

Neonatal abstinence syndrome

Delaware

2010 – 2015

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 2015 in Delaware, 1,172 cases of NAS were identified with an incidence of 18.6 cases per 1,000 births.
- ❖ The incidence of NAS increased 94 percent, from 11.9 cases per 1,000 births in 2010 to 23.0 cases per 1,000 births in 2015.
- ❖ Delaware's 2012 and 2013 NAS rates (17.8 and 18.5 cases per 1,000 births, respectively) were three times that of the 2012 U.S. rate (5.8 cases per 1,000 births).
- ❖ Median charges billed for a NAS newborn were approximately \$16,000 with a median length of stay of 11 days, nearly five times the cost and five times the stay of newborns without NAS.
- ❖ More active public health surveillance of NAS infants and mothers is needed to provide an accurate picture of the public health problem and to assess the impact of population-based and clinical interventions.

The Division of Public Health (DPH) is part of a federal technical assistance grant to build a system that prevents, recognizes, and treats substance exposure in infants. Working with the Delaware Healthy Mother and Infant Consortium, child welfare advocates, medical providers, substance abuse treatment providers, and multiple state agencies, DPH and others will be announcing a statewide plan to address this important issue in the coming months. To learn more, call 302-744-4704.



DELAWARE HEALTH AND SOCIAL SERVICES

Division of Public Health

Family Health Systems

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 used to assess opioid-induced withdrawal 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, 2010-2015 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)* diagnosis codes. The authors of this study utilized the Healthcare Cost and

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.

Utilization Project’s Kids’ Inpatient Database (KID) to identify newborns with NAS and the Nationwide Inpatient Sample (NIS) to identify mothers.

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

The identification of NAS cases was based on ICD-9-CM codes as described in the study by Patrick et al., using hospital discharge data for Delaware. The Division of Public Health (DPH) collects hospital discharge records for inpatients from all Delaware licensed hospitals. The data are collected by Delaware law (16 Del.C. Ch. 20, § 2001-2009) and include non-federal facilities. The records are collected quarterly based on the uniform claims and billing dataset (UB-82 or successor form) for all hospital inpatient discharges. The data include hospital births from Bayhealth, Beebe, Christiana Care, Nanticoke, and St. Francis.

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. Incidence is expressed per 1,000 births for any given year (e.g., denominators for 2010 were comprised of all 2010 hospital births). In addition to enumerating the NAS cases from hospital discharge data, all hospital births were matched to birth certificate data for the 2010-2015 period using a similar methodology noted in a previous brief.⁵

Neonatal abstinence syndrome (NAS) in Delaware

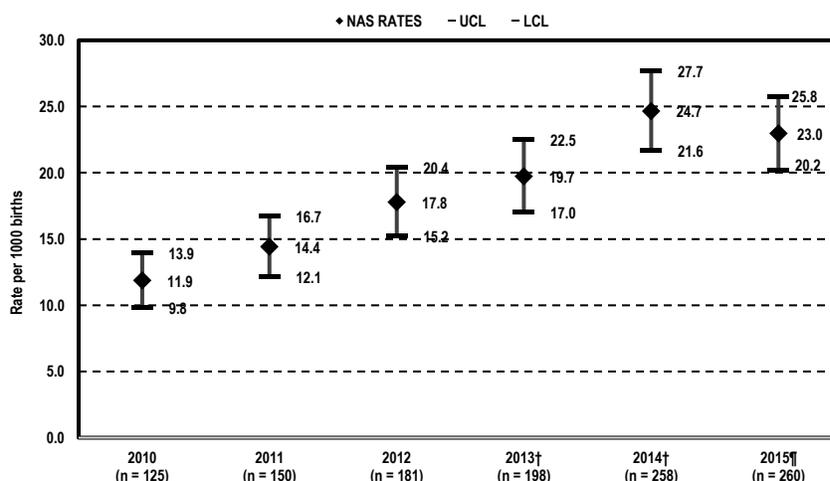
There were 1,172 cases of NAS identified in Delaware during 2010-2015 (Figure 3). The overall NAS rate for Delaware during 2010-2015 was 18.6 (95% CI: 17.6–19.7) per 1,000 births. A notable increase (~94 percent) in

Figure 2. Estimating the incidence of Neonatal abstinence syndrome²

NAS (numerator): The number of newborns in Delaware during 2010-2015 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 2010-2015.

