





SARS-CoV-2 Infection Among Pregnant People at Labor and Delivery and Changes in Infection Rates in the General Population: Lessons Learned From Illinois

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Abstract

Objectives: The Illinois Department of Public Health (IDPH) assessed whether increases in the SARS-CoV-2 test positivity rate among pregnant people at labor and delivery (L&D) could signal increases in SARS-CoV-2 prevalence in the general Illinois population earlier than current state metrics.

Materials and Methods: Twenty-six birthing hospitals universally testing for SARS-CoV-2 at L&D voluntarily submitted data from June 21, 2020 through January 23, 2021, to IDPH. Hospitals reported the daily number of people who delivered, SARS-CoV-2 tests, and test results as well as symptom status. We compared the test positivity rate at L&D with the test positivity rate of the general population and the number of hospital admissions for COVID-19–like illness by quantifying correlations in trends and identifying a lead time.

Results: Of 26 633 reported pregnant people who delivered, 96.8% ($n = 25\,772$) were tested for SARS-CoV-2. The overall test positivity rate was 2.4% ($n = 615$); 77.7% ($n = 478$) were asymptomatic. In Chicago, the only region with a sufficient sample size for analysis, the test positivity rate at L&D (peak of 5% on December 7, 2020) was lower and more stable than the test positivity rate of the general population (peak of 14% on November 13, 2020) and lagged hospital admissions for COVID-19–like illness (peak of 118 on November 15, 2020) and the test positivity rate of the general population by about 10 days (Pearson correlation = 0.73 and 0.75, respectively).

Practice Implications: Trends in the test positivity rate at L&D did not provide an earlier signal of increases in Illinois's SARS-CoV-2 prevalence than current state metrics did. Nonetheless, the role of universal testing protocols in identifying asymptomatic infection is important for clinical decision making and patient education about infection prevention and control.

Keywords

COVID-19, sentinel surveillance, labor and delivery, universal testing, SARS-CoV-2

Early indicators of changes in SARS-CoV-2 transmission can provide state and local health departments valuable lead time to respond with appropriate action. Illinois is using COVID-19 hospital admissions and test positivity rate (TPR) in the general population to indicate changes in SARS-CoV-2 prevalence in Illinois. However, hospital admissions for COVID-19 lag infection by 10–17 days,^{1,2} and TPR in the general population does not reliably portend hospitalizations, likely because outpatient testing is less reliable as a result of variability in testing availability and demand.³ Sentinel surveillance, or tracking recent infections among subgroups (sentinel populations), can be used to predict

infection transmission rates in the general population.^{4,5} Pregnant people continued to present for labor and delivery during the pandemic and have been proposed as a sentinel population for monitoring trends in SARS-CoV-2 transmission.^{6,7} In New York City, pregnant women had a similar seroprevalence of SARS-CoV-2 as the general population in early to mid-2020,^{8,9} and the prevalence of SARS-CoV-2 at labor and delivery was inversely correlated with mobility reductions early in the epidemic.¹⁰

The Illinois Department of Public Health (IDPH) conducted a survey (unpublished) of the 97 birthing hospitals in Illinois in late May 2020 to understand COVID-19 practices

and policies related to obstetric and neonatal services. Forty-seven birthing hospitals in Illinois reported implementing universal testing for people admitted for labor and delivery, potentially allowing for sentinel tracking of changes in SARS-CoV-2 transmission.

IDPH implemented a sentinel surveillance system to assess whether trends in the prevalence of SARS-CoV-2 infection among pregnant people presenting for labor and delivery could provide a leading indicator of increases in population-wide COVID-19 prevalence compared with trends in TPR in the general population and in the number of hospital admissions for COVID-19-like illness (CLI). We describe IDPH's experience and findings from implementing the labor and delivery sentinel surveillance system.

Materials and Methods

Data Collection

From July 13, 2020, through February 2, 2021, IDPH requested that birthing hospitals conducting universal testing for SARS-CoV-2 voluntarily submit daily aggregated data through a weekly Research Electronic Data Capture (REDCap) survey.^{11,12} Birthing hospitals shared data with IDPH via REDCap by uploading a Microsoft Excel sheet with continuous data through the previous week and answering weekly questions about testing processes.

