

Postpartum Opioid-Related Mortality in Patients With Public Insurance

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OBJECTIVE: To assess the incidence and risk factors for postpartum opioid overdose death and describe other causes of postpartum death in individuals with opioid use disorder (OUD).

METHODS: We conducted a cohort study that used health care utilization data from the Medicaid Analytic eXtract linked to the National Death Index in the United States from 2006 to 2013. All pregnant individuals with live births or stillbirths and

continuous enrollment for 3 months before delivery were eligible, including 4,972,061 deliveries. A subcohort of individuals with a documented history of OUD in the 3 months before delivery was identified. We estimated the cumulative incidence of death as occurring between delivery and 1 year postpartum among all individuals and individuals with OUD. Risk factors for opioid overdose death were assessed using odds ratios (ORs) and descriptive statistics, including demographics, health care utilization, obstetric conditions, comorbidities, and medications.

RESULTS: The incidence of postpartum opioid overdose death per 100,000 deliveries was 5.4 (95% CI 4.5–6.4) among all individuals and 118 (95% CI 84–163) among individuals with OUD. Individuals with OUD had a sixfold higher incidence of all-cause postpartum death than all individuals. Common causes of death in individuals with OUD were other drug- and alcohol-related deaths (47/100,000), suicide (26/100,000), and other injuries, including accidents and falls (33/100,000). Risk factors strongly associated with postpartum opioid overdose death included mental health and other substance use disorders. Among patients with OUD, postpartum use of medication to treat OUD was associated with 60% lower odds of opioid overdose death (OR 0.4, 95% CI 0.1–0.9).

CONCLUSION: Postpartum individuals with OUD have a high incidence of postpartum opioid overdose death and other preventable deaths, including nonopioid substance-related injuries, accidents, and suicide. Use of medications for OUD is strongly associated with lower opioid-related mortality.

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Opioid overdose is an important cause of maternal mortality and accounts for up to 10% of pregnancy-associated deaths in the United States.¹ Approximately 75% of deliveries among individuals with opioid use disorder (OUD) are covered by Medicaid²; however, the incidence of maternal mortality

See related editorial on page 653.

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due to opioid overdose has not been described on a national level in this population with public insurance, according to our search of articles on PubMed from its inception through the end of 2021, using the keywords “(pregnancy or postpartum) AND opioid overdose.” In addition to the risk of fatal overdose, individuals with OUD may be at increased risk for other causes of maternal mortality, but this has not been well characterized. A majority of pregnant individuals with OUD have comorbid depression and anxiety, both of which are strong risk factors for suicide.^{3,4} Pregnant individuals with OUD may also be at heightened risk for homicide, drug-related accidents, or medical complications related to OUD (eg, endocarditis, sepsis, and liver failure).⁵ It has also been suggested that pregnant individuals with OUD may be more vulnerable to certain obstetric complications that may increase the risk of death in the postpartum period.²

Given limited data on the reasons for the vulnerability of the postpartum period to opioid overdose death and the burden of death in the postpartum period among individuals with OUD, we used a unique cohort of pregnant individuals with Medicaid insurance in the United States linked to National Death Index data to describe the incidence of and risk factors for postpartum mortality related to opioid use. We describe the incidence of other causes of death in postpartum individuals with OUD and compare these estimates with those for the full population with Medicaid insurance to understand whether postpartum individuals with OUD are particularly vulnerable in the postpartum period, beyond an increased risk for opioid overdose death.

METHODS

We identified a pregnancy cohort nested in the Medicaid Analytic eXtract (MAX), which includes health care utilization data for individuals with Medicaid insurance in the United States. Deliveries that ended in live birth or stillbirth were identified, and the date of delivery was determined through linkage to an infant record or the date of the hospital procedure.⁶ Individuals aged 12–55 years at delivery with at least 3 months of continuous eligibility in Medicaid before the date of delivery were included. We required 3 months of continuous enrollment before delivery to allow for assessment of OUD and risk factors in pregnancy. Deliveries were linked to the National Death Index by using the beneficiary identification number and state of residence. Deaths that occurred from the delivery date through 365 days after the delivery date (the year postpartum) were

included. Deliveries occurring between 2006 and 2013 were included in the analysis because linkage of MAX data to the National Death Index was only available for these years.

We identified a subgroup of pregnancies with OUD documented within the 3 months before delivery, including the delivery encounter. Opioid use disorder was identified using diagnosis codes for opioid dependence or overdose (Appendix 1, available online at <http://links.lww.com/AOG/D67>) or receipt of medications for OUD (MOUD), including procedure codes for methadone administration or dispensing of buprenorphine. This study was approved by the IRB of Brigham and Women’s Hospital, which waived the need for informed consent.