Figure 3. Neonatal Abstinence Syndrome Rates for 2010-2015 with 95% Confidence Intervals



Source: Delaware Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2015.
²Rates 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 data contains ICD-9-CM and ICD-10-CM changes and may be an underestimate.

⁵ Hussaini, SK. Neonatal abstinence syndrome: Delaware, 2010-2013. *Research Brief*. Delaware 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

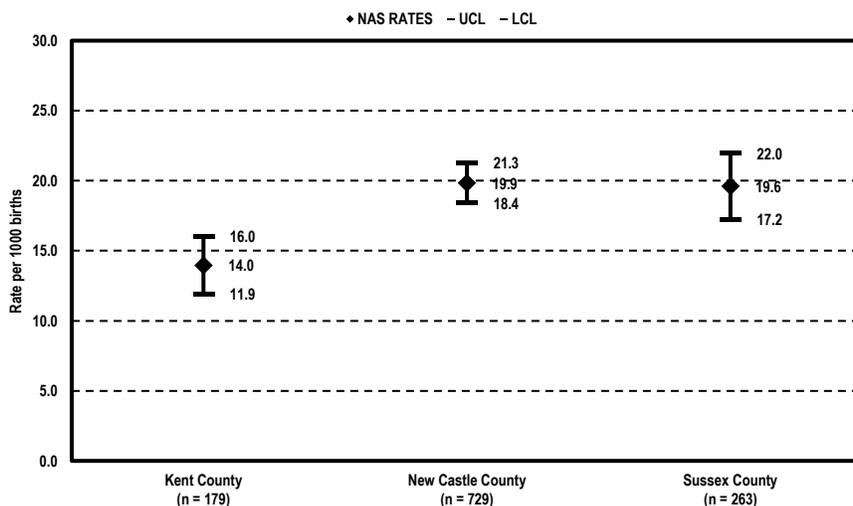
NAS rates occurred, from 11.9 per 1,000 births in 2010 to 23.0 per 1,000 births in 2015.

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.”⁶ The U.S. rate for the most recent data available for 2012 was 5.8 per 1,000 births per year.⁷ Delaware’s 2012 and the six-year average (i.e., 2010-2015) NAS rates were three times that of the 2013 U.S. rate. It is important to note that changes in the ICD-9-CM to ICD-10-CM in October of 2015 may have resulted in underreporting of NAS in 2015, which shows a decline. However, 2016 data will provide a better overview if indeed there is a declining trend in NAS rates.

Figure 4 displays the overall NAS rates for Delaware by county and Figure 5 displays NAS rates for Delaware by year. Although the overall rate of NAS was highest in New Castle County during the six-year period (19.9 cases per 1,000 births; 95% CI:18.4–21.3), the Sussex County NAS rate surpassed the New Castle County NAS rate during 2014 and 2015 (Figure 5).

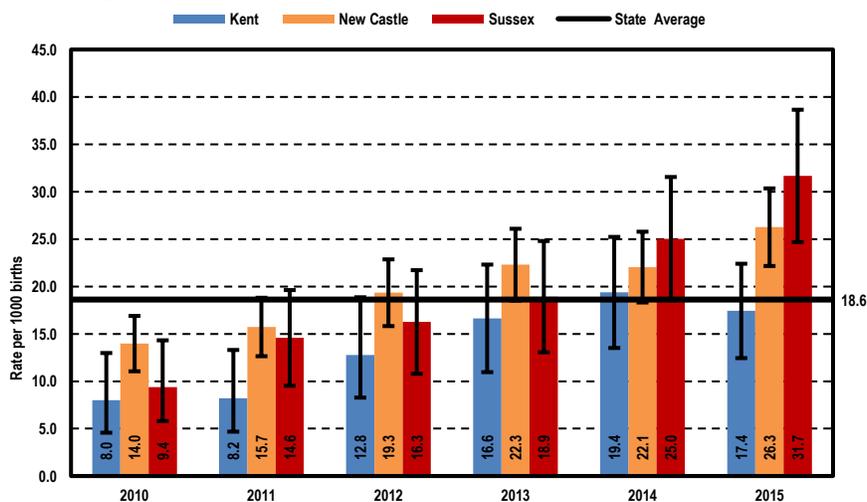
To further identify the sub-county level NAS cases, a ZIP Code Tabulation Areas

