Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Environmental Contamination and Childbirth

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INTRODUCTION

Childbirth is the most common reason for hospitalization in the United States (3.9 million/year). 1,2 The prevalence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection among patients admitted for labor and delivery is between 0% and 15.4%; most patients are asymptomatic.^{3–5} The extent of SARS-CoV-2 environmental contamination during childbirth is not known. Coughing, speaking, vomiting,

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Alison Edelman disclosed receiving royalties from UpToDate. Leslie Dietz disclosed receiving funds from Oregon Health and Science University for working on C. difficile, Viewglass, to evaluate glass as a microbial reservoir. She received a SARE grant to determine effects of mixed species rotational grazing in soil, and a USDA/USFS grant to study microbial presence and persistence on wood in a health care setting. Mark Fretz disclosed previous employment with ZGF Architects that ended in November 2017, and receiving an NSF travel scholarship for the WAFES conference and honorarium with the Oregon Department of Environmental Quality. Kevin Van Den Wymelenberg disclosed that other than his employment with UO, he is currently contemplating a financial relationship with Enviral Tech, a local environmental testing company, as a consultant to their company, but it has not been determined if he will do this or sign any documents. He has received honorariums for travel accommodations as in-kind contributions from conferences and industry events in the last 36 months, including from: Banbury Event Center, Alfred P Sloan Foundation, LightFair International, Illuminating Engineering Society of North America, and the Velux Foundation. The other authors did not report any potential conflicts of interest.

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and breathing have all been shown to generate aerosols and droplets.⁶ Expiratory forces are increased during active labor. In addition, the second stage of labor often results in significant fecal contamination, which has been associated with SARS-CoV-2 detection in surface and aerosol samples.7 We aimed to evaluate SARS-CoV-2 environmental contamination in the labor and delivery environment and on personal protective equipment to provide preliminary data as a foundation for future research and guidance for continued protection of health care workers.

METHODS

We conducted this study at a single academic institution from March 2020 to June 2020. The protocol was approved by the Oregon Health & Sciences University Institutional Review Board. Universal SARS-CoV-2 polymerase chain reaction testing occurred for all patients admitted to the labor and delivery unit. Environmental swabs were collected from room surfaces and health care workers' face shields. In addition, passive and active air samples were collected. Reverse transcription polymerase chain reaction targeting the spike gene was used to detect SARS-CoV-2 RNA (see Appendix 1, available online at http://links.lww.com/AOG/C57).

RESULTS

We obtained samples for two vaginal and two cesarean births (four asymptomatic patients who tested positive for SARS-CoV-2). General anesthesia was not used for any of these four deliveries. Patients were unable to consistently wear masks during vaginal birth 2 and cesarean birth 1.

In baseline empty room samples, viral RNA was detected in 3 of 45 (6.7%) surface swabs and 1 of 23 (4.3%) passive air samples. After delivery, the total proportion of positive samples increased for both surface swabs (8/45, 17.8%) and passive air samples

Table 1. Surface Swabs and Passive Air Samples Collected From Unoccupied, Clean Rooms (Empty Room) and After Delivery*

	Empty Room			After Delivery		
	Gene Copies/Microliter	No. Positive	Highest Gene Copies/Microliter	Gene Copies/Microliter	No. Positive	Highest Gene Copies/Microliter
Surface swabs						
Vaginal birth 1	1.23 ± 3.92	2/11 (18)	13.0	2.11 ± 6.99	1/11 (9)	23.2
Vaginal birth 2	0.05 ± 0.15	1/9 (11)	0.48	4.72 ± 7.36	6/9 (67)	10.1
Cesarean birth 1	0	0/12 (0)	NA	0	0/12 (0)	NA
Cesarean birth 2	0	0/13 (0)	NA	0.04 ± 0.17	1/13 (8)	0.63
Total	1.28	3/45 (7) [†]		6.87	8/45 (18) [‡]	
Passive air samples (/h)						
Vaginal birth 1	0.23 ± 0.52	1/5 (20)	1.16	0	0/5	NA
Vaginal birth 2	0	0/5 (0)	NA	1.70 ± 2.29	4/5 (80)	5.57
Cesarean birth 1	0	0/7 (0)	NA	0	0/7 (0)	NA
Cesarean birth 2	0	0/6 (0)	NA	0.10	1/6 (17)	0.24
Total	0.23	1/23 (4)		1.80	5/23 (22)	

Data are mean±SD or n/N (%) unless otherwise specified.

