

Risk Factors, Trends, and Outcomes Associated With Postpartum Sepsis Readmissions

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OBJECTIVE: To evaluate the prevalence, timing, clinical risk factors, and adverse outcomes associated with postpartum readmissions for maternal sepsis.

METHODS: We conducted a retrospective cohort study of delivery hospitalizations and 60-day postpartum readmissions for females aged 15–54 years with and without sepsis using the 2016–2020 Nationwide Readmissions Database. Temporal trends in sepsis diagnoses during delivery hospitalizations and 60-day postpartum readmissions were analyzed with the National Cancer Institute's

Joinpoint Regression Program to estimate the average annual percent change with 95% CIs. Logistic regression models were fit to determine whether delivery hospitalization characteristics were associated with postpartum sepsis readmissions, and unadjusted and adjusted odds ratios with 95% CIs were reported. Adverse outcomes associated with sepsis during delivery hospitalization and readmission were described, including death, severe morbidity, a critical care composite, and renal failure.

RESULTS: Overall, 15,268,190 delivery hospitalizations and 256,216 associated 60-day readmissions were included after population weighting, of which 16,399 (1.1/1,000 delivery hospitalizations) had an associated diagnosis of sepsis at delivery, and 20,130 (1.3/1,000 delivery hospitalizations) had an associated diagnosis of sepsis with postpartum readmission. A sepsis diagnosis was present in 7.9% of all postpartum readmissions. Characteristics associated with postpartum sepsis readmission included younger age at delivery, Medicaid insurance, lowest median ZIP code income quartile, and chronic medical conditions such as obesity, pregestational diabetes, and chronic hypertension. Postpartum sepsis readmissions were associated with infection during the delivery hospitalization, including intra-amniotic infection or endometritis, wound infection, and delivery sepsis. Sepsis diagnoses were associated with 24.4% of maternal deaths at delivery and 38.4% postpartum, 2.2% cases of nontransfusion severe morbidity excluding sepsis at delivery and 13.6% postpartum, 15.6% of critical care composite diagnoses at delivery and 30.1% postpartum, and 11.1% of acute renal failure diagnoses at delivery and 36.4% postpartum.

CONCLUSION: Sepsis accounts for a significant proportion of postpartum readmissions and is a major contributor to adverse outcomes during delivery hospitalizations and postpartum readmissions.

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Sepsis is an important cause of maternal morbidity in the United States, particularly during the first 6–8 weeks after delivery. According to the Centers for Disease Control and Prevention's (CDC) Pregnancy Mortality Surveillance System, sepsis and infection accounted for 14.3% of maternal deaths from 2017 to 2019.¹ An analysis of the Nationwide Readmissions Database from 2013 to 2016 found that 50% of maternal sepsis cases occurred after delivery discharge, with these readmissions accounting for 45% of sepsis-related maternal deaths.² Previous analysis of national data found that maternal sepsis and sepsis-related maternal deaths were increasing in the United States.^{2,3} Despite the clinical importance of postpartum infection and sepsis, there are few recent population-based data on sepsis readmissions trends, risk factors, and related outcomes. It is possible that clinical practice changes in sepsis management and antibiotic prophylaxis may have affected sepsis readmission risks.^{4–9} The objectives of this study were to determine trends in postpartum readmissions with sepsis and related sepsis risk factors and outcomes using updated data from a large administrative database.

METHODS

The Nationwide Readmissions Database, developed for the Healthcare Cost and Utilization Project, was used to identify delivery hospitalizations and associated postpartum readmissions from 2016 to 2020 for this retrospective cohort study. The Nationwide Readmissions Database is an all-payer database with data collected on a state level capable of tracking patients across hospital admissions within a state within a given year. The Nationwide Readmissions Database is drawn from the Healthcare Cost and Utilization Project State Inpatient Databases, which include administrative discharge data from hospitalizations within a given state. The State Inpatient Databases contain a core set of clinical and nonclinical information on all patients, including individuals covered by Medicare, Medicaid, or private insurance, as well as those who are uninsured. State Inpatient Database data elements include principal and secondary diagnoses and procedures, admission and discharge status, patient demographics characteristics (eg, sex, age, and, for some states, race), expected payment source, total charges, and length of stay. These data are included in the Nationwide Readmissions Database with the exception of race and ethnicity. The Nationwide Readmissions Database includes public and community hospitals and academic medical centers.¹⁰ It has been used across a