The data requested included the daily number of pregnant people who delivered and, among them, the number who (1) had scheduled deliveries, (2) were tested for SARS-CoV-2 during their hospitalization for labor and delivery (or within 72 hours prior to admission for scheduled deliveries [eg, cesarean delivery, induction]), (3) received a positive test result for SARS-CoV-2, and (4) received a positive test result for SARS-CoV-2 but were asymptomatic (ie, displayed no signs or symptoms of COVID-19¹³). The weekly questions asked hospitals what type of specimens were being collected (nasal, nasopharyngeal, oropharyngeal, saliva, or other) and which SARS-CoV-2 laboratory tests were being used: RealTime SARS-CoV-2 Assay (Abbott), ID NOW (Abbott/Alere), BinaxNOW (Abbott), Xpert Xpress SARS-CoV-2 (Cepheid), 2019-Novel Coronavirus (2019-nCoV) Real-Time RT-PCR Diagnostic Panel (Centers for Disease Control and Prevention), Panther Fusion SARS-CoV-2 Assay (Hologic), laboratory-developed testing procedure (testing services) with EUA submission, cobas

SARS-CoV-2 (Roche Diagnostics), TaqPath COVID-19 Combo Kit (Thermo Fisher Scientific), other (specify), and unknown. Because of fluctuations in testing resources, some hospitals chose not to test pregnant people who had already received a positive test result for COVID-19 during their pregnancy. Thus, hospitals were also asked whether pregnant people who had received a positive test result for COVID-19 during pregnancy prior to admission (or earlier than 72 hours prior to admission if the person had a scheduled delivery) would be retested for COVID-19 upon admission (or within 72 hours of a scheduled delivery). This project did not require institutional review board approval because it was considered public health practice (surveillance) conducted by the state health department, not a research activity.

Implementation

To assess the feasibility of aggregate data collection and ensure that collection and submission of data would be minimally time consuming, IDPH piloted the surveillance system with a convenience sample of 8 hospitals from July 13 through August 15, 2020. The 8 birthing hospitals were chosen based on their geographic location, size, willingness to participate, and strong history of partnership with IDPH. IDPH emailed the REDCap survey to its points of contact at each participating pilot hospital on Mondays. In the first week, pilot hospitals were given until Friday to submit data from the previous 3 weeks to establish a baseline for data analysis. Subsequently, pilot hospitals were asked to submit data by 5 PM on Tuesday for data through the previous Saturday. The hospitals compiled data on a weekly basis and manually entered the data into the sentinel surveillance system. IDPH monitored hospital submissions for data quality and reporting and provided participating hospitals with gentle email reminders and REDCap support when needed.

After soliciting feedback and clarifying instructions for data collection and submission, IDPH opened participation on a rolling basis to all Illinois birthing hospitals that were universally testing pregnant people for SARS-CoV-2 during their hospitalization for labor and delivery, accepting data collected on August 16, 2020, onward. Hospitals were invited to participate through direct emails from the 10 Illinois administrative perinatal centers and through announcements made during weekly Illinois Perinatal Quality Collaborative webinars and bimonthly Illinois Perinatal Advisory Committee meetings.

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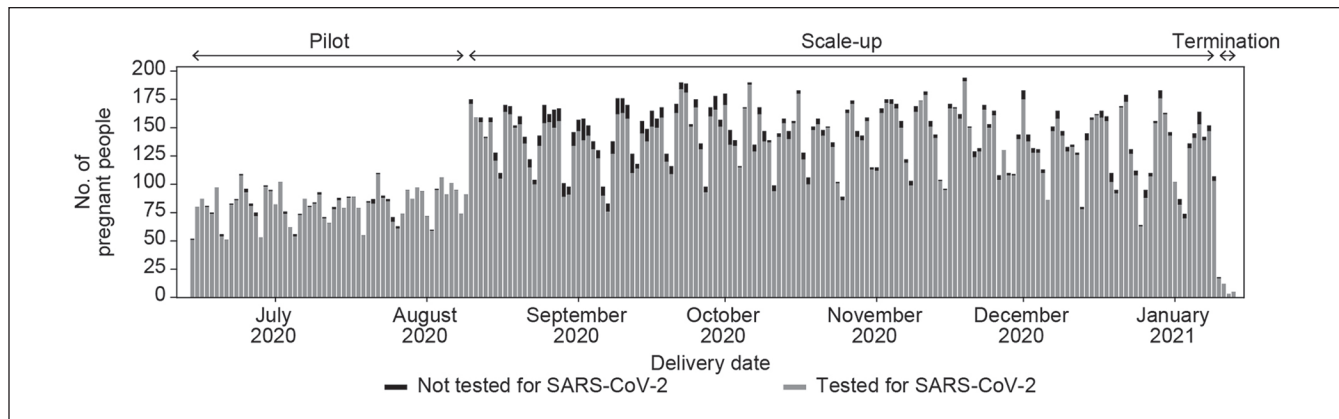