Cause of death was classified using the International Classification of Diseases, Tenth Revision coded primary and contributing causes of death in the National Death Index record. Opioid overdose deaths were identified using the Substance Abuse and Mental Health Services Administration’s definition, which includes opioid-related overdoses of accidental, intentional, and undetermined intent.⁷ To be counted as an opioid overdose death, individuals were required to have a primary cause of death due to drugs (accidental poisoning [X40-X44], intentional self-poisoning [X60-X64], assault by drugs [X85], or poisoning of undetermined intent [Y10-Y14]) and an opioid-related contributing cause of death (T40.1-T40.4, T40.6). In a sensitivity analysis, the definition of opioid overdose death was broadened to include any death with a code that indicates opioid overdose or OUD as a primary or contributing cause (Appendix 2, available online at <http://links.lww.com/AOG/D67>) to capture potential opioid-related deaths that did not meet our primary definition of opioid overdose death.

Other categories for causes of death considered included pregnancy- or delivery-related death (ie, with a pregnancy- or delivery-related code); circulatory system diseases; cancer; suicide (excluding opioid-related deaths); homicide, other drug- and alcohol-related deaths; other injuries, including car accidents, falls, and other types of accidental deaths; and other diseases. If no cause of death was listed in the National Death Index, the death was categorized as “unknown” (Appendix 2, <http://links.lww.com/AOG/D67>, for a complete list of International Classification of Diseases, Tenth Revision codes for each cause of death).

Various risk factors were identified to determine potential associations with opioid overdose death and non-opioid overdose death. Race and ethnicity were



defined using enrollment files and included the following categories: Asian/Pacific Islander, Black, Hispanic or Latina, White, and other or unknown race and ethnicity (includes Native American, Alaskan native, and those identifying as more than one group). Non-White categories were combined in the population with OUD due to sparse data. Baseline risk factors were assessed from 3 months before delivery through delivery and included mental health disorders, opioid indications, sexually transmitted infections, tobacco use, and psychotropic medication use, which was identified by the presence of diagnosis and procedure codes and medication dispensing records (definitions in Appendix 3, available online at <http://links.lww.com/AOG/D67>). Diagnoses for non-opioid substance use were also assessed during the 3 months before delivery. Delivery characteristics included stillbirth, preterm birth, cesarean delivery, and *severe maternal morbidity*, which was defined as a composite of potentially life-threatening conditions caused or aggravated by pregnancy (Appendix 3, <http://links.lww.com/AOG/D67>).^{8,9} Health care utilization metrics were assessed both during the 3 months before delivery and during the postpartum period and included receipt of MOUD, as well as the number of opioid dispensings (excluding MOUD), outpatient visits, emergency department visits, inpatient visits, and distinct generic prescription drugs dispensed.

The incidence of death was calculated in the full population and in the subpopulation with OUD. Pregnant individuals were followed from delivery until death, until their continuous enrollment ended, or until they reached the end of the follow-up period (365 days after delivery), whichever happened first. Incidence of death by cause was estimated using cause-specific cumulative incidence for each identified cause of death. Incidence estimates are presented per 100,000 deliveries with 95% CIs.

We used a case-control design for the analysis of pregnancy and postpartum risk factors. We matched opioid overdose deaths to nondeaths, randomly selected without replacement, using a 1:5 ratio on state (because Medicaid eligibility requirements can vary by state) and the number of days from delivery until the death date, requiring that individuals in the control group were still enrolled in Medicaid at the time of the death of the individual in the case group. Matching was completed separately for both the full population and in the subpopulation with OUD. Postpartum risk factors were assessed until the day the death occurred or until the matched day of death in individuals in the control group. Separately for each risk factor, odds ratios and 95% CIs, adjusted

for state to account for matching, were calculated using logistic regression comparing pregnant individuals who died and individuals did not die. Given the small number of opioid overdose deaths, only univariate associations were evaluated. Health care utilization variables are presented using median number of visits (with interquartile ranges) or the proportion with any visit by setting (eg, emergency department visit). Risk factors were also examined for non-opioid overdose death in the same manner by matching non-opioid overdose deaths to nondeaths using the same criteria.

RESULTS

There were 4,972,061 deliveries available for analysis that met the eligibility criteria. A total of 1,393 deaths by any cause were recorded during the first year postpartum, corresponding to a cumulative incidence of 51.1 per 100,000 deliveries (95% CI 48.3–54.1) (Fig. 1). Opioid overdose was the cause of death for 135 individuals (9.7%), with a cumulative incidence of 5.4 per 100,000 deliveries (95% CI 4.5–6.4). The most common other causes of death were pregnancy- or delivery-related deaths, other injuries, and other diseases, with cumulative incidences of 9.6 per 100,000, 8.9 per 100,000, and 6.3 per 100,000, respectively (Fig. 2). Of all postpartum deaths, 69.6% were late maternal deaths, occurring more than 42 days after delivery (Appendix 4, available online at <http://links.lww.com/AOG/D67>).