wide number of medical and surgical subspecialties, including obstetrics, to evaluate readmission hospitalizations.^{11–15} Unweighted, the 2020 Nationwide Readmissions Database contained data from about 17 million hospitalizations from geographically dispersed states accounting for 62% of U.S. residents and 61% of all U.S. hospitalizations.¹⁶ Data in the Nationwide Readmissions Database can be weighted to provide national estimate calculations of all patient readmissions; these weights were used in this analysis.

Delivery hospitalizations were identified with the use of International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis codes using approaches that ascertain more than 95% of deliveries.^{17,18} Females aged 15–54 years were included in the analysis. Those with sepsis were identified with ICD-10-CM codes used by the CDC.¹⁹ Readmissions were identified with Healthcare Cost and Utilization Project methodology; the Nationwide Readmissions Database includes patient linkage numbers that identify discharges belonging to the same individual within a given state within the same calendar year. If there was more than one readmission, only the first readmission was included in the analysis. Because the Nationwide Readmissions Database data sets are year-based and cannot be linked, only delivery hospitalizations for which discharge occurred from January 1 to October 31 for each year were included. Delivery hospitalizations from November through December were not included because readmissions for the subsequent 60 days could not be fully ascertained. To maintain patient privacy, cell sizes of 10 or fewer are not reported per the Healthcare Cost and Utilization Project data-use agreement. Inpatient deaths during delivery hospitalizations were excluded from readmission analyses.

This study had several objectives. The first objective was to determine risk for sepsis and trends over time during delivery hospitalizations and during 60-day postpartum readmissions. Readmissions through 60 days postpartum were analyzed to ascertain cases of sepsis likely related to the delivery hospitalization. The second objective was to determine whether demographic, hospital, and clinical factors were associated with risk for 60-day postpartum sepsis readmissions. The third objective was to determine how many days sepsis readmissions after delivery hospitalization discharge occurred. The fourth objective was to describe adverse outcomes associated with sepsis during delivery hospitalizations and postpartum readmissions, including 1) death, 2) nontransfusion severe maternal morbidity excluding sepsis, 3) a composite of critical care procedures and



complications (defined below), and 4) acute renal failure.

The diagnosis of sepsis was based on codes used by the CDC and includes pregnancy-specific sepsis codes (Appendix 1, available online at <http://links.lww.com/AOG/D489>). Conditions in the critical care composite were identified through literature review^{20–24} and included mechanical ventilation and intubation, central monitoring, coma, acute cerebrovascular disease, extracorporeal membrane oxygenation, Swan–Ganz catheter monitoring, cardiac rhythm conversion, and respiratory failure. Severe maternal morbidity was defined on the basis of a composite measure from the CDC.²⁵ The CDC composite includes 21 diagnoses and conditions, including transfusion, shock, stroke, heart failure, sepsis, and other conditions identified by International Classification of Diseases, Ninth and Tenth Revision codes. Because transfusion is the most common diagnosis in the severe maternal morbidity composite, is unlikely to lead to long-term sequelae, may be a process measure, and is not necessarily representative of large-volume transfusion,²⁶ this analysis excluded transfusion from the severe maternal morbidity composite, along with sepsis and evaluated risk, for the remaining 19 diagnoses and conditions.

Demographic, clinical, and hospital factors available in the Nationwide Readmissions Database possibly associated with sepsis readmissions and present during the delivery hospitalization were analyzed. Demographic factors included year of delivery, payer information, maternal age (categorized as 15–19, 20–24, 25–29, 30–34, 35–39, and 40–44 years), and median household income quartile based on ZIP code. Hospital factors included hospital bed volume (small, medium, and large) and hospital teaching status (metropolitan teaching, nonmetropolitan, and metropolitan nonteaching). Clinical risk factors during the delivery hospitalization identified with ICD-10-CM codes included obesity, chronic hypertension, hypertensive disorders of pregnancy (including gestational hypertension and preeclampsia), pregestational diabetes, mode of delivery (primary cesarean delivery, repeat cesarean delivery, and operative and nonoperative vaginal delivery), intra-amniotic infection or endometritis, pneumonia, sepsis, wound infections, and the critical care composite.