Figure 1. Total number of pregnant people who were and were not laboratory tested for SARS-CoV-2 during hospitalization for labor and delivery, by delivery date, 26 hospitals, Illinois, June 21, 2020–January 23, 2021.

Data Analysis

Daily aggregated counts of deliveries at each hospital and associated meta-data were imported, cleaned, and processed weekly using Radr version 1.4.0, dplyr version 1.0.4, and lubridate version 1.7.9 on R version 4.0.3.

We calculated TPR at labor and delivery by dividing the number of pregnant people who received a positive test result for SARS-CoV-2 by the total number of pregnant people tested for SARS-CoV-2 during their hospitalization for labor and delivery. We calculated binomial 95% CIs with the *proportion_confint* function in the python statsmodels package version 0.9.0. We calculated TPR for the general population by dividing the number of positive specimens by the total number of specimens. We obtained positive test results for the general inpatient (including a small percentage of tests conducted at labor and delivery) and outpatient population from the Illinois National Electronic Disease Surveillance System database and included only polymerase chain reaction (PCR) tests prior to October 14, 2020, but both antigen and PCR tests afterward. Daily CLI admissions were obtained from IDPH's syndromic surveillance and were defined as hospital admissions with either (1) fever and cough, shortness of breath, or difficulty breathing or (2) the presence of coronavirus diagnosis codes.¹⁴ The analysis code is available at <https://github.com/numalari-amodeling/labor-and-delivery-surveillance-paper-2021>.

To oversee the COVID-19 pandemic response, IDPH divided Illinois into 11 COVID-19 regions. We compared centered 7-day moving average time series of TPR at labor and delivery, TPR among the general population, and hospital admissions for CLI in each region. We determined the lead time of TPR at labor and delivery relative to TPR in the general population and relative to hospital admissions for CLI by cross-correlation on centered, 7-day moving averages for each time series, calculated by using pandas version 0.25.3 on Python version 3.6. TPR at labor and delivery was offset by a lag number of days and subsequently correlated with each TPR in the general population and hospital

admissions for CLI in that region. We calculated the Pearson correlation coefficients for lags between -30 and 20 days and identified the lag resulting in maximum correlation. We calculated moving averages using the pandas *rolling* function on a centered 7-day window.

Results

Of 98 birthing hospitals in Illinois, 26 (26.5%) voluntarily submitted data to the Illinois COVID-19 labor and delivery sentinel surveillance system. Twenty-one hospitals were in the greater Chicago metropolitan area, of which 8 were within Chicago city limits (Illinois COVID-19 Region 11); 5 hospitals were located outside the Chicago metropolitan area, in the northern half of the state.

The sentinel surveillance system included 26 633 pregnant people reported to have had deliveries spanning from June 21, 2020, through January 23, 2021, at the 26 participating hospitals. Of all pregnant people who delivered, 25 772 (96.8%) were tested for SARS-CoV-2 infection. The average reported daily number of pregnant people delivering was approximately 82 during the pilot phase and 143 during the scale-up phase (Figure 1).

The percentage of pregnant people admitted to labor and delivery who were tested for SARS-CoV-2 infection remained high ($>90\%$) during the study period but varied by hospital, ranging from 68% to 100%. Thirteen hospitals reported that they did not test patients who had received a positive test result for COVID-19 within a given time frame (40-90 days prior to admission when specified) at some point during data collection. Hospitals primarily administered PCR SARS-CoV-2 molecular laboratory tests to pregnant people in labor and delivery during the program; 21 (80.8%) hospitals used only PCR tests and 5 (19.2%) used PCR and antigen tests at some point during the study period.

