

Neonatal abstinence syndrome

Delaware

2010 – 2017

Highlights

- Neonatal abstinence syndrome (NAS) is a withdrawal syndrome in newborns occurring after birth that is primarily caused by maternal opiate use during pregnancy.
- According to hospital discharge data, during 2010 to 2017 in Delaware, 1,713 cases of NAS were identified with an incidence of 20.5 cases per 1,000 births.
- A total of 12 iatrogenic cases were identified during the entire 2010-2017 time-period. The NAS rate excluding these 12 cases was 24.9 per 1,000 births in 2017. There was a ten percent drop in the incidence of NAS (excluding iatrogenic cases) from 27.6 cases per 1,000 births in 2016 to 24.7 cases per 1,000 births in 2017.
- The incidence of NAS increased 130 percent, from 12.0 cases per 1,000 births in 2010 to 27.6 cases per 1,000 births in 2016. The NAS rate for Delaware was about four times that of the U.S. rate based on the latest data available for 2013.
- Median length of stay for NAS affected newborn was 17 days in 2017 as compared to 2 days for a non-NAS newborn. Median length of stay for NAS newborns increased 112 percent during 2010-2017 time-period from 8 days in 2010 to 17 days in 2017. There was considerable variation in the length of stay between hospitals.
- Continued public health surveillance of NAS infants and mothers is needed as there is no current consensus regarding the case definition and emerging epidemiology of NAS and the long-term impact on population health.



DELAWARE HEALTH AND SOCIAL SERVICES
Division of Public Health
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What is neonatal abstinence syndrome (NAS)?

Neonatal abstinence syndrome (NAS) is a withdrawal syndrome in newborns following birth that is primarily caused by maternal opiate use during the prenatal period (antepartum).¹ First described by Dr. Loretta Finnegan in the 1970s, this condition is perhaps better described as neonatal withdrawal, given the implicit nature of abstinence as a choice to refrain from doing something and a newborn's inability to functionally abstain.² The National Institutes of Health (NIH) defines NAS as a group of problems that occurs in a newborn exposed to addictive illegal or prescription drugs while in the mother's womb (i.e., in utero exposure).³ Use of substances such as amphetamines, barbiturates, benzodiazepines, and opiates (e.g., diazepam, clonazepam, cocaine, marijuana, heroin, methadone, codeine, hydrocodone, Vicodin oxycodone, or OxyContin) by women during the prenatal period has been associated with both obstetrical and neonatal complications including NAS. A newborn's presentation of NAS varies (Figure 1) and may be influenced by factors that not only include licit and illicit exposures but also include maternal physiology, epigenetic modifications, and genetic predisposition.⁴ NAS infants are more likely to experience adverse neonatal outcomes such as low birthweight (LBW, <2,500 grams or 5 pounds, 8 ounces) than infants without NAS – a major risk factor for infant mortality.

Figure 1. Neonatal abstinence syndrome (NAS) characteristics²

- high-pitched cry / irritability
- respiratory distress
- sleep-wake disturbances
- alterations in infant tone and movement (hyperactive primitive reflexes, hypertonicity, and tremors with resultant skin excoriations)
- feeding difficulties, gastrointestinal disturbances (vomiting and loose stools)
- autonomic dysfunction (sweating, sneezing, fever, nasal stuffiness, and yawning)

Assessment of neonatal abstinence syndrome (NAS)

A typical mechanism for NAS assessment and evaluation is the Finnegan Scoring System and/or its variant. The objective of the assessment is to quantify the severity of symptoms to determine the need for intervention.³ While this type of data may be available at the hospital and/or clinic level, these data are not typically reported to population registries such as vital record systems or captured in hospital discharge datasets. To enumerate NAS incidence at a population level, 2010-2017 hospital discharge data from Delaware hospitals were utilized. Cases were identified using criteria based on the national incidence study by Patrick et al. using *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*. The authors of this study utilized the Healthcare Cost and Utilization Project's Kids' Inpatient Database (KID) to identify newborns with NAS and the Nationwide Inpatient Sample (NIS) to identify

¹ Patrick SW, Schumacher RE, Benneyworth BD, Krans EE, McAllister JM, Davis MM. Neonatal Abstinence Syndrome and Associated Health Care Expenditures: United States, 2000-2009. *JAMA* 2012 May; 307(18):1934-1940.

² McQueen K, Murphy-Oikonen J. Neonatal Abstinence Syndrome. *N Engl J Med*. 2016 Dec; 375(25):2468-2479.