Analyses of demographic, hospital, and clinical risk factors were conducted to describe the differences in baseline characteristics between patients with and those without a 60-day postpartum sepsis readmission. All demographic, hospital, and clinical risk factors were obtained from the delivery hospitalization.

Comparisons were made with the χ^2 test with $P < .05$ considered statistically significant. The association between clinical, demographic, and hospital factors at delivery and risk for postpartum sepsis readmission was analyzed with unadjusted logistic regression models with unadjusted odds ratios (ORs) with 95% CIs as measures of association. Multivariable logistic regression models were then fitted with the aforementioned clinical, demographic, and hospital factors. Measures of association were described with the use of adjusted ORs with 95% CIs. Trends analyses for delivery sepsis, postpartum sepsis readmission, or either delivery or postpartum readmission sepsis during the study period (2016–2020) were performed with the National Cancer Institute's Joinpoint Regression Program 4.8.0.1.²⁷ The proportions of 60-day postpartum sepsis readmissions with 1) death, 2) nontransfusion severe maternal morbidity, 3) a composite of critical care procedures and complications, and 4) acute renal failure were determined. In evaluating 60-day postpartum sepsis readmission, we determined the proportion of readmission that occurred during each 10-day increment after discharge.

All analyses were conducted with SAS 9.4 and the Joinpoint Regression Program. We followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for cohort studies for this analysis.²⁸ This study was deemed exempt by the Columbia University and University of California–San Francisco IRBs given the deidentified and publicly available nature of the data.

RESULTS

An estimated 15,268,190 delivery hospitalization and 256,216 associated 60-day postpartum readmissions from 2016 to 2020 were identified for the analysis (Fig. 1). Unweighted, there were 8,205,466 delivery hospitalizations (Appendix 2, available online at <http://links.lww.com/AOG/D489>). A sepsis diagnosis was present in 1.1 per 1,000 delivery hospitalizations ($n=16,399$), and a 60-day postpartum sepsis readmission occurred after 1.3 per 1,000 delivery hospitalizations ($n=20,130$). A sepsis diagnosis was present among 7.9% of all postpartum readmissions (20,130 of 256,216 readmissions). The most common postpartum sepsis readmission diagnoses were puerperal sepsis ($n=12,562$), other sepsis ($n=6,877$), sepsis without shock ($n=2,314$), sepsis after an obstetric procedure ($n=1,617$), and sepsis with septic shock ($n=1,554$) (Appendix 1, <http://links.lww.com/AOG/D489>). In total, 410 patients had a diagnosis of sepsis both during delivery and during a postpartum readmission (Table 1). Half of 60-day postpartum sepsis