Of the 48,902 individuals with OUD documented in the 3 months before delivery, 102 died during the first year postpartum, corresponding to a cumulative incidence of 316 per 100,000 (95% CI 258–385) (Fig. 1). Opioid overdose was the most common cause of death (38 individuals; cumulative incidence 118/100,000), followed by other drug- and alcohol-related deaths (47/100,000), other injuries (33/100,000), and suicide (6/100,000) (Fig. 2). The incidence of death among pregnant individuals with OUD was more than twice as large as the incidence in the full population for every cause of death except cancer. The timing of maternal deaths was similar to that observed in the full population of postpartum individuals (Appendix 4, <http://links.lww.com/AOG/D67>).

When broadening the definition of opioid overdose death to include all deaths with primary or contributing causes of death related to opioids, the cumulative incidence was 5.8 per 100,000 deliveries (95% CI 4.9–6.9) in the full population and 124 per 100,000 deliveries (95% CI 89–170) in the population with OUD.



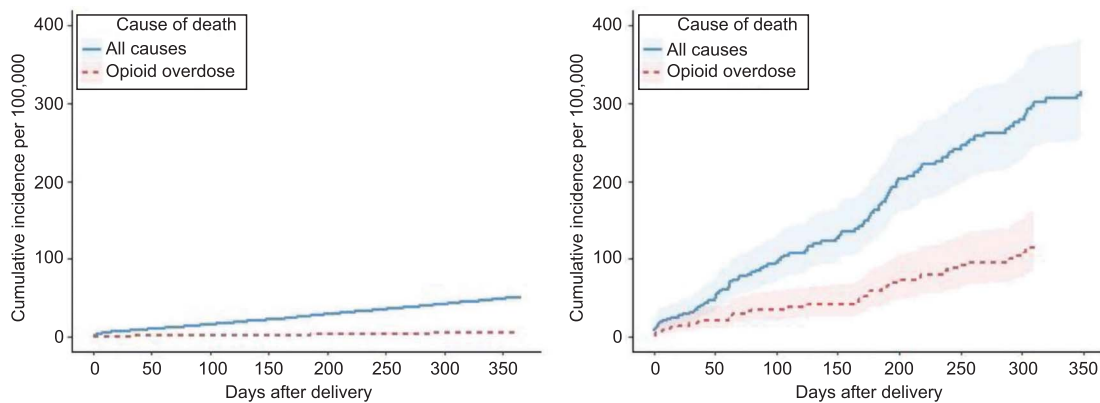


Fig. 1. Cumulative incidence of death by all causes and by opioid overdose during the first year postpartum among individuals with deliveries in the MAX-NDI (Medicaid Analytic eXtract-National Death Index) linked cohort. **A.** Among all pregnant individuals, the incidence of postpartum death at 1 year postpartum was 51.1/100,000 deliveries (95% CI 48.3–54.1) from all causes and 5.4/100,000 deliveries (95% CI 4.5–6.4) from opioid overdose. **B.** Among pregnant individuals with opioid use disorder, the incidence of postpartum death at 1 year postpartum was 316/100,000 deliveries (95% CI 258–389) from all causes and 118/100,000 deliveries (95% CI 84–163) from opioid overdose.

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Opioid overdose death was more likely among individuals with pregnancy complications (eg, stillbirth, severe maternal morbidity), preterm birth, cesarean delivery, comorbidities, tobacco use, pre-

scription opioid analgesic indications, OUD, and other substance use disorders (Fig. 3). The odds of an opioid overdose death were lower among individuals of non-White race compared with White