Figure 4. Neonatal Abstinence Syndrome Rates for 2010-2015 with 95% Confidence Intervals



Source: Delaware Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2015. *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 data contains ICD-9-CM and ICD-10-CM changes and may be an underestimate. 6

Figure 5. Neonatal Abstinence Syndrome Rates for 2010-2015 with 95% Confidence Intervals



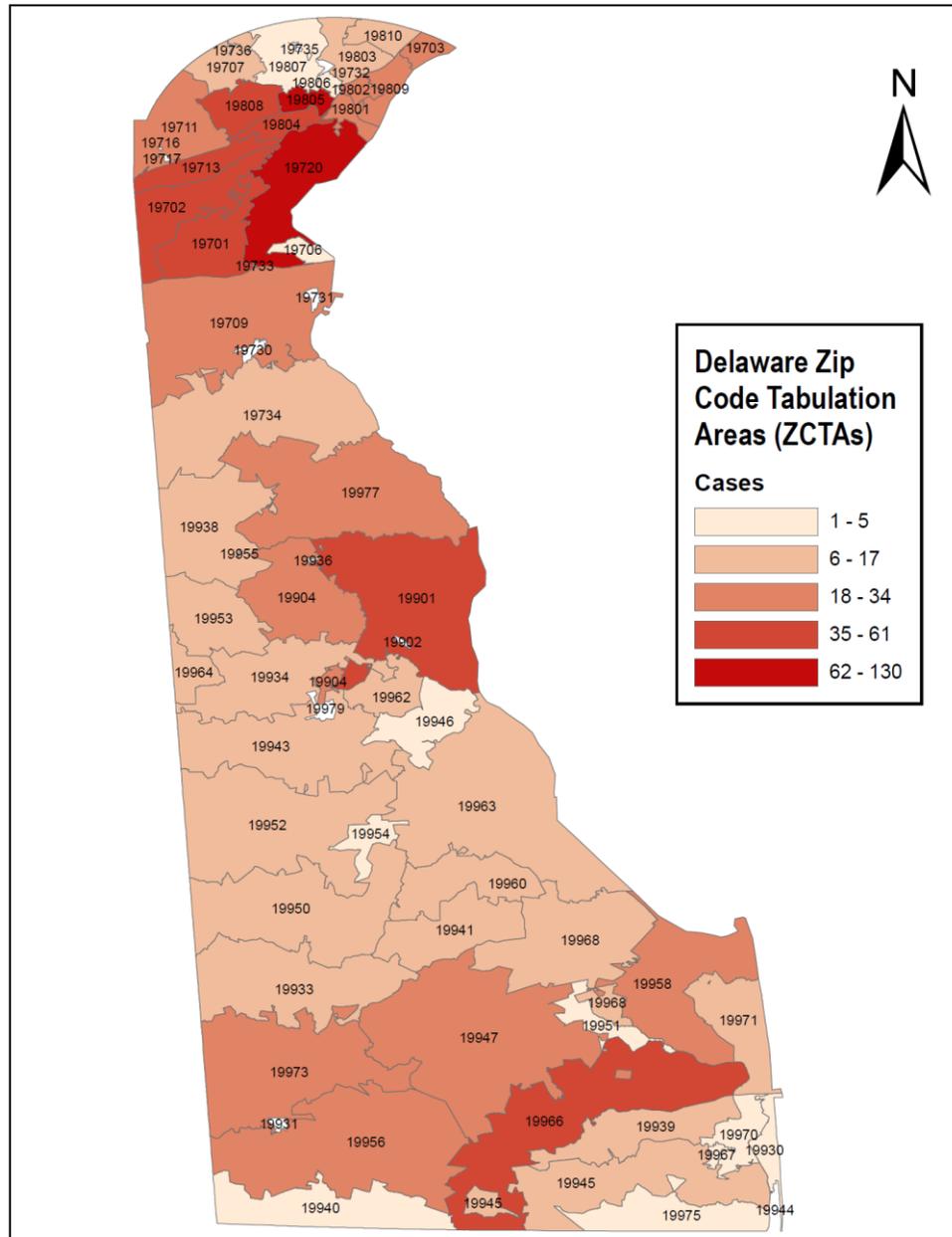
Source: Delaware Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2015. *Rates are presented with 95% confidence intervals; UCL = upper confidence limit; LCL = lower confidence limit. †2013 and 2014 data were revised due to updated records for 2013 and 2014 in Hospital Discharge Data. ‡2015 data contains ICD-9-CM and ICD-10-CM changes and may be an underestimate. 6

