

# Neonatal Abstinence Syndrome, Michigan, 2010 – 2015

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This presentation provides information about the study of neonatal abstinence syndrome in the State of Michigan, 2010-2015.

This presentation was prepared by the Michigan Department of Health and Human Services (MDHHS) Maternal and Child Health Epidemiology Section

Data source: Michigan Resident Live Birth Files Linked with Michigan Hospital Discharge Data (12/3/2018), Division for Vital Records and Health Statistics, MDHHS

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## Background

- Neonatal abstinence syndrome (NAS) is greatly associated with opioid use in pregnancy and is an emerging public health concern, with recent studies documenting a substantial increase in the rate of U.S. infants diagnosed.<sup>1-5</sup>
- NAS risk is greatest with maternal usage of opioids analgesics and heroin<sup>2,6</sup>; however, prenatal usage of non-narcotic drugs can cause similar NAS.<sup>1</sup>
- NAS infants are more likely to be born preterm<sup>4</sup>; be admitted to a neonatal intensive care unit (NICU)<sup>7</sup>; and need longer hospitalization (measured as length of stay [LOS])<sup>2-5</sup>.
- Little information is available that quantifies the additional LOS of NAS infants compared to other infants after controlling for maternal and infant factors.<sup>4,8</sup>

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This slide details the background of the study that was conducted. This study is an update from the study of Hekman et al. (2013) using the data from 2010 to 2015.

## Objective & Hypothesis

- Objective:
  - This project will examine the diagnosis of treated neonatal abstinence syndrome among Michigan infants from 2010-2015 and hospital length of stay between infants with and without the syndrome.
  - This study is an update of the Hekman et al. (2013)\* study using the Michigan data from 2010 to 2015.
- Hypothesis:
  - Treated neonatal abstinence syndrome infants have a longer hospital length of stay than infants without the syndrome after controlling for maternal and infant factors.

\* Hekman KA, Grigorescu VI, Cameron LL, Miller CE, Smith RA. Neonatal withdrawal syndrome, Michigan, 2000-2009. *Am J Prev Med.* 2013;45(1):113-117.  
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This slide details the objective and hypothesis of this study.

## Methods: Study Population and Data Source

- A population-based retrospective cohort study was conducted using Michigan live birth records from 2010-2015 linked with hospital discharge data for infants born to Michigan resident mothers.
- Hospital discharge data contained discharge diagnosis records for all Michigan short-stay hospitals and hospitals in contiguous areas of Ohio, Indiana, Wisconsin and other states.
- Live birth certificate data were linked with hospital discharge records by probabilistic, followed by deterministic, linkages performed for maternal and infant files.
- Overall, 98% of birth certificate records are matched with their corresponding hospital discharge newborn records.

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This slide details the study population and data source of this study.

## Methods: Measures

- Live birth certificate records provided the following data: maternal age; maternal race; education; tobacco use during pregnancy; Kotelchuck index; payment source; marital status; gestational diabetes during pregnancy; gestational hypertension during pregnancy; infant year of birth; gender; Caesarean-section delivery; birthweight; and estimated gestational weeks.
- Hospital discharge data provided infant LOS (measured in days) and NICU usage.
- Infants with treated NAS were identified by any diagnosis of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code of 779.5 (drug withdrawal syndrome in newborn) or Tenth Revision (ICD-10-CM) diagnosis code of P96.1 (neonatal withdrawal symptoms from maternal use of drugs of addiction).

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This slide details the measures that were used in this study.

## Methods: Statistical Analysis

- Maternal and infant demographic and health outcome differences were measured between infants with and without treated NAS using percentages (crude rate per 100) and 95% confidence intervals (95% CIs).
- Multivariable regression models were constructed to examine the adjusted impact of treated NAS diagnosis on infant hospital length of stay and fit using negative binomial distribution.
- Potential covariates were included based on possible associations with both treated NAS and infant LOS:
  - Maternal race; Caesarean-section delivery; low birthweight; marital status; insurance type; inadequate Kotelchuck index; smoking; gestational diabetes during pregnancy; and gestational hypertension during pregnancy.
- Adjusted incidence rate ratios (IRRs) and 95% CIs were calculated using SAS, version 9.4.

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This slide details the statistical analyses that were used in this study.