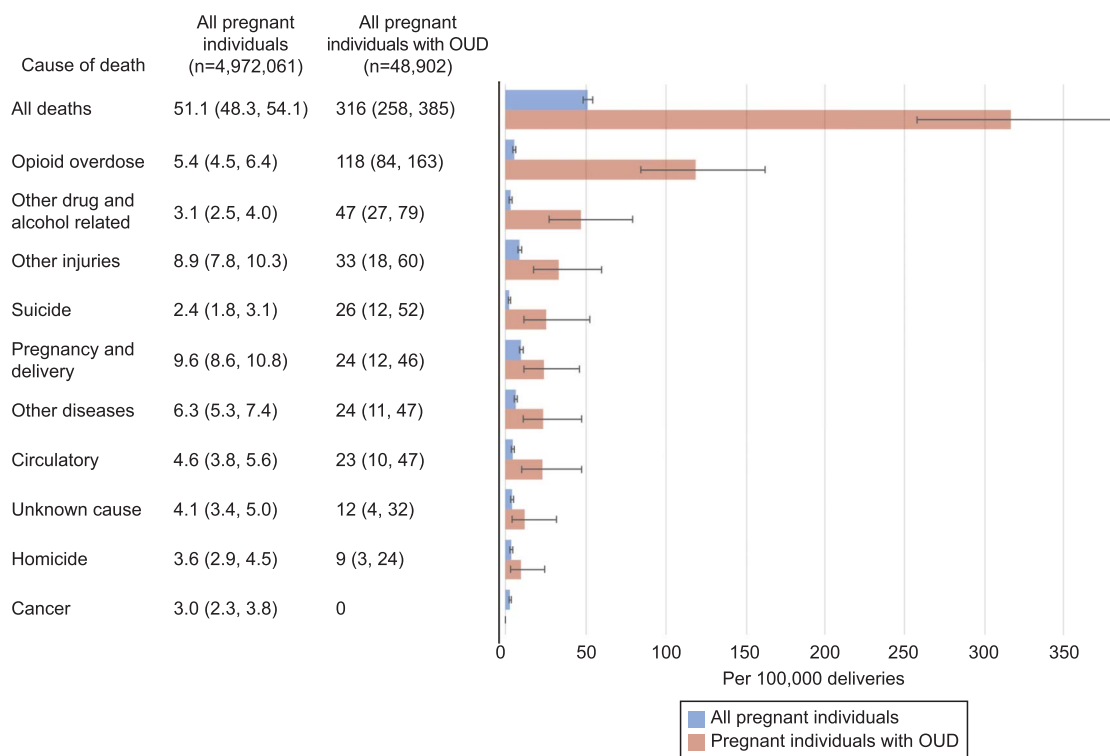


Fig. 2. Distribution of causes of death and cumulative incidence per 100,000 deliveries of specific causes of death by 1 year postpartum. OUD, opioid use disorder.

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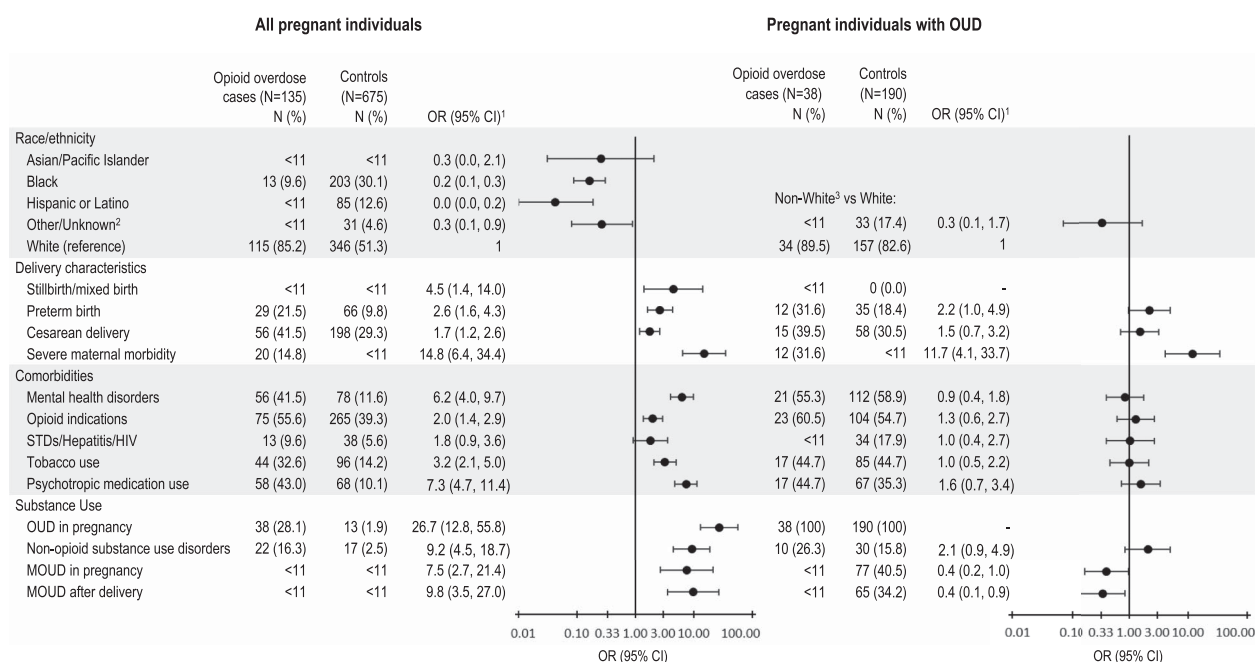


Fig. 3. Characteristics of pregnant individuals with opioid overdose deaths and matched individuals in a control group. ¹Odds ratios (ORs) were adjusted for state to account for matching of individuals in the opioid overdose death case group to the nondeath control group. ²Other race and ethnicity includes American Indian, Alaskan Native, and more than one race. ³Race and ethnicity groups collapsed to White and non-White due to small counts in non-White groups in the population with OUD. Event counts are obscured when there were fewer than 11 in Medicaid Analytic eXtract due to the Centers for Medicare & Medicaid Services' cell size suppression policy. STD, sexually transmitted disease; HIV, human immunodeficiency virus.

Suarez. Postpartum Opioid-Related Mortality. *Obstet Gynecol* 2023.

individuals. This is in contrast to results for non-opioid overdose deaths, where Black individuals and individuals of other or unknown race and ethnicity groups had the highest risk of death (Appendix 5, available online at <http://links.lww.com/AOG/D67>).