⁶ 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.

⁷ Patrick SW, Davis MM, Lehmann CU, et al. *J Perinatol*. 2015 Aug; 35(8):650-5.

(ZCTAs) data map for NAS cases was developed for the 2010-2015 period (Figure 6). Darker shades in the map represent higher number of NAS cases during the six-year period. ZCTAs 19805 and 19720 had NAS cases ranging from 62 to 130 during 2010-2015.

Figure 6. Neonatal Abstinence Syndrome (NAS) cases by ZIP Code Tabulation Areas (ZCTAs) in Delaware, 2010-2015



Source: Delaware Health and Social Services, Division of Public Health, Delaware Health Statistics Center, Hospital Discharge and Vital Records Data, 2010-2015.

Table 1 provides an overview of the characteristics of NAS infants in Delaware during 2010-2015 using Hospital Discharge Data as the data source. NAS infants were more likely to experience respiratory distress (7 percent) as compared to non-NAS infants (~3 percent); were more likely to be on Medicaid (71 percent); were more likely to be white (81 percent); more likely to have a longer length of stay (median = 11.0 days; IQR = 14 days) as compared to non-NAS infants (median = 2.0 days; IQR = 1 day); and more likely to have higher billed charges (median = \$16,636; IQR = \$23,872) as compared to non-NAS infants (median = \$2,943; IQR = \$2,543).

Table 1. Characteristics of newborns diagnosed with neonatal abstinence syndrome (NAS) in Delaware, 2010-2015.

Characteristics	Total (N = 62,953)	
	Neonatal Abstinence Syndrome (NAS) (N = 1,172)	All other hospital births in Delaware (N = 61,781)
Gender (Male)	636 (54.3%)	31,409 (50.8%)
Clinical conditions		
Respiratory diagnoses	82 (7%)	1,882 (3%)
Seizures	7 (1%)	103 (0%)
Insurance Status		
Medicaid	830 (71%)	27,967 (45%)
Private payers	63 (5%)	19,744 (32%)
Other	14 (1%)	2,666 (4%)
Unknown	265 (23%)	11,404 (18%)
Race and Ethnicity		
White	945 (81%)	33,054 (54%)
African American or Black	149 (13%)	16,933 (27%)
Other	69 (6%)	10,375 (17%)
Unknown/Refused	9 (1%)	1,419 (2%)
Median charges in dollars (IQR)	\$16,636 (\$23,072)	\$2,943 (\$2,543)
Median length of stay in days (IQR)	11.0 (14.0)	2.0 (1.0)

Source: Delaware Health and Social Services, Division of Public Health, Hospital Discharge Data, 2010-2015.

[†]Median charges are billed charges and not costs reimbursed with interquartile range (IQR).