³ U.S. National Library of Medicine. Neonatal Abstinence Syndrome. National Library of Medicine Website. Available at <http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0004566/>. Accessed on September 7, 2012.

⁴ Jansson LM, Velez M. Neonatal abstinence syndrome. *Curr Opin Pediatr*. April 2012; 24(2):252-258.

mothers. Due to the changes in ICD-9-CM on 1st October, 2015 to ICD-10-CM, NAS code of P96.1 has also been used by several studies in the U.S.^{5,6,7}

How is Neonatal abstinence syndrome (NAS) determined for this report?

The identification of NAS cases was based on ICD-9-CM and ICD-10-CM codes for all inpatient hospital births in Delaware using hospital discharge data. The Division of Public Health (DPH) collects hospital discharge records for inpatients from all Delaware licensed hospitals. Hospitals are required by Delaware law (16 Del.C. Ch. 20, § 2001-2009) to submit inpatient hospital discharge data from the uniform claims and billing dataset (UB-82 or successor form) to the Delaware Health Statistics Center on a quarterly basis. Hospital births from Bayhealth, Beebe, Christiana Care, Nanticoke, and St. Francis are part of the data that are collected.

Figure 2. Estimating the incidence of Neonatal abstinence syndrome

NAS (numerator): The number of newborns in Delaware during 2010-2017 with any underlying **ICD-9-CM** diagnosis code of 779.5 “drug withdrawal syndrome in a newborn.” Changes in **ICD-10-CM** in October 2015 led to incorporation of P96.1 in enumeration.

Denominator: All hospital births in Delaware during 2010-2017.

Neonatal abstinence syndrome rates for Delaware were estimated using the formula provided in Figure 2. The numerator is defined as babies born meeting the NAS case definition; the denominator includes all reported births for the calendar year. Iatrogenic cases were identified based on Patrick et al.’s study. A total of 12 cases were identified during the entire 2010-2017 time-period and the results presented exclude these 12 cases as there was no significant difference in NAS rates after exclusion. In addition to enumerating the NAS cases from hospital discharge data, all hospital births were matched to birth certificate data for the 2010-2017 period using a similar methodology noted in a previous brief.⁸

Neonatal abstinence syndrome (NAS) in Delaware

There were 1,701 cases of NAS identified in Delaware during 2010-2017 (Figure 3). The overall NAS rate for Delaware during 2010-2017 was 20.6 (95% CI: 19.6–21.6) per 1,000 births. There was a significant increase in NAS rates (~108 percent), from 12.0 per 1,000 births in 2010 to 24.9 per 1,000 births in 2017.

⁵ Maalouf FI, Cooper WO, Stratton SM, Dudley JA, Ko J, Banerji A, Patrick SW. Positive Predictive Value of Administrative Data for Neonatal Abstinence Syndrome. *Pediatrics*. 2019 Jan; 143(1). pii: e20174183.

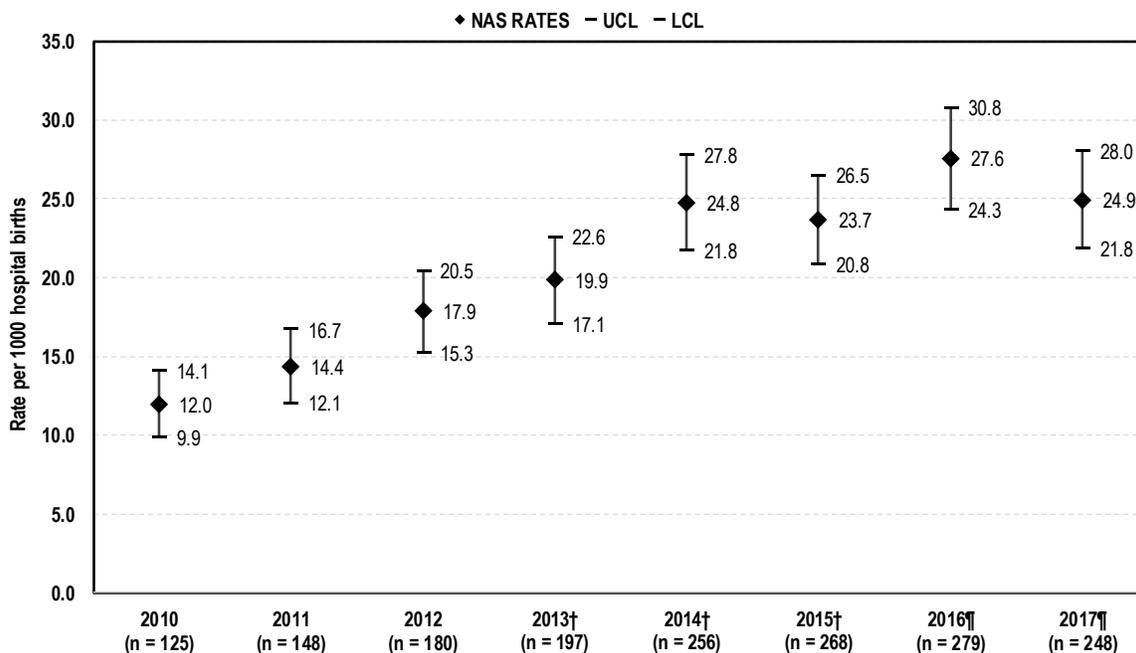
⁶ Lind JN, Ailes EC, Alter CC, et al. Leveraging Existing Birth Defects Surveillance Infrastructure to Build Neonatal Abstinence Syndrome Surveillance Systems — Illinois, New Mexico, and Vermont, 2015–2016. *MMWR Morb Mortal Wkly Rep* 2019;68:177–180