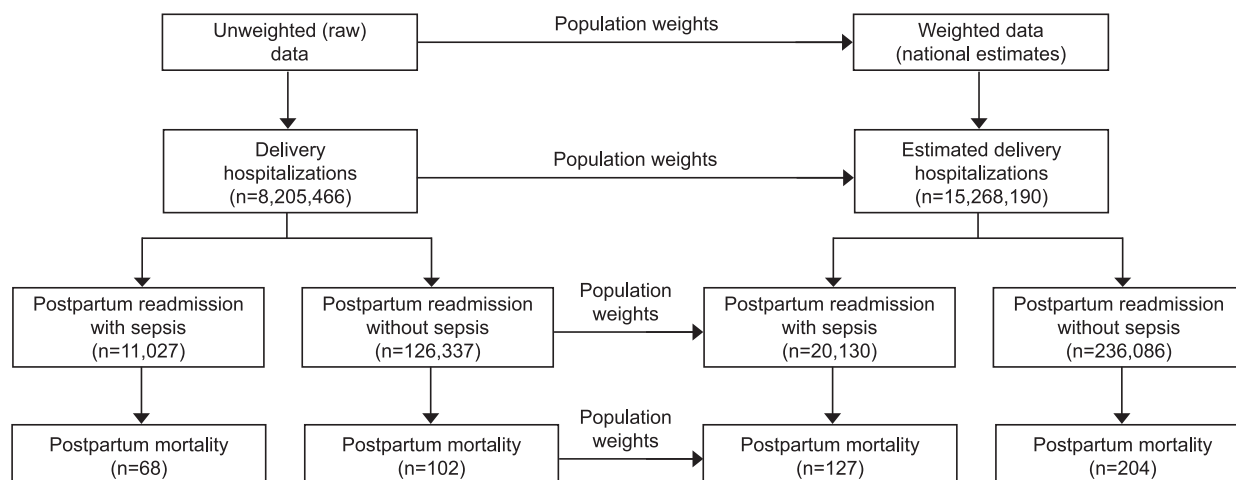


Fig. 1. Derivation of the delivery hospitalization study population with unweighted and weighted data, including the outcome of delivery hospitalization inpatient mortality.

Liu. Outcomes Associated With Postpartum Sepsis Readmissions. Obstet Gynecol 2024.

readmissions (48.7%) occurred within the first 10 days of delivery hospitalization discharge (Fig. 2).

In Joinpoint analysis, trends in sepsis were significant for delivery hospitalizations (average annual percent change [AAPC] 7.6%, 95% CI, 4.8–10.4% analyzing January–December deliveries; AAPC 8.0%, 95% CI, 5.5–10.6% analyzing January–October delivery hospitalizations) and delivery or postpartum readmission sepsis (AAPC 3.6%, 95% CI, 0.2–7.1%) but not for postpartum sepsis readmissions (AAPC 0.1%, 95% CI, –5.6% to 6.1%) (Fig. 3).

Sepsis during delivery hospitalization was associated with Medicaid insurance and lower median ZIP code income quartile (Table 1). Chronic medical conditions, including chronic hypertension, pregestational diabetes, and obesity, were also significantly associated with delivery hospitalization sepsis. Infections, including intra-amniotic infection or endometritis, wound infection, and pneumonia, were associated with sepsis. Primary cesarean delivery was associated with delivery hospitalization sepsis. Primary cesarean delivery accounted for 44.3% of deliveries with sepsis and 16.7% of deliveries without sepsis. Among 60-day postpartum readmissions, the factors associated with a sepsis diagnosis included Medicaid insurance, younger maternal age, infections at delivery, and primary cesarean delivery.

In unadjusted logistic regression, several delivery hospitalization demographic and clinical factors were associated with 60-day postpartum readmission. Age 15–19 years compared with age 25–29 years as the referent (OR 1.48, 95% CI, 1.36–1.61), Medicaid insurance compared with commercial insurance (OR

1.77, 95% CI, 1.70–1.85), and lowest compared with highest median ZIP code income quartile (OR 1.60, 95% CI, 1.49–1.70) were associated with 60-day postpartum sepsis readmission (Table 2). Chronic condition diagnoses, including obesity (OR 1.71, 95% CI, 1.61–1.81), pregestational diabetes (OR 3.46, 95% CI, 3.14–3.83), and chronic hypertension (OR 1.81, 95% CI, 1.63–2.00), were associated with 60-day postpartum sepsis readmission. Infections during the delivery hospitalization, including intra-amniotic infection or chorioamnionitis (OR 2.61, 95% CI, 2.42–2.82), wound infection (OR 3.82, 95% CI, 3.02–4.82), and delivery sepsis (OR 19.67, 95% CI, 17.06–22.66), were associated with 60-day postpartum sepsis. The critical care composite (OR 12.47, 95% CI, 10.32–15.07) was also associated with 60-day postpartum sepsis. In adjusted analyses, these significant associations were generally attenuated but retained significance. Estimates were similar with unweighted data (Appendix 3, available online at <http://links.lww.com/AOG/D489>).