Among individuals with OUD, the direction of the associations with individual risk factors was generally similar (although estimated with much less precision), with a few notable exceptions. Comorbidities (ie, mental health disorders; sexually transmitted diseases, hepatitis, human immunodeficiency virus [HIV]) and tobacco use were not strongly associated with opioid overdose death (Fig. 3). Use of MOUD showed a strongly protective association with opioid overdose death: The odds ratio was 0.4 (95% CI 0.2–1.0) for MOUD in pregnancy and 0.4 (95% CI 0.1–0.9) for MOUD use after delivery. Use of MOUD was similarly strongly associated with lower odds of non-opioid overdose death in individuals with OUD (Appendix 6, available online at <http://links.lww.com/AOG/D67>).

Health care utilization among pregnant individuals with postpartum opioid overdose death was greater than that among individuals in the matched

control group during pregnancy and after delivery (Table 1). A high proportion of individuals in the case group with postpartum overdose death had an opioid analgesic dispensing between delivery and the date of death (79.3% vs 56.7% among individuals in the control group). The proportion of individuals with a postpartum opioid analgesic dispensing was lower among individuals in the case and control groups in the population with OUD than in the full population. Emergency department utilization during pregnancy and after delivery appeared to be greater among individuals in the case group with opioid overdose death than in the matched control group in both the full population and the population with OUD.

DISCUSSION

In this cohort of pregnant individuals with Medicaid insurance, the incidence of opioid overdose death was more than 20-fold higher in individuals with OUD compared with the general population (5.4/100,000 deliveries in the pregnant population overall and 118/100,000 in individuals with OUD). Additionally, the incidence of death was much greater among individuals with OUD compared with the full population for



Table 1. Health Care Utilization of Pregnant Individuals With Opioid Overdose Death and Individuals in a Matched Control Group*

Health Care Utilization	All Pregnant Individuals		Pregnant Individuals With OUD	
	Opioid Overdose Deaths (n=135)	Matched Control Group (n=675)	Opioid Overdose Deaths (n=38)	Matched Control Group (n=190)
During pregnancy				
Opioid dispensing	47 (34.8)	70 (10.4)	12 (31.6)	44 (23.2)
ED visit	59 (43.7)	177 (26.3)	20 (52.6)	62 (32.6)
Hospitalization [†]	17 (12.6)	41 (6.1)	Fewer than 11 [‡]	25 (13.2)
No. of dispensed generic medications	3 (1–6)	2 (0–3)	3 (1–5)	2.5 (1–5)
No. of outpatient visits	15 (8–27)	13 (7–24)	23 (9–39)	19 (9–35)
After delivery				
Opioid dispensing	107 (79.3)	383 (56.7)	21 (55.3)	89 (46.8)
ED visit	76 (56.3)	191 (28.3)	22 (57.9)	67 (35.3)
Hospitalization [†]	21 (15.6)	22 (3.3)	Fewer than 11 [‡]	13 (6.8)
No. of dispensed generic medications	6 (3–12)	3 (1–6)	7.5 (2–13)	4 (1–8)
No. of outpatient visits	4 (2–9)	3 (1–6)	5.5 (3–13)	5 (2–10)

Data are n (%) or median (interquartile range).

ED, emergency department.

* Health care utilization during pregnancy was measured from 90 days before delivery until the day before the delivery admission date or 3 days before the delivery date for deliveries occurring in outpatient settings. Health care utilization after delivery was measured from the day after delivery until the day before death (or matched day of death in the control group) within 1 year postpartum.

[†] For hospitalizations, both the admission and discharge date had to fall within the utilization window. This avoided capturing the delivery hospitalization or a hospitalization that ended in death.

[‡] Event counts are obscured when there are fewer than 11 in Medicaid Analytic eXtract due to the Centers for Medicare & Medicaid Services' cell size suppression policy.

all non-opioid overdose causes of death, except cancer. Severe maternal morbidity, mental health conditions, and documented substance use disorders were associated with risk of opioid overdose death. Among individuals with OUD, MOUD was strongly associated with a decreased incidence of opioid overdose death.

The incidence of death among pregnant individuals with OUD has not been previously reported. Although it is expected that the burden of opioid overdose would be substantially greater in this population, the greater incidence of mortality across nearly all causes is an important finding. The largest discrepancies in incidence estimates between the population with OUD and the full population were in other drug- and alcohol-related deaths (approximately 15 times higher), suicides (approximately 11 times higher, not including deaths due to opioid overdose), and circulatory deaths (approximately five times higher). The association between substance use disorders and suicide in the general population has been demonstrated previously, especially for opioid and alcohol use disorders.¹⁰ There is also evidence that OUD is strongly associated with an increased risk of suicide in women, even after adjusting for psychi-

atric diagnoses.¹¹ Data from delivery hospitalizations suggest that pregnant individuals with OUD at the time of delivery are at increased risk of cardiac arrest, in addition to an increased risk of in-hospital mortality.² Pregnant individuals with OUD are at greater risk of severe maternal morbidity.¹² We found that patients with OUD and severe maternal morbidity had a much greater risk of opioid overdose death, signaling that severe maternal morbidity is a marker of a particularly high-risk group.