⁷ Patrick SW, Faherty LJ, Dick AW, Scott TA, Dudley J, Stein BD. Association Among County-Level Economic Factors, Clinician Supply, Metropolitan or Rural Location, and Neonatal Abstinence Syndrome. *JAMA*. 2019;321(4):385–393. doi:10.1001/jama.2018.20851

⁸ Hussaini, SK. Neonatal abstinence syndrome: Delaware, 2010-2013. *Research Brief*. Delaware Department of Health and Social Services, Division of Public Health. Published May 2017. Available at: http://dethrives.com/wp-content/uploads/2013/06/Neonatal-abstinence-syndrome-Delaware-2010-2013_final_approved.pdf

The NAS rate between 2016 and 2017 also declined by approximately 10 percent, following changes from ICD9-CM on 1st October 2015 to ICD-10-CM.

Figure 3. Neonatal Abstinence Syndrome Rates excluding iatrogenic cases, Delaware, 2010-2017



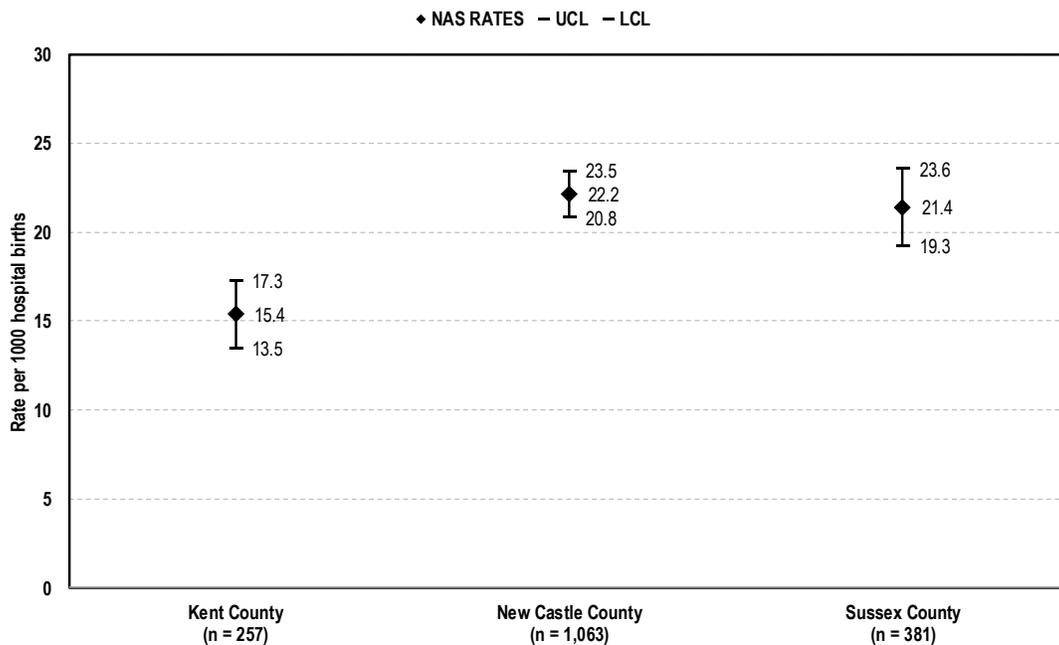
Source: Delaware Department of Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2017.
 *Rates are presented with 95% confidence intervals; UCL = upper confidence limit; LCL = lower confidence limit.
 †2013 and 2014 data were revised due to updated records for 2013 and 2014 in Hospital Discharge Data.
 ¶ 2015 and 2016 data contains ICD-9-CM and ICD-10-CM changes as well as lower number of records compared to births and may be an underestimate.