During delivery hospitalizations, sepsis diagnoses were associated with a significant portion of adverse outcomes, including 24.4% of maternal deaths, 2.2% cases of nontransfusion severe morbidity excluding sepsis, 15.6% of critical care composite diagnoses, and 11.1% of acute renal failure diagnoses (Table 3). Evaluating 60-day postpartum readmissions, we found that sepsis was associated with 38.4% of postpartum deaths, 13.6% of cases of nontransfusion severe morbidity excluding sepsis, 30.1% of critical care composite diagnoses, and 36.4% of cases of acute renal failure.



Table 1. Demographics Based on the Presence or Absence of Infection and Sepsis

Characteristic	Delivery Hospitalization			Readmission		
	Sepsis Absent	Sepsis Present	P	Sepsis Absent	Sepsis Present	P
Maternal age (y)			<.01			<.01
15–19	786,921 (5.2)	1,180 (7.2)		12,357 (5.2)	1,466 (7.3)	
20–24	2,943,514 (19.3)	3,321 (20.3)		42,884 (18.2)	4,778 (23.7)	
25–29	4,439,666 (29.1)	4,265 (26.0)		62,097 (26.3)	5,616 (27.9)	
30–34	4,373,739 (28.7)	4,121 (25.1)		64,903 (27.5)	4,941 (24.5)	
35–39	2,219,751 (14.6)	2,736 (16.7)		41,695 (17.7)	2,661 (13.2)	
40–44	488,198 (3.2)	776 (4.7)		12,148 (5.2)	668 (3.3)	
Payer			<.01			<.01
Medicare	119,765 (0.8)	248 (1.5)		4,209 (1.8)	355 (1.8)	
Medicaid	6,316,063 (41.4)	8,291 (50.6)		111,806 (47.4)	10,978 (54.5)	
Private insurance	8,115,129 (53.2)	7,132 (43.5)		110,537 (46.8)	7,948 (39.5)	
Self-pay	228,299 (1.5)	328 (2.0)		2,850 (1.2)	301 (1.5)	
Other	446,868 (2.9)	368 (2.2)		6,340 (2.7)	511 (2.5)	
Median income quartile by ZIP code			<.01			<.01
1 (lowest)	4,155,746 (27.4)	5,180 (31.8)		74,982 (32.0)	6,750 (33.7)	
2	4,017,507 (26.5)	3,949 (24.3)		62,188 (26.5)	5,281 (26.4)	
3	3,822,594 (25.2)	3,858 (23.7)		55,599 (23.7)	4,764 (23.8)	
4 (highest)	3,152,359 (20.8)	3,299 (20.3)		41,617 (17.8)	3,210 (16.1)	
Clinical factors						
Chronic hypertension	359,341 (2.4)	774 (4.7)	<.01	14,530 (6.2)	841 (4.2)	<.01
Pregestational diabetes	191,445 (1.3)	645 (3.9)	<.01	7,633 (3.2)	850 (4.2)	<.01
Obesity	1,553,301 (10.2)	2,863 (17.5)	<.01	43,352 (18.4)	3,261 (16.2)	<.01
Hypertensive disorders of pregnancy	1,799,250 (11.8)	3,480 (21.2)	<.01	63,320 (26.8)	3,644 (18.1)	<.01
Intra-amniotic infection or endometritis	453,801 (3.0)	8,212 (50.1)	<.01	10,782 (4.6)	1,514 (7.5)	<.01
Wound infection	29,482 (0.2)	640 (3.9)	<.01	1,323 (0.6)	149 (0.7)	<.01
Pneumonia	17,052 (0.1)	2,198 (13.4)	<.01	925 (0.4)	147 (0.7)	<.01
Delivery sepsis	NA	NA	NA	931 (0.4)	410 (2.0)	<.01
Critical care composite	11,150 (0.1)	2,068 (12.6)	<.01	1,085 (0.5)	212 (1.1)	<.01
Mode of delivery			<.01			<.01
Nonoperative vaginal	9,763,525 (64.0)	6,496 (39.6)		115,084 (48.8)	9,466 (47.0)	
Operative vaginal	610,172 (4.0)	838 (5.1)		8,343 (3.5)	803 (4.0)	
Primary cesarean	2,552,290 (16.7)	7,258 (44.3)		64,765 (27.4)	6,296 (31.3)	
Repeat cesarean	2,325,803 (15.3)	1,807 (11.0)		47,895 (20.3)	3,564 (17.7)	
Hospital teaching status and location			<.01			<.01
Metropolitan nonteaching	3,051,121 (20.0)	2,294 (14.0)		40,054 (17.0)	3,848 (19.1)	
Metropolitan teaching	10,780,931 (70.7)	13,531 (82.5)		178,730 (75.7)	14,786 (73.5)	
Nonmetropolitan	1,419,737 (9.3)	574 (3.5)		17,302 (7.3)	1,495 (7.4)	
Hospital bed volume			.01			<.01
Small	2,621,603 (17.2)	2,018 (12.3)		36,268 (15.4)	3,072 (15.3)	
Medium	4,277,427 (28.1)	4,011 (24.5)		62,899 (26.6)	5,647 (28.1)	
Large	8,352,760 (54.8)	10,370 (63.2)		136,919 (58.0)	11,411 (56.7)	
Year of delivery			<.01			<.01
2016	3,166,451 (20.8)	2,862 (17.5)		45,726 (19.4)	4,042 (20.1)	
2017	3,096,397 (20.3)	3,033 (18.5)		46,536 (19.7)	4,108 (20.4)	
2018	3,046,743 (20.0)	3,463 (21.1)		47,546 (20.1)	4,162 (20.7)	
2019	3,012,957 (19.8)	3,402 (20.8)		50,027 (21.2)	4,146 (20.6)	
2020	2,929,242 (19.2)	3,639 (22.2)		46,250 (19.6)	3,673 (18.3)	