There are limited incidence data on pregnancy-associated mortality involving opioids. A study involving 22 states using death certificate data estimated that the pregnancy-associated mortality ratio (ie, deaths that occurred during pregnancy or within 1 year after pregnancy) due to opioids increased from 1.3 per 100,00 live births in 2007 to 4.2 per 100,000 in 2016, which accounted for 10% of all pregnancy-associated deaths in 2016.¹ An updated analysis using death certificates reported that the *pregnancy-associated mortality ratio due to drugs* (defined as deaths of unintentional and undetermined intent due to drug poisoning, drug-induced diseases, and mental or behavioral disorders due to drugs including opiates, narcotics, and psychotropics) was 4.7 per 100,000 for 2010–2019,



representing 11% of all pregnancy-associated deaths during this period.¹³ Unlike our study, these estimates include deaths occurring during pregnancy, rely on the pregnancy checkbox on death certificates, which is known to have errors in documenting pregnant or postpartum status,¹⁴ and do not have health insurance information.

Given the over-representation of OUD in the population with Medicaid insurance,² it is important to understand the burden of opioid overdose mortality in this population. Compared with pregnant individuals with private insurance, pregnant individuals in California with Medicaid insurance had 2.2 times the rate of death overall and 3.4 times the rate of death due to drugs or suicide in the year after delivery.¹⁵ Our estimate for the incidence of opioid overdose death at 5.4 per 100,000 deliveries, despite not including deaths occurring during pregnancy, is higher than the previous national estimate of 4.2 per 100,000 live births, reflecting this increased burden in the population with Medicaid insurance. Our finding that opioid overdose deaths account for approximately 1 in 10 maternal deaths from 2007 to 2014 is also consistent with the previously reported estimate of 10%.¹

We also found that pregnant individuals who had postpartum opioid overdose death did not have less health care utilization during pregnancy or after delivery than individuals in the matched control group who did not die postpartum. The majority of individuals with opioid overdose deaths had an emergency department visit between delivery and death, not including visits occurring on the death date. A similar finding about high emergency department utilization was reported among individuals with postpartum drug-related deaths in California.¹⁵ This high health care utilization in the postpartum period suggests that there are opportunities for intervention for these patients, especially in those with a history of OUD. Emergency department utilization was high overall in our cohort, which reflects greater emergency department utilization by patients with Medicaid insurance compared with patients with private insurance or no insurance in the general population and among pregnant individuals.^{16–18}

It is also notable that only 28% of the individuals with opioid overdose deaths had a documented history of OUD (based on either recorded diagnosis or OUD treatment) at delivery or in the 3 months before delivery. This increased to 40% when diagnoses and OUD treatment through the date of death were included. Despite the frequent health care utilization in both outpatient and emergency settings, issues with opioid use appear to be unrecognized

before the fatal overdose event for a majority of individuals in our cohort. It should be noted, however, that under-recording of the diagnosis in electronic health records and claims data in general, due to stigma and legal considerations, and under-recording among individuals with public insurance in particular, due to receiving treatment outside of Medicaid, might be other factors contributing to the low proportion of individuals with a documented diagnosis of OUD.

Among individuals with OUD, MOUD was strongly associated with a decreased risk of opioid overdose death. In nonpregnant individuals with OUD, numerous studies have shown a decreased risk of death overall and decreased risk due to opioid overdose when patients are actively on treatment with buprenorphine or methadone.¹⁹ Similarly, among pregnant individuals with OUD in Massachusetts, rates of overdose events occurring in the year before or after delivery were significantly lower when patients were actively receiving buprenorphine or methadone.²⁰ Despite the observed benefits of MOUD during pregnancy and the postpartum period, discontinuation of MOUD in the postpartum period is common, especially among patients with a shorter duration on MOUD during pregnancy.^{21,22} This highlights the importance of starting and maintaining MOUD during pregnancy and the postpartum period. We also found that MOUD in patients with OUD was associated with a decreased risk of non-opioid-related deaths, which may reflect some misclassification in the cause of death or indirect effects of MOUD on mortality through better engagement with care.

Using linked MAX and National Death Index data to evaluate maternal deaths in the United States has several advantages. It allows for investigation of death in a very large and nationally representative cohort. Unlike reports that rely on the death certificate pregnancy checkbox, timing of death in relation to pregnancy and delivery can be accurately described. Medicaid records also provide extensive information on health status and health care utilization leading up to death, including diagnosis of OUD, which allows us to examine key risk factors. However, our study also has some limitations. Due to the identification of pregnancy through the delivery event, we are unable to observe deaths occurring during pregnancy. The cohort includes individuals who die while they remain enrolled in Medicaid after delivery. Therefore, our findings cannot necessarily be generalized to patients who lose Medicaid eligibility and potentially lose access to treatment. The data used in this analysis include the most recently