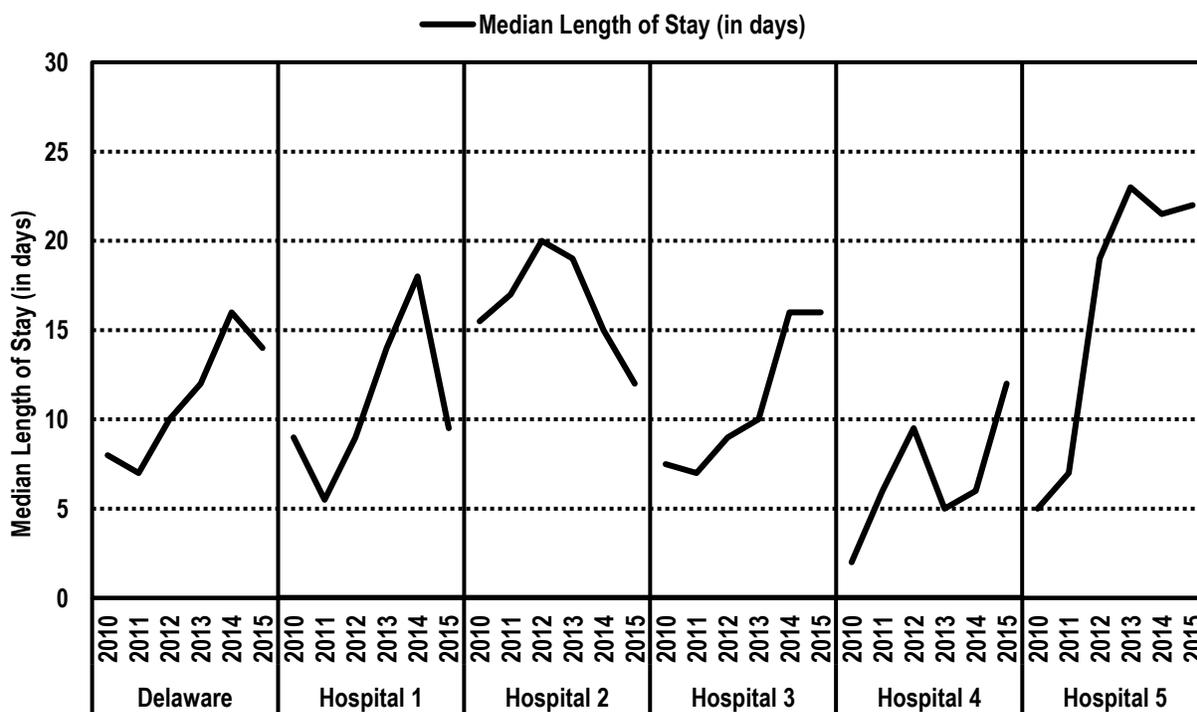
[‡]Median length of stay is the difference between date of discharge and date of admission.

While recent evidence suggests that observing opioid-exposed neonates for five days is adequate, the American Academy of Pediatrics (AAP) recommends that opioid-exposed neonates be observed for three to seven days before discharge. The differences in recommendation are perhaps due to the fact that NAS neonates are at an increased risk for re-admission. As Patrick et al. note, "...when compared with

uncomplicated term infants, infants diagnosed with NAS were more than twice as likely to be readmitted to the hospital.”⁸

Most characteristics of the newborns diagnosed with NAS were different from those of Patrick et al.’s study on NAS except the distribution of males and females. Consistent with Patrick et al.’s study, males were more likely to be diagnosed with NAS (~56 percent) than females (~44 percent). The differences in Delaware estimates and the U.S. estimates were specific to respiratory distress, which was 8 percent in Delaware and 31 percent in the U.S. Similarly, Delaware’s estimate for seizures was less than 1 percent compared to 2 percent in the U.S. There were no indications of feeding difficulties in Delaware’s estimate, while the U.S. estimate was 18 percent. The median length of stay was approximately 11 days in Delaware and lower compared to the average length of stay in the U.S. (~16 days). The differences in some characteristics are perhaps related to geographic variability as well as variability in the quality of ICD-9-CM data coding. Although, median length of stay increased during 2010 to 2015, it is evident that there is considerable variation in the length of stay between hospitals for NAS (Figure 7).

