active maternal pushing and expulsive efforts, including increased respiratory efforts and occasional increased vocalizations as well. Transmission through respiratory droplets and aerosols during parturition is increasingly plausible, given the increased respiratory effort required during the 2nd stage of labor. Other actions such as coughing, sneezing, and volume of vocalization can also produce infectious aerosols of SARS-CoV-2, each which can occur during the 2nd stage of labor (4–6). We aimed to determine if SARS-CoV-2 would be present in the air during active labor and the 2nd stage of labor in participants diagnosed with COVID-19.
RESULTS

Six symptomatic patients with SARS-CoV-2 had air samples processed (two filters per patient representing the two samplers above, 12 total); all were PCR positive via nasopharyngeal swab between 0 and 5 days of admission. No patients were positive 6 or 7 days before labor. Subject 2-01 was not able to tolerate wearing a mask through the entire labor and delivery process. All of the other subjects were able to wear their masks for the entire period (active labor through delivery of the neonate). Subject 5 was positive on day of admission via nasopharyngeal swab (consent not given for other swabs). Of the 6 patient paired air samples processed, no samples registered as positive (Table 1), however all positive external RT-qPCR reaction controls containing purified plasmid provided consistent positive signal. The recovery efficiency of captured surrogate virus from the membrane was 12.4%, and the limit of detection of this was 14.4 RT-qPCR Units/mL. It should be noted that RNA was tested, and the current sampling configuration and parameters would be expected to yield positive results given previous reports with RT-qPCR (8–10). PCR testing was negative for the 6 patient buccal and perianal swabs. Information about the Ct values of the patients’ positive tests from centralized testing laboratories was not available as patient identifiers with the testing were not made available to the authors.

DISCUSSION

This study investigated the potential for aerosolization of SARS-CoV-2 in positive mothers during the second stage of vaginal delivery. Air sampling both beside the patient and 6–10 feet away failed to detect SARS-CoV-2 RNA in all samples tested, suggesting that either generation of SARS-CoV-2 aerosols is not very common during vaginal delivery in settings with consistent mask use by laboring patients or aerosols are rapidly transported away from the patient area by the high ventilation rates. The limit of detection of the assay was found to be 14.4 RT-qPCR Units/mL using a structurally similar surrogate virus (human coronavirus 229E); thus the possibility that virus was being aerosolized and captured at levels below this limit of detection exists and should be considered a potential limitation of this work (8). Similarly, follow-up study with validation of the sampling parameters were not completed given restrictions in capacity; however, similar instruments and sampling parameters to those used here demonstrate positive sampling results for both infectious virus and RNA (8). Factors contributing to the inability to isolate aerosolized virus could be lower titer of virus shed by the participants (all were healthy and younger than age 40) (11), or virus was aerosolized but remained below the assay detection limit due to the transient occupancy of the room. In fact, difficulty in recovering viral signal from these types of samples has been previously discussed (8, 12–15). It is possible that having a younger, immunocompetent population of mothers results in shedding of virus for shorter periods than the larger population as a whole (16). Buccal and perianal swabs were negative, and participants may not have been actively shedding at delivery despite all testing positive within 5 days; the authors
| Subject 2-01  | 2 | Fever, SOB, PNA | No | No | No<sup>a</sup> | Yes | 7:00 | 0:30 |
| Subject 2-02  | 2 | None | No | Yes | Yes | No | 2:00 | 0:08 |
| Subject 2-03  | 1 | None | No | No | Yes | No | Not recorded | Not recorded |
| Subject 2-04  | 5 | Nasal congestion | No | No | Yes | Yes | 12:22 | 0:35 |
| Subject 2-05  | 0<sup>a</sup> | None | No | No | Yes | No | Not recorded | Not recorded |
| Subject 2-06  | 4 | Aguesia | No | No | Yes | No | 8:00 | 0:46 |

<sup>a</sup>No buccal or perianal swabs were taken as the patient did not consent.

<sup>b</sup>Although masks were strongly encouraged during labor, one patient could not tolerate pushing during labor with it in place and removed it.

<sup>c</sup>1st date of labor defined as the time period from 0 to 10 cm dilation.

<sup>d</sup>2nd stage of labor defined as the time from 10 cm dilation to delivery of the neonate.

recognize that this is a serious limitation in interpreting the results of this brief report. However, this is less likely for Subject 5 who was positive on day of admission via nasopharyngeal swab, but who did not consent to buccal or perianal swabs. Because of the nature of the information for each subject, Ct values of subjects’ positive tests obtained were not available; however, the limits of detection of the testing platforms used by the central laboratories ranged from about 50–100 genomic copies per reaction. While SARS-CoV-2 has been recovered from buccal and rectal swabs, the positive percent agreement remains 56% with buccal swabs and is more useful in early viral detection (17). Rectal swabs have shown poorer positivity rates at 10–27% (18–20) and are likely a better test further into the disease course. Another limitation of this study is the low sample size of patients able to be enrolled during the study period. In particular, this was a consequence of the comparatively low SARS-CoV-2 positivity rate among the broader western and central Massachusetts communities during the study period, limitations related to the number of patients who both tested positive for SARS-CoV-2 and went into labor within 7 day inclusion period; and the fact that a number of patients who tested positive for SARS-CoV-2 and were symptomatic ultimately delivered by cesarean for a variety of medical and obstetric indications.

The results of this study correspond to numerous other reports failing to detect a high degree of aerosolized SARS-CoV-2 in rooms with modern ventilation (21, 22). Two of the patients were placed in negative pressure rooms, while the other four patients were placed in standard labor and delivery rooms, in a modern hospital building with open space. This work also supports other reports showing a dramatic reduction in viral transmission by those wearing masks (23), as nearly all patients were masked at the time of vaginal delivery. Although the buccal and perianal swabs were negative, work to test the presence of virus on the inside of the patients’ masks or surfaces in the room was not conducted, but would be the basis for interesting future work. The results from this work and considering the limitations mentioned above, the difficulty of identifying positive values provide an initial suggestion that transmission of SARS-CoV-2 by patients in labor is unlikely during the second stage of labor during maternal pushing efforts in modern hospital settings where masks are required. Even if some viral particles are airborne, masking and ventilation may prevent significant transmission of virus on the labor floor.

**DATA AVAILABILITY STATEMENT**

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

**ETHICS STATEMENT**

The studies involving human participants were reviewed and approved by Institutional Review Boards at Baystate Health Medical Center (BH-20-150) and University of Massachusetts Memorial Medical Center (H00020140). The patients/participants provided their written informed consent to participate in this study.

**AUTHOR CONTRIBUTIONS**

CSc, EM, HL, CR, and MM designed and supervised data acquisition. MM and CSc acquired funding and equipment. CSc, EM, AS, CSu, and MM conducted experiments and acquired data. CSc, EM, HL, CR, CSu, AS, and MM developed initial draft and revised draft. All authors contributed to the article and approved the submitted version.

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