(5/23, 21.7%) (Table 1). The greatest change from baseline was after vaginal birth 2 (negative pressure room). After vaginal birth 2, the majority of the passive air settling dishes tested positive (four of five). Three of these positive settling dishes were located more than 6 feet from the patient bed.

Postdelivery active air sampling results were not consistent by delivery type. No viral RNA was detected by active air sampling before or after cesarean birth 2, whereas it was detected after vaginal birth 2 (14.4 gene copies/L air) and cesarean birth 1 (4.80 gene copies/L air).

Postdelivery face shield sampling results also varied by delivery type. SARS-CoV-2 RNA was not detected on any face shield (surgeons, anesthesiologist, or nurses) after either cesarean birth. The health care worker personal protective equipment for vaginal birth 1 was not obtainable. All health care worker face shields were positive for SARS-CoV-2 RNA after vaginal birth 2 (Fig. 1).

DISCUSSION

We found that patients with asymptomatic SARS-CoV-2 infection give rise to SARS-CoV-2 environmental contamination during childbirth. One vaginal birth resulted in viral RNA airborne dispersion at a distance greater than 6 feet, and the care team had significant facial exposure to SARS-CoV-2. Our findings suggest that the risk of SARS-CoV-2 transmission from labor and delivery is higher than previously thought. In contrast, Ong et al⁸ found no health care worker personal protective equipment contamination among those

caring for patients with symptomatic COVID-19 not undergoing aerosol-generating procedures. Speech generates large- and small-particle aerosols. Particle emission rate increases 10-fold with loud as compared with quiet speaking. Shouting and heavy breathing during painful active labor likely generates considerable viral-laden particles. We posit that these airborne particles caused personal protective equipment contamination and also provide an explanation for our positive passive air sampling distant from the patient. We suspect that the extent of contamination varies by delivery type and other patient factors, such as mask-wearing.

Our study limitations include a small sample size and the inability to determine airborne particle size and virus viability or infectivity. It is also important to acknowledge that a small number of baseline samples detected SARS-CoV-2 RNA. No environment is sterile, and SARS-CoV-2 RNA may remain detectable in the environment for at least 17 days. ¹⁰ Prior room occupants tested "nondetectable" for SARS-CoV-2, but

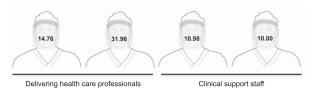


Fig. 1. Viral copy numbers per face shield swab (gene copies/microliter) from the health care team after vaginal birth 2. Illustration by Dr. Mark Fretz. Used with permission. *Hermesch. SARS-CoV-2 Environmental Contamination and Childbirth. Obstet Gynecol* 2020.

NA, not applicable.

^{*} Data for each individual birth are presented as mean gene copy concentration in recovered buffer.

[†] Location of positive surface swabs: floor (n=2), door curtain (n=1).

^{*} Location of positive surface swabs: bed stirrups (n=2), floor (n=3), door curtain (n=1), newborn isolette (n=1), keyboard (n=1).

asymptomatic visitors and health care workers are not routinely tested. Our results reinforce the importance of universal masking, excellent hand hygiene, environmental cleaning, and visitor-limitation policies that minimize exposure and contamination risk.

These findings support the American College of Obstetricians and Gynecologists' personal protective equipment recommendations for obstetriciangynecologists.¹¹ Our current practice is to use airborne isolation precautions, including N95 respirators and face shields for all deliveries of patients who test positive for SARS-CoV-2 or are of unknown status. These precautions appear particularly important given the difficulty of patient mask-wearing during active labor. Although preliminary in nature, our data demonstrate unique risk for SARS-CoV-2 exposure during labor through prolonged, close contact and a droplet- and aerosol-generating process.

As personal protective equipment is depleted, 12,13 risk stratification of patient interactions is used to ensure availability for the highest-risk situations. To our knowledge (based on a PubMed search using the terms "aerosol-generating procedure" with "vaginal birth" or "cesarean birth" and using the timeframe "all dates"), a direct comparison between childbirth and other aerosolgenerating procedures has not been done to support the current Centers for Disease Control and Prevention statement that, "Forceful exhalation during the second stage of labor is not considered an aerosol-generating procedure for respirator prioritization during shortages over procedures more likely to generate higher concentrations of infectious respiratory aerosols."14 This lack of data highlights the critical need to further evaluate interventions that mitigate health care worker risk while caring for patients during birth, the most frequent hospitalization encounter in the United States.

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