Figure 7. Length of Stay for Neonatal Abstinence Syndrome (NAS) cases, in Delaware by Hospital, 2010-2015



Source: Delaware Health and Social Services, Division of Public Health, Hospital Discharge Data, 2010-2015.

⁸ Patrick SW, Burke JF, Biel TJ, Auger KA, Goyal NK, Cooper WO. Risk of Hospital Readmission Among Infants With Neonatal Abstinence Syndrome. *Hosp Pediatr.* 2015 Oct; 5(10): 513–519

Mother and infant characteristics of NAS in Delaware

The matched hospital discharge and vital birth record datasets containing singleton births was utilized to further examine the newborn as well as maternal characteristics. With the exception of 2015 data, over 90 percent of the total NAS cases (n = 1,052) for singleton deliveries was available for analyses for 2010-2015 period. There were notable differences in maternal characteristics of NAS and non-NAS infants (Tables 2 and 3).

Table 2. Characteristics of women delivering singleton infants with neonatal abstinence syndrome (NAS) in Delaware, 2010-2015.

Maternal and newborn characteristics for singleton births [¶]	Total (N = 58,988)	
	Neonatal Abstinence Syndrome (NAS) (N = 1,052)	All other hospital births in Delaware [†] (N = 57,936)
Maternal Age		
Less Than 15 years	0 (0%)	54 (0.1%)
15-19 years	25 (2.4%)	4,228 (7.3%)
20-24 years	284 (27%)	13,334 (23%)
25-29 years	383 (36.4%)	16,857 (29.1%)
30-34 years	269 (25.6%)	15,169 (26.2%)
35-39 years	77 (7.3%)	6,767 (11.7%)
40-44 years	13 (1.2%)	1,441 (2.5%)
45+ years	1 (0.1%)	86 (0.1%)
Maternal Insurance Status		
Medicaid	874 (83.1%)	28,598 (49.4%)
Private payers	146 (13.9%)	26,799 (46.3%)
Other	30 (2.9%)	2,421 (4.2%)
Unknown/Refused	2 (0.2%)	118 (0.2%)
Maternal Race and Ethnicity		
White	874 (83.1%)	30,511 (52.7%)
African American or Black	124 (11.8%)	15,834 (27.3%)
Hispanic	40 (3.8%)	8,102 (14%)
Other	13 (1.2%)	3,469 (6%)
Unknown/Refused	1 (0.1%)	16 (0.0%)

Table 2 contd/.

Maternal characteristics for singleton births [¶]	Total (N = 58,988)	
	Neonatal Abstinence Syndrome (NAS) (N = 1,052)	All other hospital births in Delaware [†] (N = 57,936)
Maternal Education		
< 9 years of schooling	30 (2.9%)	3,276 (5.7%)
9-11 years of schooling	254 (24.1%)	7,793 (13.5%)
High school graduate	450 (42.8%)	14,622 (25.2%)
1-3 years of college	273 (26%)	15,469 (26.7%)
> 3 college graduate	32 (3%)	16,442 (28.4%)
Unknown/Refused	13 (1.2%)	334 (0.6%)
Maternal County of Residence		
Kent	170 (16.2%)	11,863 (20.5%)
New Castle	660 (62.7%)	34,510 (59.6%)
Sussex	222 (21.1%)	11,563 (20%)
Prenatal Care		
No prenatal care	82 (7.8%)	1,416 (2.4%)
First Trimester	642 (61%)	43,587 (75.2%)
Second Trimester	236 (22.4%)	9,510 (16.4%)
Third Trimester	64 (6.1%)	2,548 (4.4%)
Unknown/Refused	28 (2.7%)	8,75 (1.5%)
Maternal comorbidities		
Pre-pregnancy weight		
Underweight	71 (6.7%)	2,549 (4.4%)
Normal weight	517 (49.1%)	24,721 (42.7%)
Overweight	267 (25.4%)	14,835 (25.6%)
Class I Obesity	99 (9.4%)	7,836 (13.5%)
Class II Obesity	42 (4%)	3,810 (6.6%)
Class III Obesity	30 (2.9%)	3,230 (5.6%)
Unknown/Refused	26 (2.5%)	955 (1.6%)
Cigarette Use		
Smoked during pregnancy	737 (70.1%)	6,223 (10.7%)
Hepatitis		
Hepatitis C	98 (9.3%)	147 (0.3%)