The overall TPR at labor and delivery was 2.4% ($n = 615$) during the study period. Most pregnant people who received a positive test result in the labor and delivery senti-

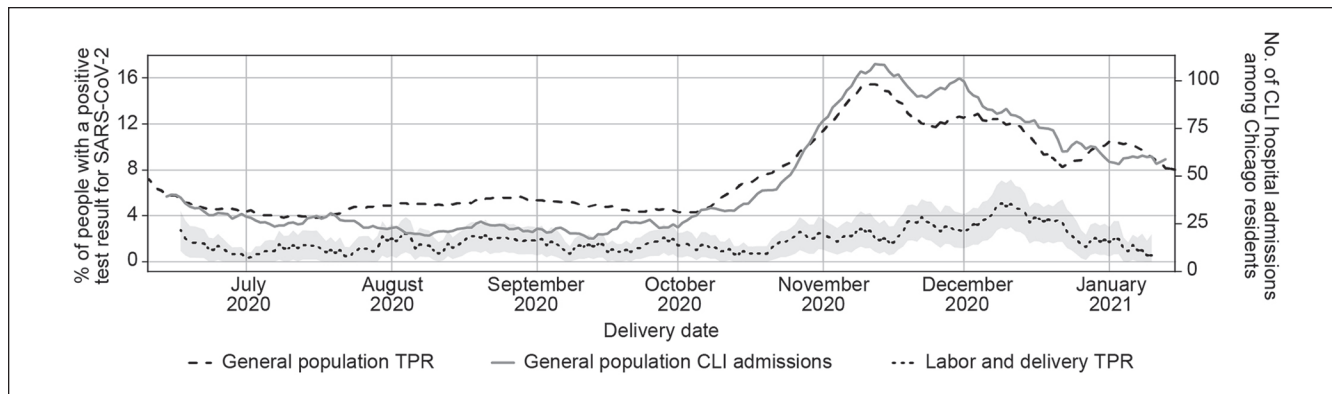


Figure 2. Centered, 7-day moving averages of test positivity rate (TPR) at labor and delivery, TPR in the general population, and hospital admissions for COVID-19-like illness (CLI) at 8 hospitals, by delivery date, Chicago, June 21, 2020–January 23, 2021. TPR at labor and delivery was calculated per pregnant person, whereas TPR in the general population was calculated per specimen; data on hospital admission for CLI were restricted to Chicago residents. Shading indicates 95% CIs. Data source: Illinois Department of Public Health.¹⁴

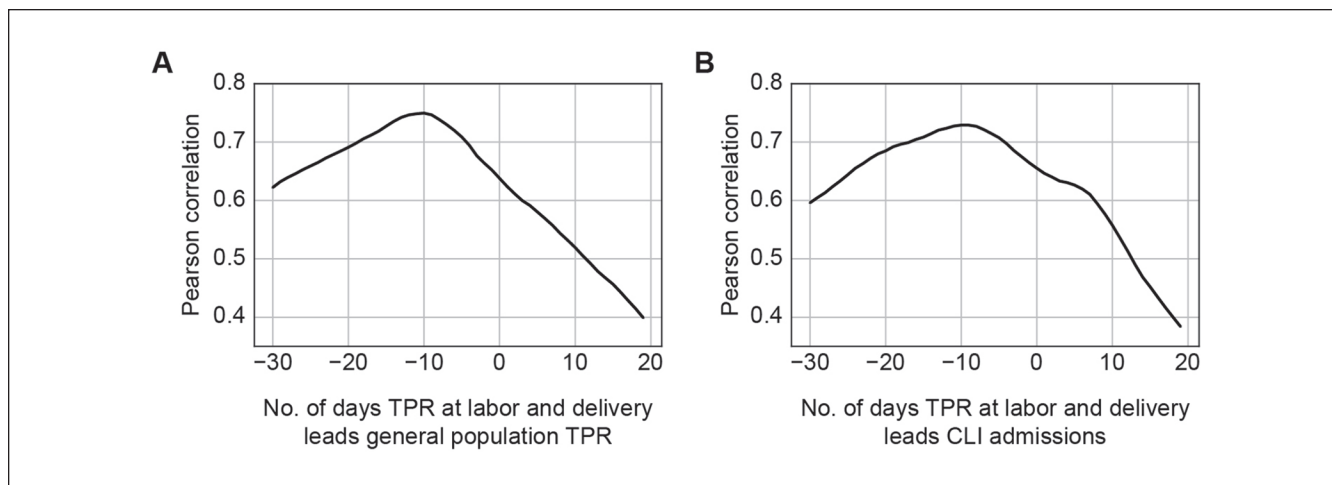


Figure 3. Correlation between centered, 7-day moving average time-series graphs of test positivity rate (TPR) at labor and delivery and (A) TPR in the general population. (B) Hospital admissions for COVID-19-like illness (CLI), calculated by varying lead time of TPR at labor and delivery, 8 hospitals, Chicago, June 21, 2020–January 23, 2021. Data source: Illinois Department of Public Health.¹⁴

nel surveillance system (77.7%, n = 478) were asymptomatic at the time of testing.