NA, not applicable.

Data are n (%) unless otherwise specified.

DISCUSSION

In this retrospective cohort study, we found that sepsis accounted for a significant proportion of all 60-day postpartum readmissions with the majority of post-

partum readmissions occurring within the first 10 days postpartum. Sepsis risk during delivery increased from 2016 to 2020 but remained stable for postpartum



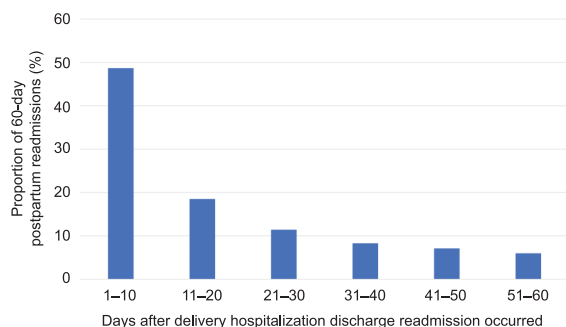


Fig. 2. Proportion of postpartum sepsis readmissions occurring within 60 days of a delivery hospitalization by each 10-day increment after discharge.

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readmissions. Sixty-day postpartum sepsis readmissions were associated with a number of delivery hospitalization demographic and clinical factors, including chronic medical conditions such as obesity, pregestational diabetes, and chronic hypertension. Finally, infection during delivery admission, including intra-amniotic infection or endometritis, wound infection, and sepsis at delivery, was associated with increased odds of postpartum sepsis readmission. Sepsis accounted for a large proportion of adverse delivery and postpartum outcomes, including maternal deaths, nontransfusion severe morbidity, critical care composite diagnoses, and renal failure.

Sepsis continues to be a leading cause of maternal morbidity and mortality, particularly during the postpartum period. Prior studies have demonstrated that the incidence of sepsis and sepsis-related deaths in the United States is steadily increasing.^{2,3} Our findings support that these trends have not reversed. We found sepsis to be increasing during delivery hospitalization and stable during postpartum readmissions over the 5-year study period. A study analyzing 2002–2015 data from the National Inpatient Sample found that sepsis during delivery hospitalizations was associated with a range of comorbidities and increased risk for maternal mortality.²⁹ A prior analysis of the Nationwide Readmissions Database found that half of maternal sepsis cases occurred after delivery discharge and accounted for a large proportion of sepsis-related maternal deaths postpartum.² Our findings further support the importance of sepsis as a key contributor to maternal morbidity and mortality with updated data through 2020. Given that sepsis during delivery hospitalizations and postpartum readmissions accounted for a significant proportion of maternal death, severe maternal morbidity, critical care diagnoses, and renal failure, improved

prevention, detection, and evidence-based management of sepsis are likely to be key components in improving overall maternal outcomes. Sepsis care improvements may also be important in reducing disparities given that sepsis was associated with Medicaid insurance, young maternal age, and lower ZIP code income quartile.