available data from the National Death Index for individuals with Medicaid insurance nationwide, which includes years 2006–2013. Nevertheless, our estimates of the incidence of opioid overdose death and the proportion of postpartum deaths attributable to opioids were consistent with estimates using more recent data.^{1,13} Given the limited number of opioid overdose deaths, our risk factor analysis only considered univariate associations. Opioid overdose deaths are likely to be under-recorded on death certificates due to the widespread use of the code for poisoning by “other and unspecified drugs” (T50.9).²³ Analyses that imputed the drug involved in unspecified overdose deaths have estimated that adjusted national opioid overdose death rates are approximately 25% higher than estimates based on opioid codes alone; however, this varied substantially by state.^{24,25} Therefore, our observed incidence of opioid overdose death may be an underestimate.

In summary, opioid overdose is an important cause of postpartum death among pregnant individuals with Medicaid insurance in the United States, accounting for about 10% of all postpartum deaths. Pregnant individuals with OUD also have a high incidence of postpartum death from other preventable causes of premature mortality, including other drug- and alcohol-related deaths, suicide, and other injuries and accidents. Risk factor analyses for opioid overdose death revealed potential avenues for intervention through interaction during postpartum outpatient and emergency department visits and by increasing access to MOUD and sustaining MOUD maintenance during the first-year-postpartum period, which was strongly protective against overdose. Additional evidence-based prevention interventions could include naloxone prescribing and training to pregnant and postpartum individuals with substance use history and to partners and significant others,^{26,27} screening and brief interventions for reduction of substance use²⁸ and suicide risk,²⁹ and emphasis on personal safety (safe driving, falls prevention, averting domestic violence). Interventions targeted to support this high-risk group of patients during the postpartum period are needed not only to prevent overdose, but other causes of maternal death, as well.

REFERENCES

- Gemmill A, Kiang MV, Alexander MJ. Trends in pregnancy-associated mortality involving opioids in the United States, 2007–2016. *Am J Obstet Gynecol* 2019;220:115–6. doi: 10.1016/j.ajog.2018.09.028
- Maeda A, Bateman BT, Clancy CR, Creanga AA, Leffert LR. Opioid abuse and dependence during pregnancy: temporal trends and obstetrical outcomes. *Anesthesiol J Am Soc Anesthesiol* 2014;121:1158–65. doi: 10.1097/ALN.0000000000000472
- Mangla K, Hoffman MC, Trumpff C, O’Grady S, Monk C. Maternal self-harm deaths: an unrecognized and preventable outcome. *Am J Obstet Gynecol* 2019;221:295–303. doi: 10.1016/j.ajog.2019.02.056
- Comtois KA, Schiff MA, Grossman DC. Psychiatric risk factors associated with postpartum suicide attempt in Washington State, 1992–2001. *Am J Obstet Gynecol* 2008;199:120.e1–5. doi: 10.1016/j.ajog.2008.02.011
- Degenhardt L, Bucello C, Mathers B, Briegleb C, Ali H, Hickman M, et al. Mortality among regular or dependent users of heroin and other opioids: a systematic review and meta-analysis of cohort studies. *Addiction* 2011;106:32–51. doi: 10.1111/j.1360-0443.2010.03140.x
- Palmsten K, Huybrechts KF, Mogun H, Kowal MK, Williams PL, Michels KB, et al. Harnessing the Medicaid Analytic eXtract (MAX) to evaluate medications in pregnancy: design considerations. *PLoS One* 2013;8:e67405. doi: 10.1371/journal.pone.0067405
- Substance Abuse and Mental Health Services Administration. Using International Classification of Diseases (ICD) codes to assess opioid-related overdose deaths. Accessed January 4, 2021. <https://mnprc.org/wp-content/uploads/2019/01/using-icd-10-codes-to-assess-opioid-related-overdose-deaths.pdf>
- Kuklina EV, Whiteman MK, Hillis SD, Jamieson DJ, Meikle SF, Posner SF, et al. An enhanced method for identifying obstetric deliveries: implications for estimating maternal morbidity. *Matern Child Health J* 2008;12:469–77. doi: 10.1007/s10995-007-0256-6
- Callaghan WM, MacKay AP, Berg CJ. Identification of severe maternal morbidity during delivery hospitalizations, United States, 1991–2003. *Am J Obstet Gynecol* 2008;199:133.e1–8. doi: 10.1016/j.ajog.2007.12.020
- Conner KR, Bridge JA, Davidson DJ, Pilcher C, Brent DA. Metaanalysis of mood and substance use disorders in proximal risk for suicide deaths. *Suicide Life Threat Behav* 2019;49:278–92. doi: 10.1111/sltb.12422
- Bohnert KM, Ilgen MA, Louzon S, McCarthy JF, Katz IR. Substance use disorders and the risk of suicide mortality among men and women in the US Veterans Health Administration. *Addict Abingdon Engl* 2017;112:1193–201. doi: 10.1111/add.13774
- Jarlenski M, Krans EE, Chen Q, Rothenberger SD, Cartus A, Zivin K, et al. Substance use disorders and risk of severe maternal morbidity in the United States. *Drug Alcohol Depend* 2020;216:108236. doi: 10.1016/j.drugalcdep.2020.108236
- Margerison CE, Roberts MH, Gemmill A, Goldman-Mellor S. Pregnancy-associated deaths due to drugs, suicide, and homicide in the United States, 2010–2019. *Obstet Gynecol* 2022;139:172–80. doi: 10.1097/AOG.0000000000004649
- Creanga AA, Thoma M, MacDorman M. Value and disvalue of the pregnancy checkbox on death certificates in the United States—impact on newly released 2018 maternal mortality data. *Am J Obstet Gynecol* 2020;223:393.e1–4. doi: 10.1016/j.ajog.2020.05.046
- Goldman-Mellor S, Margerison CE. Maternal drug-related death and suicide are leading causes of postpartum death in California. *Am J Obstet Gynecol* 2019;221:489.e1–9. doi: 10.1016/j.ajog.2019.05.045
- Kilfoyle KA, Vrees R, Raker CA, Matteson KA. Non-urgent and urgent emergency department use during pregnancy: an observational study. *Am J Obstet Gynecol* 2017;216:181.e1–7. doi: 10.1016/j.ajog.2016.10.013