Data released by the U.S. Centers of Disease Control and Prevention (CDC) for 28 states indicates that “the overall incidence of NAS in the states has increased almost 300 percent during 1999–2015, from 1.5 to 6.0 cases per 1,000 hospital births.”⁹ The U.S. rate for the most recent data available for 2013 was 5.8 per 1,000 births per year.¹⁰ Following changes in ICD-9-CM to ICD-10-CM, no national estimates for NAS are currently available, except estimates from the CDC for 2015, from a tri-state analyses that suggests that the NAS incidence during 2015 were 3.0 per 1,000 births for Illinois, 7.5 for New Mexico, and 30.8 for Vermont.⁶ Delaware’s 2016 and 2017 NAS rates were approximately four times that of the 2013 U.S. rate.

Figure 4 displays the overall NAS rates for Delaware by county. Although the overall rate of NAS was highest in New Castle County during the eight-year period (22.2 cases per 1,000 births; 95% CI:20.8–23.5), the Sussex County NAS rate was similar to the New Castle County NAS rate during same time- period (21.4 per 1,000 births; 95%CI: 19.3-23.6). Figure 5 displays NAS rates by county by year.

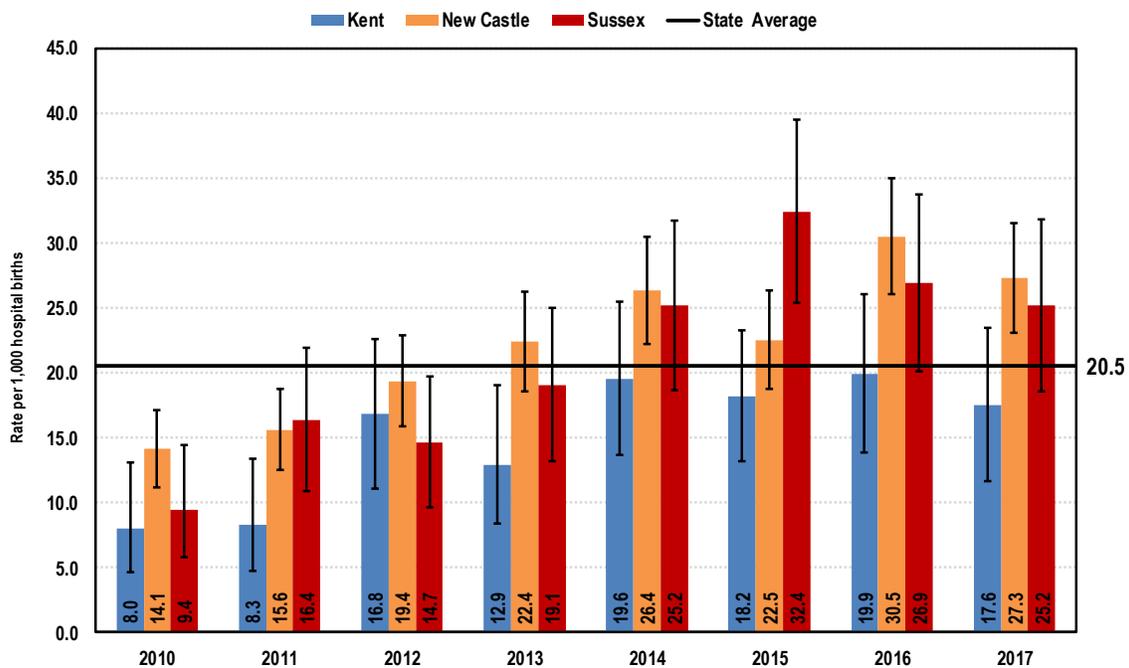
⁹ Ko JY, Patrick SW, Tong VT, Patel R, Lind JN, Barfield WD. Incidence of Neonatal Abstinence Syndrome – 28 States, 1999-2015. *Morbidity and Mortality Weekly Report (MMWR)*. 2016 Aug; 65(31):799-802.
¹⁰ Patrick SW, Davis MM, Lehmann CU, et al. *J Perinatol*. 2015 Aug; 35(8):650-5.