Because chronic conditions were associated with postpartum sepsis readmissions, it is likely many patients at risk are also at higher risk for other postpartum complications. Although postpartum sepsis admissions are rare, occurring after about 1 per 1,000 delivery hospitalizations, a shorter-interval follow-up after delivery discharge for patients at high risk may be indicated. This follow-up may include a shorter-interval visit than the routine 6-week postpartum visit. Other interventions such as nurse visits, telehealth, educational interventions, community-based interventions, and mobile health technology may also play a role in improving care.

There are important limitations to consider in the interpretation of this study. First, this study was performed analyzing only administrative hospital discharge data. This database does not include office visits and other outpatient care. We are also limited by not being able to analyze details of clinical management during inpatient hospitalizations. Because we are not able to review clinical records, we are not able to determine when an infection was first diagnosed, when sepsis was first suspected, and whether evaluation and treatment were timely. We are not able to confirm diagnoses with laboratory criteria or microbiology results or determine the duration and dose of antibiotic agents. These limitations are important

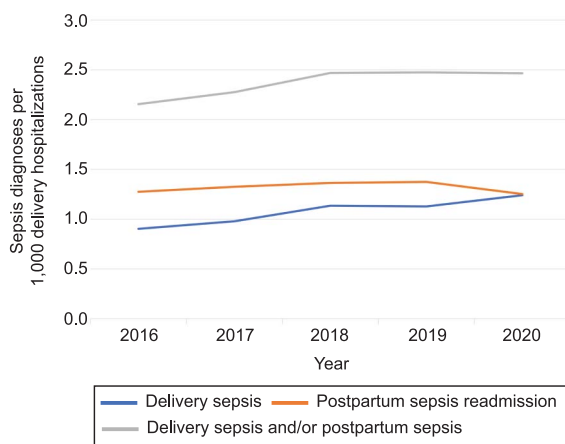


Fig. 3. Sepsis diagnoses during delivery hospitalizations and during postpartum readmissions per 1,000 delivery hospitalizations by year.

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Table 2. Unadjusted and Adjusted Logistic Regression Models for Postpartum Sepsis Readmissions (Weighted Data)