Region 11 was the only region with a sufficient sample size for evaluating pregnant people who delivered as a potential sentinel population using comparative analyses (n = 13 371). Among people presenting for labor and delivery in Chicago hospitals, TPR remained stable at 1%-2% from June through mid-October 2020 (Figure 2) and increased in November and December 2020, peaking at 5% on December 7, 2020. TPR at labor and delivery in Chicago was lower and more stable than TPR in Chicago’s general population, which started increasing at the beginning of October and peaked at 14% on November 13, 2020. Hospital admissions for CLI in Chicago also increased during October and peaked at 118 admissions on November 15, 2020.

In Chicago, trends in TPR at labor and delivery did not lead trends in TPR in the general population or hospital admissions for CLI. TPR at labor and delivery and TPR in the general population were most correlated (Pearson correlation coefficient = 0.75) when TPR at labor and delivery was pushed back by 10 days, indicating that TPR in the general population led TPR at labor and delivery by about 10 days (Figure 3A). Hospital admissions for CLI also led TPR at labor and delivery by 10 days (Pearson correlation coefficient = 0.73; Figure 3B).

Discussion

Based on data from Chicago hospitals, we found that surveilling SARS-CoV-2 prevalence among pregnant women at

labor and delivery signaled changes in SARS-CoV-2 prevalence in the general population 10 days later than current metrics being used by IDPH. TPR at labor and delivery may have been lower and more stable than TPR in the general population because TPR in the general population was not an estimate of SARS-CoV-2 prevalence and is an unstable metric that is vulnerable to fluctuations in testing demand and availability.

The timing of changes of TPR at labor and delivery may also have differed because pregnant people may be more motivated than the general population to follow public health recommendations (eg, practicing social distancing or wearing face masks) to prevent COVID-19, to protect themselves and their babies, potentially resulting in slower spread and lower rates of infection among pregnant people than among the general population. However, not all pregnant people have an equal opportunity to protect themselves from COVID-19; many factors including occupation, neighborhood, and access to health care have affected health equity during the COVID-19 pandemic.^{15,16} People of color disproportionately contract COVID-19 at higher rates than their White counterparts do, even among pregnant people with low socioeconomic status.^{15,17}

More than three-fourths of pregnant people who were infected with SARS-CoV-2 in our study were asymptomatic. Two small studies, one conducted in 3 New York City hospitals and the other in a hospital in Mineola, New York, also found high rates of asymptomatic infections among pregnant people who received a positive test result for SARS-CoV-2 during March and April 2020 (79% and 66%, respectively).^{18,19} Most participating hospitals in our study used PCR tests to test pregnant people for SARS-CoV-2. PCR tests may detect SARS-CoV-2 in a person who no longer has an active infection and would no longer transmit the virus; as such, guidance on precaution and isolation practices to prevent COVID-19 transmission is primarily based on symptom onset and timing of exposure when this information is available.²⁰ In asymptomatic cases in which onset is unknown, guidance on precaution and isolation practices is based on the earliest positive molecular or antigen laboratory test result.¹⁹ Thus, our study highlights the role of universal SARS-CoV-2 testing protocols in identifying asymptomatic infection, so that the patient can be counseled about using preventive public health measures (eg, wearing personal protective equipment, social distancing), and proper infection control and prevention measures can be taken to prevent further spread of COVID-19 to newborns, to staff, and to the community.

The aggregate data reporting was developed to minimize the time burden on participating hospitals. Data collection varied by hospital and depended on the number of deliveries, the medical record system, and personnel available to assist with data collection and submission. Still, over time, many hospitals expressed fatigue with submitting data every week and began to submit data and answer survey questions in a less timely manner. At IDPH, after developing the surveillance

system, the time it took for 1 staff member to submit surveys, monitor hospital participation, and prepare data for analysis was about 2 hours each week.