Figure 4. Neonatal Abstinence Syndrome Rates by County, Delaware 2010-2017



Source: Delaware Department of Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2017.
 *Rates are presented with 95% confidence intervals; UCL = upper confidence limit; LCL = lower confidence limit.
 †2013 and 2014 data were revised due to updated records for 2013 and 2014 in Hospital Discharge Data.
 ‡2015 and 2016 data contains ICD-9-CM and ICD-10-CM changes as well as lower number of records compared to births and may be an underestimate.

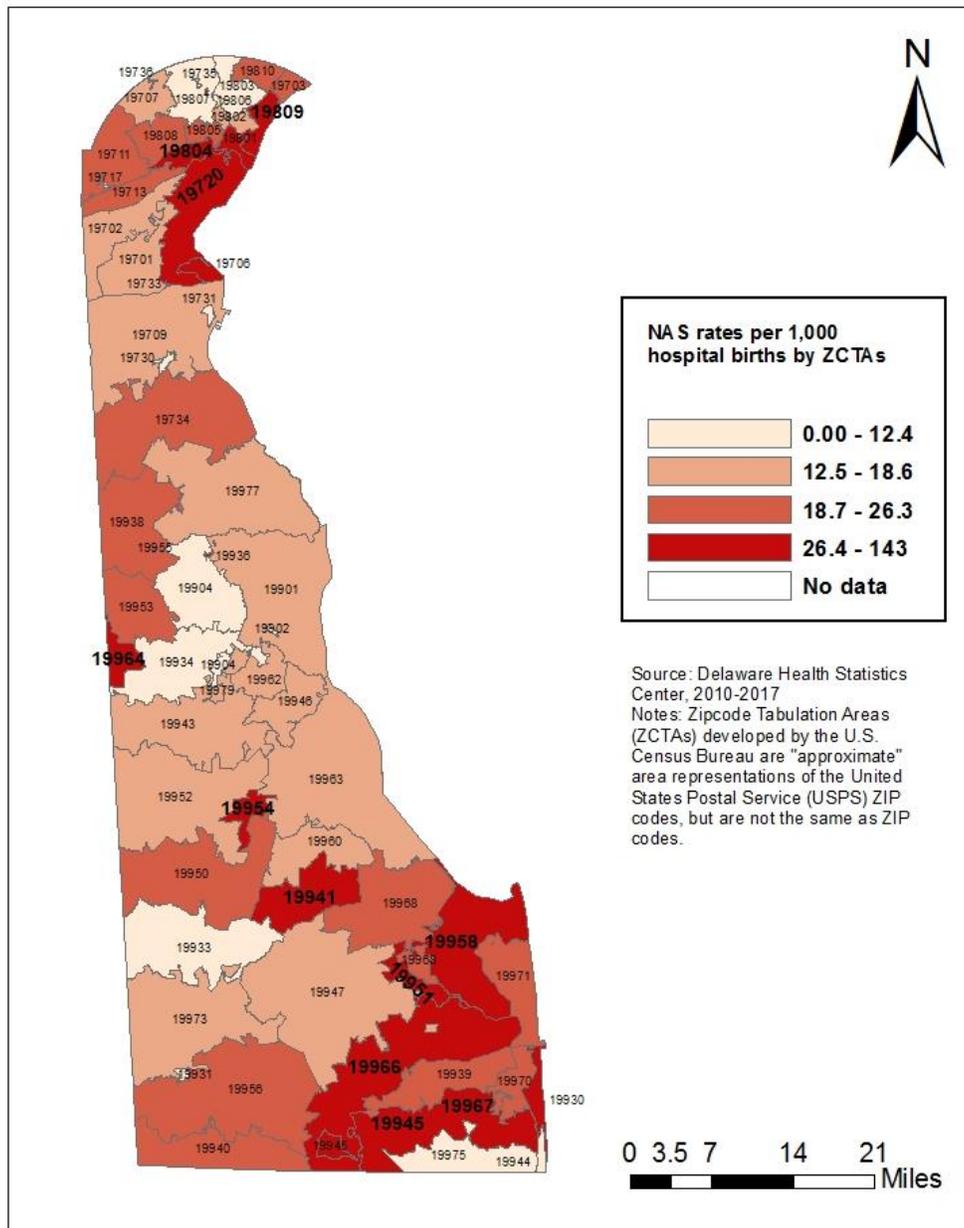
Figure 5. Annual Neonatal Abstinence Syndrome Rates by County, Delaware, 2010-2017



Source: Delaware Department of Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2017.
 *Rates are presented with 95% confidence intervals; UCL = upper confidence limit; LCL = lower confidence limit.
 †2013 and 2014 data were revised due to updated records for 2013 and 2014 in Hospital Discharge Data.
 ‡2015 and 2016 data contains ICD-9-CM and ICD-10-CM changes as well as lower number of records compared to births and may be an underestimate.