Delivery Hospitalization Characteristics	Postpartum Sepsis Readmission	
	Unadjusted Model	Adjusted Model
Maternal age (y)		
15–19	1.48 (1.36–1.61)	1.31 (1.20–1.43)
20–24	1.28 (1.21–1.35)	1.20 (1.13–1.27)
25–29	Ref	Ref
30–34	0.89 (0.84–0.94)	0.94 (0.89–1.00)
35–39	0.95 (0.88–1.01)	0.95 (0.89–1.02)
40–44	1.08 (0.96–1.21)	0.96 (0.85–1.07)
Payer		
Medicare	3.04 (2.59–3.57)	2.48 (2.12–2.91)
Medicaid	1.77 (1.70–1.85)	1.61 (1.54–1.69)
Private insurance	Ref	Ref
Self-pay	1.36 (1.15–1.60)	1.39 (1.18–1.64)
Other	1.16 (1.02–1.33)	1.17 (1.03–1.34)
Median income quartile by ZIP code		
1 (lowest)	1.60 (1.49–1.70)	1.20 (1.12–1.29)
2	1.29 (1.21–1.38)	1.08 (1.01–1.16)
3	1.22 (1.15–1.30)	1.09 (1.03–1.17)
4 (highest)	Ref	Ref
Clinical factors		
Chronic hypertension	1.81 (1.63–2.00)	1.46 (1.31–1.62)
Pregestational diabetes	3.46 (3.14–3.83)	2.21 (1.99–2.45)
Obesity	1.71 (1.61–1.81)	1.27 (1.20–1.35)
Hypertensive disorders of pregnancy	1.65 (1.57–1.74)	1.33 (1.26–1.40)
Intra-amniotic infection or endometritis	2.61 (2.42–2.82)	1.87 (1.72–2.03)
Wound infection	3.82 (3.02–4.82)	1.92 (1.50–2.46)
Pneumonia	5.83 (4.64–7.33)	1.36 (1.01–1.84)
Delivery sepsis	19.67 (17.06–22.66)	7.01 (5.78–8.50)
Critical care composite	12.47 (10.32–15.07)	2.98 (2.28–3.88)
Mode of delivery		
Nonoperative vaginal	Ref	Ref
Operative vaginal	1.37 (1.23–1.51)	1.34 (1.21–1.49)
Primary cesarean	2.55 (2.43–2.67)	2.23 (2.12–2.34)
Repeat cesarean	1.58 (1.49–1.67)	1.52 (1.44–1.61)
Hospital teaching status and location		
Metropolitan nonteaching	1.09 (1.03–1.15)	1.03 (0.97–1.09)
Metropolitan teaching	0.83 (0.76–0.92)	0.76 (0.69–0.84)
Nonmetropolitan	Ref	Ref
Hospital bed volume		
Small	0.89 (0.83–0.96)	0.92 (0.85–0.99)
Medium	Ref	Ref
Large	1.04 (0.98–1.10)	1.01 (0.96–1.07)
Year of delivery		
2016	Ref	Ref
2017	1.04 (0.97–1.13)	1.03 (0.96–1.11)
2018	1.07 (0.99–1.16)	1.06 (0.99–1.15)
2019	1.08 (1.01–1.17)	1.08 (1.01–1.16)
2020	0.98 (0.91–1.07)	0.97 (0.90–1.05)

Ref, referent.

Data are odds ratio (95% CI).

because sepsis outcomes are dependent on appropriate clinical management and because underascertainment and misclassifications are concerns of administrative data studies. Second, it is possible that

some complications such as wound infection could be a result of sepsis rather than a cause. In addition, because most wound infections are diagnosed after delivery discharge, it is likely that the association



Table 3. Clinical Outcomes Associated With Sepsis Diagnosis

Clinical Diagnosis	Total Cases	Death	Severe Morbidity*	Critical Care Composite	Renal Failure
Sepsis during delivery hospitalization	16,399	260 (1.6)	5,997 (36.3)	2,068 (12.4)	2,435 (14.7)
Sepsis during readmission	20,130	127 (0.6)	5,135 (26.0)	1,099 (5.6)	2,583 (13.1)
All delivery hospitalizations	15,268,190	1,067 (0.0)	269,287 (1.8)	13,218 (0.1)	21,888 (0.1)
All postpartum readmissions	256,216	330 (0.1)	37,640 (14.7)	3,653 (1.4)	7,100 (2.8)
Proportion of all outcomes associated with sepsis (%)					
Delivery hospitalizations	NA	24.4	2.2	15.6	11.1
Postpartum readmissions	NA	38.4	13.6	30.1	36.4

NA, not applicable.

Data are n or n (%) unless otherwise specified.

* The severe morbidity composite excludes transfusion and sepsis but includes other Centers for Disease Control and Prevention diagnoses.

between this risk factor and sepsis is underestimated. Third, the Nationwide Readmissions Database does not include data on race and ethnicity, and disparities could not be evaluated.

The main strengths of the study include that we were able to analyze a population that is nationally representative, that we were able to follow patients through time using a cohort design analyzing exposures documented during the delivery hospitalization, that we were able to analyze relatively rare outcomes, and that it is appropriate to evaluate disease burden and health care utilization using administrative data.

In summary, this study found that sepsis accounts for a significant proportion of postpartum readmissions, that the incidence of sepsis during delivery hospitalizations and during postpartum readmissions does not appear to be decreasing, and that sepsis is a major contributor to adverse outcomes during delivery hospitalizations and postpartum readmissions.

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