Source: Delaware Health and Social Services, Division of Public Health, Hospital Discharge Data, Vital Records Data, 2010-2015

[¶]Data for singleton births obtained from birth certificate data for 2010-2015

Table 3. Newborn characteristics (singletons) with neonatal abstinence syndrome (NAS) in Delaware, 2010-2015.

Maternal and newborn characteristics for singleton births [†]	Total (N = 58,988)	
	Neonatal Abstinence Syndrome (NAS) (N = 1,052)	All other hospital births in Delaware [†] (N = 57,936)
Infant outcomes		
Low birth weight	202 (19.2%)	3,944 (6.8%)
Preterm birth	203 (19.3%)	6,152 (10.6%)
Small for gestational age	274 (26%)	7,061 (12.2%)

Source: Delaware Health and Social Services, Division of Public Health, Hospital Discharge Data, Vital Records Data, 2010-2015

[†]Data for singleton births obtained from birth certificate data for 2010-2015

Consistent with Patrick et al.'s study, 19 percent of the infants were low birthweight during the 2010-2015 period. While Patrick et al.'s did not characterize the gestational age in their study, 19 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: 19.9; 95% CI:17.4–22.8). According to Janson et al.,⁹ “exposures such as cocaine, nicotine, [serotonin reuptake inhibitors] SRIs, and polydrugs can potentiate the infant's expression of opioid-induced NAS.” In the hospital discharge data sample of the 1,052 infants diagnosed with NAS, 26 infants also had a diagnostic code for cocaine (760.75), and 51 infants had a diagnostic code for narcotics (760.72).

Implications of findings and future steps

The overall NAS rate for Delaware during 2010-2015 was 18.6 (95% CI: 17.6–19.7) per 1,000 births. A notable increase (~94 percent) in NAS rates occurred, from 11.9 per 1,000 births in 2010 to 23.0 per 1,000 births in 2015. During 2010-2015, 1,172 cases of NAS were identified in Delaware using the hospital discharge data with an incidence rate of 18.6 (95% CI: 17.6–19.7) per 1,000 births, which is three times higher than the U.S. rate of 5.8 cases per 1,000 births. One of the major findings of this research brief is that there was a significant increase (~94 percent) in NAS rates, from 11.9 per 1,000 births in 2010 to 23.0 per 1,000 births in 2015. In terms of financial burden, the median charges billed for a NAS newborn were approximately \$17,000 with a median length of stay of 11 days. This compares to a non-NAS newborn with

⁹ See footnote 3 of this research brief.

a median cost of approximately \$3,000 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. Another major finding is that NAS rates in Sussex County surpassed the New Castle County rates in 2014 and 2015.

This updated brief from the previous 2010-2013 research brief¹⁰ 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 and there is considerable lag in availability of these data to rapidly assess trends. In addition, the number of records in the Hospital Discharge Data for inpatient hospital births has varied considerably over the years, making it difficult to match them to vital records data. To adequately capture the incidence and obtain more current information, active surveillance of drug-exposed infants and mothers is needed. This will enable a better understanding of the epidemiological risks of drug exposures in newborns and enable detailed analyses of maternal characteristics.

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¹⁰ Hussaini, SK. Neonatal abstinence syndrome: Delaware, 2010-2013. Research Brief. Delaware Health and Social Services, Division of Public Health. Published May 2017.