To further identify the sub-county level NAS cases, a ZIP Code Tabulation Areas (ZCTAs) data map for NAS cases was developed for the 2010-2017 period (Figure 6). Darker shades in the map represent higher number of NAS rates during the eight-year period. While some areas seem to have 'higher rates' of NAS, the total number of cases during the entire time-period could have been very low. Hence, the sub-county level NAS rates need to be interpreted with caution.

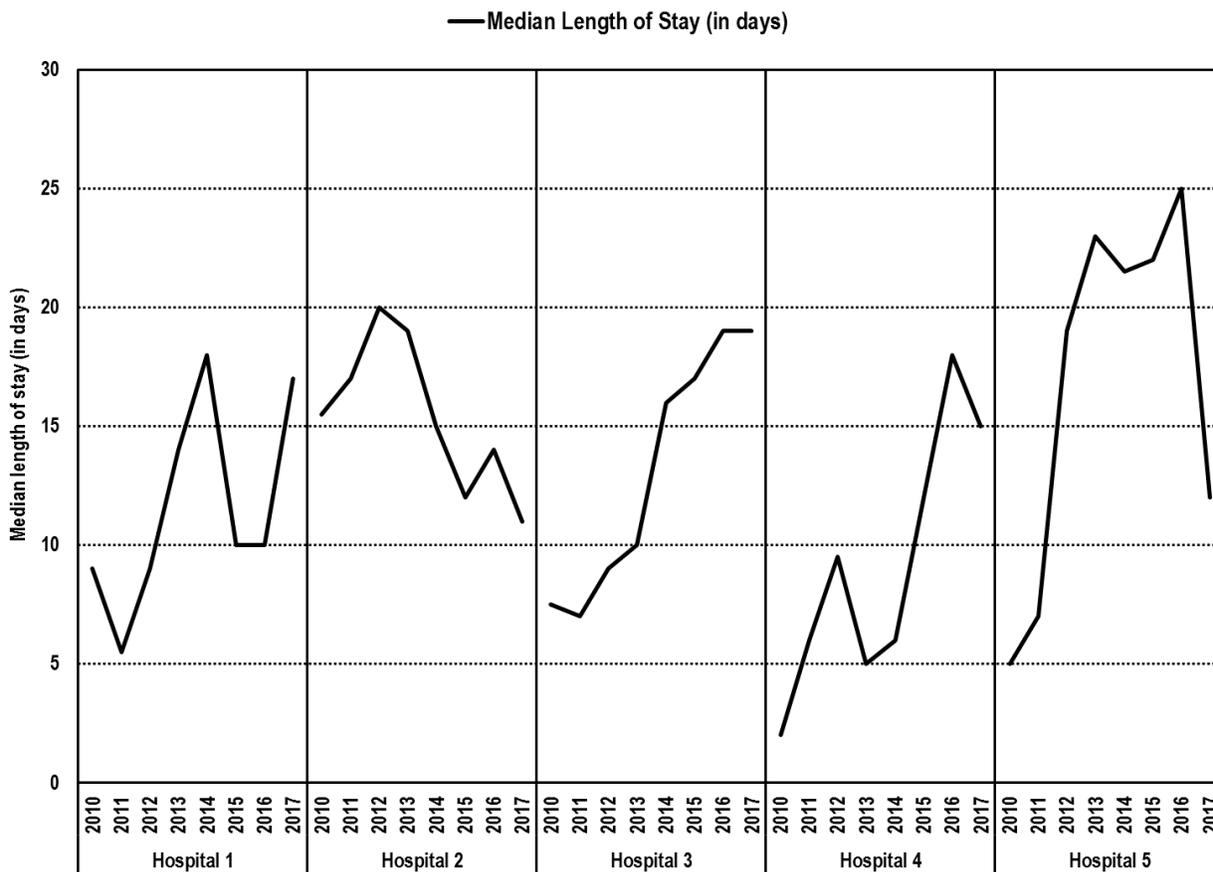
Figure 6. Neonatal Abstinence Syndrome (NAS) Rates by ZIP Code Tabulation Areas (ZCTAs) in Delaware, 2010-2017



Source: Delaware Department of Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2017.