The lag time in data reporting made real-time analysis difficult because the amount of available data was already low, especially in regions outside Chicago. IDPH asked hospitals to submit data by Tuesday for the prior week, so in the best-case scenario, surveillance data lagged by 3-9 days. A few hospitals were unable to submit data from the prior week until the following Thursday or Friday, and other hospitals were unable to submit data every week, further postponing the timeliness of data reporting. Because a few hospitals consistently submitted data on Thursday or Friday and IDPH had to manually compile data from all hospitals that submitted, IDPH usually waited until Friday evening each week to clean, finalize, and submit data into the surveillance system. In addition, IDPH measured TPR among pregnant people at labor and delivery by date of delivery but accepted results of SARS-CoV-2 tests from any time during the delivery hospitalization or within 3 days prior to a scheduled delivery, which may have increased the lag time.

Some of the data collected were not as useful as intended. Weekly information on the types of laboratory test(s) used at each hospital was collected to help account for changes in testing that may have affected TPR. However, because some hospitals used more than 1 type of SARS-CoV-2 laboratory test, it was not possible to account for changes. IDPH asked hospitals to share data on the number of scheduled deliveries to track the percentage of pregnant people who were more likely to have been tested prior to labor and delivery admission, which increased the lag time of the data. This measure turned out to be the most difficult for many hospitals to supply because it was not easily extracted from electronic medical records and often needed to be manually determined. In the end, we did not adjust for time differences because of scheduled deliveries in the analyses.

Limitations

This study had several limitations. First, data were not representative of birthing hospitals in each region nor representative of the state of Illinois, because not all birthing hospitals were universally testing and, of the ones that were universally testing, not all chose to participate in the surveillance system (reasons for nonparticipation were not collected). At the time of the May 2020 survey, no birthing hospitals in central or southern Illinois were conducting universal SARS-CoV-2 testing. Of the 46 hospitals in Illinois that reported not conducting universal testing at labor and delivery, 35 stated they would have interest in starting universal testing if rapid test supplies were available. Major barriers included lack of availability of rapid test supplies, rationing of supplies within the facility, and limited in-house capacity to process tests. More birthing hospitals in Illinois began universally testing pregnant people at labor and delivery during our study.

Second, of the birthing hospitals that participated, information from some pregnant people who delivered was not collected because some people declined SARS-CoV-2 laboratory testing and some hospitals chose not to retest people who had already received a positive test result for SARS-CoV-2 prior to labor and delivery admission (or within 3 days prior to a scheduled delivery). The reasons why some pregnant people refused SARS-CoV-2 testing are unknown; misinformation about COVID-19 or the fear of potential changes in hospital labor and delivery practices for pregnant people who received a positive test result may have contributed to higher refusal rates.²¹

Third, we did not collect individual-level data; as such, we were unable to analyze factors that may have been associated with pregnant people who received a positive test result for SARS-CoV-2, such as whether an individual was an essential worker. Had we collected individual-level data for testing, we also could have adjusted the labor and delivery TPR by test sensitivity or, if cycle threshold values were available, used cycle threshold–adjusted positivity to better account for active infection, which may have improved our ability to detect a lead time.²² Obtaining individual-level data from hospitals and mandating hospitals to participate would have required data use agreements and lengthy legal approval processes that would not have allowed IDPH to immediately begin collecting timely data to track recent infections as required for sentinel surveillance.

Practice Implications

Surveilling pregnant people as a sentinel population did not help IDPH predict increases in SARS-CoV-2 prevalence in the general population. Changes in COVID-19 prevalence at labor and delivery might not be representative of the general population in Illinois. Pregnant people may be more motivated than the general population to follow public health recommendations for COVID-19 prevention to protect their baby.

Nonetheless, surveilling pregnant people during epidemics and public health emergencies can provide important information about their experience during the event and about risk, health outcomes, treatment, and prevention among pregnant people and their infants. Universal COVID-19 testing protocols are important for clinical decision making and patient education about infection prevention and control, as many pregnant people were asymptomatic at labor and delivery in our study.

We also found it time consuming for birthing hospitals to collect and manually report data, some of which were not readily identifiable in medical records, on a weekly basis. Creating a hospital-based surveillance system that allows readily accessible data in electronic health records to be directly captured and submitted to a surveillance system in an automated or near-automated fashion would be timelier and more sustainable.

Disclaimer

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Declaration of Conflicting Interests

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