

Letters

RESEARCH LETTER

Neonatal Abstinence Syndrome Incidence and Health Care Costs in the United States, 2016

Neonatal abstinence syndrome (NAS) is a withdrawal syndrome primarily occurring in infants with in utero exposure to opioids. Neonatal abstinence syndrome is an important indicator of the immediate effect of the opioid crisis. Little is known about the physical and developmental health consequences of prenatal opioid exposure.¹ Neonatal abstinence syndrome incidence rates have increased from 1.5 to 8.0 per 1000 hospital births in the United States from 2004 to 2014.² Total hospital costs reached \$316 million in 2012 and accounted for 4% of all neonatal intensive care unit hospital days nationwide in 2013.^{3,4} This study provides new national incidence and cost estimates for NAS in 2016.

Methods | The study data came from the 2016 Healthcare Cost and Utilization Project (HCUP) Kids' Inpatient Database (KID), a nationally representative sample of all-payer pediatric discharges. We used the KID variable for in-hospital birth (I10_HOSPBIRTH) to identify *in-hospital births*, which were

defined as those with a primary/secondary diagnosis of live birth and no indication of birth outside the hospital or transfer from another hospital. Hospitalizations for infants born with NAS were identified using the *International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM)* code P96.1 in any diagnosis field. We converted hospital charges to costs using Healthcare Cost and Utilization Project hospital-specific cost-to-charge ratios and adjusted all costs to include physician fees based on the discharge primary diagnosis.⁵ We used Stata, version 14.2 (StataCorp) for all analyses and included survey weights to provide nationally representative estimates. Statistical significance was set at $P < .05$. The Centers for Disease Control and Prevention determined this study to be exempt from human-subject regulations and institutional review board approval, and consent was waived because deidentified retrospective data were used.

Results | The overall incidence rate of NAS was 6.7 per 1000 in-hospital births in 2016 (**Table 1**); rates were highest among American Indian/Alaska Native individuals (15.9 per 1000) and non-Hispanic white individuals (10.5 per 1000),

Table 1. Characteristics and Rates of Infants Who Received a Diagnosis of Neonatal Abstinence Syndrome vs All Other US Hospital Births, 2016

Characteristic	NAS Rate per 1000 Births	Weighted, % (95% CI)		P Value
		Infants With NAS (n = 19 397)	All Other Hospital Births (n = 1 289 728)	
Overall	6.7			
Sex				
Female	6.5	47.0 (46.2-47.7)	48.8 (48.7-48.9)	<.001
Male	7.0	52.9 (46.2-47.4)	51.1 (51.0-51.3)	
Race/ethnicity ^a				
White	10.5	72.7 (70.5-74.7)	46.3 (45.0-47.7)	<.001
Black	3.4	6.6 (6.0-7.3)	13.1 (12.4-13.8)	
Hispanic	2.5	6.8 (5.6-8.1)	18.2 (17.0-19.4)	
American Indian/Alaska Native	15.9	1.6 (1.0-2.3)	0.7 (0.5-0.8)	
Other	1.9	3.2 (2.6-4.0)	11.6 (10.8-12.4)	
Household income, quartile				
Lowest	9.3	38.7 (36.6-40.8)	28.1 (27.0-29.2)	<.001
All other	5.7	59.7 (57.6-61.8)	70.9 (69.7-72.0)	
Urban/rural				
Metropolitan	6.2	79.4 (77.2-81.5)	86.1 (85.4-86.8)	<.001
Micropolitan	9.7	11.8 (10.2-13.6)	8.2 (7.7-8.7)	
Rural	10.6	8.6 (7.5-9.7)	5.4 (5.1-5.8)	
Delivery hospital region				
Northeast	9.5	22.7 (20.0-25.7)	16.0 (14.7-17.4)	<.001
Midwest	6.3	19.8 (17.4-22.5)	21.1 (19.9-22.4)	
South	7.2	41.7 (38.4-45.0)	39.2 (37.4-41.0)	
West	4.5	15.8 (13.9-17.9)	23.7 (22.3-25.2)	

Abbreviation: NAS, neonatal abstinence syndrome.

^a Race/ethnicity categories, except Hispanic, are non-Hispanic. P values are calculated using Pearson χ^2 to compare infants with NAS with all other infants.

Table 2. Birth Hospitalization Mean Length of Stay and Costs for US Infants With Neonatal Abstinence Syndrome by Primary Payer, 2016

Characteristic	NAS Rate per 1000 Births	Mean (SD) Length of Stay, d	Cost, \$	
			Per Birth	Total
Overall	6.7	15.9 (20.4)	22 552	572 704 672
Medicaid	12.3	16.2 (20.2)	22 669	477 011 820
Private	1.5	14.9 (23.4)	25 013	65 546 327
Uninsured	7.0	11.5 (13.2)	13 516	16 420 493
Other payer ^a	3.9	16.3 (23.9)	27 153	12 937 624

Abbreviation: NAS, neonatal abstinence syndrome.

^a Other payer includes Worker's Compensation, Civilian Health and Medical Program of the Uniformed Services, Civilian Health and Medical Program of Veterans Affairs, Title V, and other government programs.

the lowest income quartile (9.3 per 1000), rural areas (10.6 per 1000), and the Northeast (9.5 per 1000). Infants with NAS had a 15.9-day (20.4-day) mean (SD) length of stay and total overall hospitalization costs were \$572.7 million (Table 2). The average cost per infant with NAS was \$22 552. Neonatal abstinence syndrome rates were highest among Medicaid-covered births (12.3 per 1000) and those without insurance (7.0 per 1000). Total costs were highest for births covered by Medicaid (\$477.0 million).

Discussion | The 2016 rate of in-hospital births with a NAS diagnosis was 6.7 per 1000. Total costs were \$572.7 million. Direct comparisons with earlier estimates are difficult because of the *ICD-10-CM* transition in 2015 and because earlier studies may not have limited the sample to in-hospital births nor included physician fees. While total costs have increased since 2012, total length of stay and the proportion of costs by payer were consistent with prior research.^{2,3} In 2016, Medicaid was responsible for 83% of charges for in-hospital births with a NAS diagnosis, indicating that state and federal budgets may continue to bear disproportionate costs as the opioid crisis evolves.

Limitations. Limitations include the lack of clinical treatment outcomes and the inability to examine the timing, duration, or type of drug exposure (illicit, prescribed, or nonopioids). Increasing access to medication-assisted treatment for pregnant women with opioid use disorder, in line with clinical guidance, and better documentation of NAS at birth may contribute to incidence rates observed. Kids' Inpatient Database only includes hospital charges; we used cost-to-charge ratios and improve on previous estimates by including physician fees.

Conclusions | Research has demonstrated that quality improvement initiatives, which standardize treatment protocols and nonpharmacological treatment of infants with NAS, can reduce inpatient length of stay.⁶ Additional research might explore the association of clinical interventions with physical, developmental, and cost outcomes and with the long-term care use and service needs of infants born with NAS.¹ These nationally representative results demonstrate the continuing association of the opioid crisis with maternal and infant health.

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