The median length of stay for NAS affected newborn was 17 days in 2017 as compared to 2 days for a non-NAS newborn. The median length of stay for NAS newborns increased 112 percent during 2010-2017 time-period from 8 days in 2010 to 17 days in 2017. There was considerable year-to-year variation in the length of stay within and between hospitals (Figure 7) as such providing opportunities for quality improvement.

Figure 7. Length of Stay (LOS) for Neonatal Abstinence Syndrome (NAS) cases by hospitals in Delaware, 2010-2017



Source: Delaware Department of Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2017.

Mother and infant characteristics of NAS in Delaware

The matched hospital discharge and birth certificate datasets was utilized to further examine the newborn as well as maternal characteristics. Over 95 percent of the total NAS cases (n = 1,624) for singleton deliveries was available for analyses for 2010-2017 period. There were significant differences in maternal characteristics of NAS and non-NAS infants (Table 2). For instance, mothers were more likely to be younger (i.e., <29 years old ~62%), with low levels of education (i.e., high school or below ~70%), more likely to be white (81%), more likely to have Medicaid as the payor of the birth, more likely to have no prenatal care

and/or entered prenatal care in the second and/or third trimester, more likely to have smoked during pregnancy.

Table 2. Characteristics of women delivering singleton infants with neonatal abstinence syndrome (NAS) in Delaware, 2010-2017.

Maternal and newborn characteristics for singleton births [†]	Total (N = 78,659) ^{††}	
	Neonatal Abstinence Syndrome (NAS) (N = 1,624)	All other non-NAS in Delaware (N = 77,035)
Maternal Age		
Less than 19 years	33 (2%)	5,372 (7%)
20-24 years	398 (24.5%)	17,018 (22.1%)
25-29 years	593 (36.5%)	22,635 (29.4%)
30-34 years	436 (26.9%)	20,641 (26.8%)
35 or more	164 (10.1%)	11,369 (14.8%)
Maternal Education		
Less than 12 years of schooling	445 (27.4%)	13,942 (18.1%)
High school graduate	695 (42.8%)	19,832 (25.7%)
12 or more years of schooling	466 (28.7%)	42,836 (55.6%)
Unknown/Refused	18 (1.1%)	425 (0.6%)
Maternal Race and Ethnicity		
White	1,315 (81%)	39,903 (51.8%)
African American or Black	213 (13.1%)	21,119 (27.4%)
Hispanic	75 (4.6%)	11,167 (14.5%)
Other	19 (1.2%)	4,821 (6.3%)
Unknown/Refused	2 (0.1%)	25 (0%)
Maternal Insurance Status		
Medicaid	1,359 (83.7%)	37,358 (48.5%)
Private payers	205 (12.6%)	36,275 (47.1%)
Self Pay	22 (1.4%)	875 (1.1%)
Other	36 (2.2%)	2,398 (3.1%)
Unknown/Refused	2 (0.1%)	129 (0.2%)
Maternal County of Residence		
Kent	257 (15.8%)	15,855 (20.6%)
New Castle	1,014 (62.4%)	45,617 (59.2%)
Sussex	353 (21.7%)	15,563 (20.2%)

Table 2 contd/.

Maternal and newborn characteristics for singleton births [¶]	Total (N = 78,659) [¶]	
	Neonatal Abstinence Syndrome (NAS) (N = 1,624)	All other non-NAS in Delaware (N = 77,035)
Prenatal Care		
No prenatal care	146 (9%)	1,416 (2.4%)
First Trimester	922 (56.8%)	43,587 (75.2%)
Second Trimester	385 (23.7%)	9,510 (16.4%)
Third Trimester	117 (7.2%)	2,548 (4.4%)
Unknown/Refused	54 (3.3%)	8,75 (1.5%)
Pre-pregnancy weight		
Underweight	96 (5.9%)	2,549 (4.4%)
Normal weight	787 (48.5%)	24,721 (42.7%)
Overweight	402 (24.8%)	14,835 (25.6%)
Obesity	302 (18.6%)	3,230 (5.6%)
Unknown/Refused	37 (2.3%)	955 (1.6%)
Cigarette Use		
Smoked during pregnancy	1,131 (69.6%)	7,665 (10%)
Hepatitis		
Hep C	184 (11.3%)	221 (0.3%)
Previous poor outcome		
Previous preterm birth	200 (12.3%)	4,244 (5.5%)
Infant outcomes		
Low birth weight	314 (19.3%)	5,298 (6.9%)
Preterm birth	269 (16.6%)	6,185 (8%)
Small for gestational age	414 (25.5%)	9,060 (11.8%)
Neonatal deaths	3 (0.2%)	338 (0.4%)
Postneonatal deaths	6 (0.4%)	104 (0.1%)