17. Vladutiu CJ, Stringer EM, Kandasamy V, Ruppenkamp J, Menard MK. Emergency care utilization among pregnant Medicaid recipients in North Carolina: an analysis using linked claims and birth records. *Matern Child Health J* 2019;23:265–76. doi: 10.1007/s10995-018-2651-6
18. Moore B, Stocks C, Owens PL. Trends in emergency department visits, 2006–2014. HCUP statistical brief #227. Accessed April 8, 2022. <https://www.hcup-us.ahrq.gov/reports/stat-briefs/sb227-Emergency-Department-Visit-Trends.jsp>
19. Sordo L, Barrio G, Bravo MJ, Indave BI, Degenhardt L, Wiessing L, et al. Mortality risk during and after opioid substitution treatment: systematic review and meta-analysis of cohort studies. *BMJ* 2017;357:j1550. doi: 10.1136/bmj.j1550
20. Schiff DM, Nielsen T, Terplan M, Hood M, Bernson D, Diop H, et al. Fatal and nonfatal overdose among pregnant and postpartum women in Massachusetts. *Obstet Gynecol* 2018;132:466–74. doi: 10.1097/AOG.0000000000002734
21. Wilder C, Lewis D, Winhusen T. Medication assisted treatment discontinuation in pregnant and postpartum women with opioid use disorder. *Drug Alcohol Depend* 2015;149:225–31. doi: 10.1016/j.drugalcdep.2015.02.012
22. Schiff DM, Nielsen TC, Hoepfner BB, Terplan M, Hadland SE, Bernson D, et al. Methadone and buprenorphine discontinuation among postpartum women with opioid use disorder. *Am J Obstet Gynecol* 2021;225:424.e1–12. doi: 10.1016/j.ajog.2021.04.210
23. Slavova S, O'Brien DB, Creppage K, Dao D, Fondario A, Haile E, et al. Drug overdose deaths: let's get specific. *Public Health Rep* 2015;130:339–42.
24. Buchanich JM, Balmert LC, Williams KE, Burke DS. The effect of incomplete death certificates on estimates of unintentional opioid-related overdose deaths in the United States, 1999–2015. *Public Health Rep* 2018;133:423–31. doi: 10.1177/0033354918774330
25. Ruhm CJ. Geographic variation in opioid and heroin involved drug poisoning mortality rates. *Am J Prev Med* 2017;53:745–53. doi: 10.1016/j.amepre.2017.06.009
26. Jones HE, Hairston E, Lensch AC, Marcus LK, Heil SH. Challenges and opportunities during the COVID-19 pandemic: treating patients for substance use disorders during the perinatal period. *Prev Med* 2021;152:106742. doi: 10.1016/j.jypmed.2021.106742
27. Blandthorn J, Bowman E, Leung L, Bonomo Y, Dietze P. Managing opioid overdose in pregnancy with take-home naloxone. *Aust N Z J Obstet Gynaecol* 2018;58:460–2. doi: 10.1111/ajo.12761
28. Wu LT, Payne EH, Roseman K, Kingsbury C, Case A, Nelson C, et al. Clinical workflow and substance use screening, brief intervention, and referral to treatment data in the electronic health records: a national drug abuse treatment clinical trials network study. *EGEMS* 2019;7:35. doi: 10.5334/egems.293
29. Sall J, Brenner L, Millikan Bell AM, Colston MJ. Assessment and management of patients at risk for suicide: synopsis of the 2019 U.S. Department of Veterans Affairs and U.S. Department of Defense Clinical Practice Guidelines. *Ann Intern Med* 2019;171:343–53. doi: 10.7326/M19-0687

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