Source: Delaware Department Health and Social Services, Division of Public Health, Hospital Discharge Data, Vital Records Data, 2010-2017

[¶]Data for singleton births obtained from birth certificate data for 2010-2017

Consistent with Patrick et al.'s study, 19 percent of the infants were low birthweight during the 2010-2017 period. While Patrick et al.'s study did not characterize the gestational age in their study, 16 percent of NAS infants in Delaware were preterm (<37 weeks of gestation), and 26 percent were small for gestational age (infants whose weight is less than the 10th percentile for gestation). Further, mothers who smoked cigarettes during pregnancy were almost 20 times more likely to have their infants be diagnosed with NAS, compared

to those who did not smoke (unadjusted OR: 20.9; 95% CI:18.7–23.3). According to Janson et al.,¹¹ “exposures such as cocaine, nicotine, serotonin reuptake inhibitors [SRIs], and polydrugs can potentiate the infant’s expression of opioid-induced NAS.” In the matched hospital discharge data and birth certificate data sample of the 1,624 infants diagnosed with NAS, 75 infants also had a diagnostic code for cocaine (760.75), and 122 infants had a diagnostic code for narcotics (760.72). Maternal cigarette use (adjusted OR = 18.2; 95%CI: 16.3-20.3), race and ethnicity (i.e., non-Hispanic white vs. other race and ethnicity AOR = 3.7; 95%CI: 2.3-5.8; non-Hispanic black vs. other race and ethnicity AOR = 1.5; 95%CI: 0.9-2.3; Hispanics vs. other race and ethnicity AOR = 1.6; 95%CI: 1.0-2.7), and having hepatitis C (AOR = 11.9; 95%CI: 9.4-15.2) had strong discriminatory power in predicting whether an infant was diagnosed with NAS or not.

Implications of findings and future steps

During 2010-2017, 1,701 cases of NAS were identified in Delaware using the hospital discharge data. The overall NAS rate for Delaware during 2010-2017 was 20.6 (95% CI: 19.6-21.6) per 1,000 births. Despite the fact the incidence of NAS increased 130 percent, from 12.0 cases per 1,000 births in 2010 to 27.6 cases per 1,000 births in 2016, there was a ten percent drop in the incidence of NAS from 27.6 cases per 1,000 births in 2016 to 24.7 cases per 1,000 births in 2017. In terms of financial burden, the overall median charges billed for a NAS newborn during 2010-2017 was approximately \$21,000 with an overall median length of stay of 14 days. This compares to a non-NAS newborn with a median cost of approximately \$3,100 and a median length of stay of two days. In addition, there was considerable variation in the length of stay in Delaware hospitals, providing opportunities for improvement as length of stay is a major driver for overall costs.

This updated brief from the previous 2010-2013 research brief¹² for Delaware has captured in detail the incidence of NAS among newborns and their maternal characteristics using hospital discharge data and matched vital records data. While this research brief highlights the incidence of NAS in Delaware newborns, it is difficult to estimate the ‘true incidence’ due to variability in reporting. For instance, administrative data sources such as the hospital discharge data and vital records data are limited due to variability in coding within and between hospitals, between years (i.e., changes from ICD-9-CM to ICD-10-CM). In addition, there is considerable lag in availability of hospital discharge data to rapidly assess trends. Although over 99 percent of the births in Delaware occur at hospitals, the NAS analyses is limited to hospital births. Approximately 99 percent of the hospital births were matched to birth certificate data that also provided additional insights to the maternal and newborn characteristics and the epidemiological risks of NAS in newborns. Maternal race and ethnicity, maternal cigarette use, and hepatitis C were the strongest predictors of mothers delivering NAS infants.

Suggested citation: Hussaini, SK. Neonatal abstinence syndrome: Delaware, 2010-2017. *Research Brief*. Delaware Department of Health and Social Services, Division of Public Health. Published June 2019.

¹¹ See footnote 3 of this research brief.

¹² Hussaini, SK. Neonatal abstinence syndrome: Delaware, 2010-2013. *Research Brief*. Delaware Department of Health and Social Services, Division of Public Health. Published May 2017.

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