# Results

Table 1. Sample size in the Michigan live birth files and MIDB linked files (2010-2015)

Birth Year	Live Birth File (Michigan Residents)	Live Birth & MIDB Linked File	Live Birth & MIDB Linked File (Michigan Residents)	Study Sample	% Matched	Infants with Treated NAS
2010	114,717	119,753	119,317	112,805	98.3	478
2011	114,159	118,849	118,399	112,153	98.2	660
2012	112,708	117,309	116,914	110,642	98.2	716
2013	113,732	117,431	116,986	111,244	97.8	843
2014	114,460	117,806	117,349	111,832	97.7	948
2015	113,211	116,894	116,487	110,590	97.7	959
Total	682,987	708,042	705,452	669,266	98.0	4,604

MIDB, Michigan Inpatient Hospital Database; NAS, neonatal abstinence syndrome.

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This slide shows the sample size for the Michigan live birth files and Michigan Inpatient Hospital Database (MIDB) linked files from 2010-2015.

Within the 2010 birth year, there were 114,717 live births born to Michigan resident women. Among the 119,753 live births linked with MIDB files, 119,317 live births were born to Michigan resident women. After excluding multiple hospitalizations, there were 112,805 infants included in the study. So 98.3% of birth certificate records were matched with their corresponding hospital discharge newborn records. In 2010, 478 infants were diagnosed with treated neonatal abstinence syndrome (NAS).

Within the 2011 birth year, there were 114,159 live births born to Michigan resident women. Among the 118,849 live births linked with MIDB files, 118,399 live births were born to Michigan resident women. After excluding multiple hospitalizations, there were 112,153 infants included in the study. So 98.2% of birth certificate records were matched with their corresponding hospital discharge newborn records. In 2011, 660 infants were diagnosed with treated NAS.

Within the 2012 birth year, there were 112,708 live births born to Michigan resident women. Among the 117,309 live births linked with MIDB files, 116,914 live births were

born to Michigan resident women. After excluding multiple hospitalizations, there were 110,642 infants included in the study. So 98.2% of birth certificate records were matched with their corresponding hospital discharge newborn records. In 2012, 716 infants were diagnosed with treated NAS.

Within the 2013 birth year, there were 113,732 live births born to Michigan resident women. Among the 117,431 live births linked with MIDB files, 116,986 live births were born to Michigan resident women. After excluding multiple hospitalizations, there were 111,244 infants included in the study. So 97.8% of birth certificate records were matched with their corresponding hospital discharge newborn records. In 2013, 843 infants were diagnosed with treated NAS.

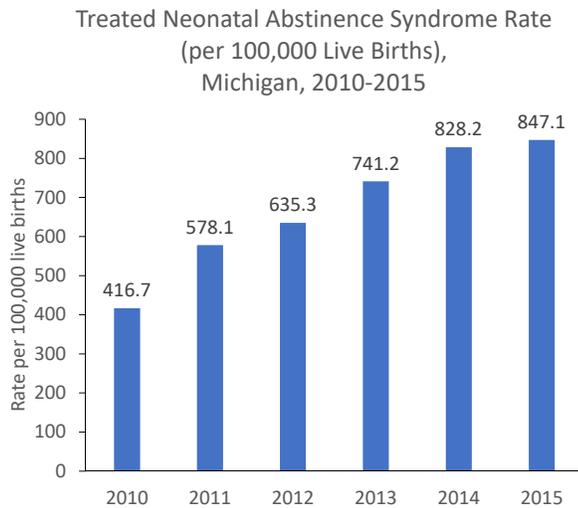
Within the 2014 birth year, there were 114,460 live births born to Michigan resident women. Among the 117,806 live births linked with MIDB files, 117,349 live births were born to Michigan resident women. After excluding multiple hospitalizations, there were 111,832 infants included in the study. So 97.7% of birth certificate records were matched with their corresponding hospital discharge newborn records. In 2014, 948 infants were diagnosed with treated NAS.

Within the 2015 birth year, there were 113,211 live births born to Michigan resident women. Among the 116,894 live births linked with MIDB files, 116,487 live births were born to Michigan resident women. After excluding multiple hospitalizations, there were 110,590 infants included in the study. So 97.7% of birth certificate records were matched with their corresponding hospital discharge newborn records. In 2015, 959 infants were diagnosed with treated NAS.

For all six birth years (2010-2015), there were 682,987 live births born to Michigan resident women. Among the 708,042 live births linked with MIDB files, 705,452 live births were born to Michigan resident women. After excluding multiple hospitalizations, there were 669,266 infants included in the study. So 98.0% of birth certificate records were matched with their corresponding hospital discharge newborn records. In 2010-2015, 4,604 infants were diagnosed with treated NAS.

## Results

- Treated NAS was identified by any diagnosis of ICD-9 (779.5) or ICD-10 (P96.1).
- From 2010 to 2015, the overall birth rate of infants with treated NAS increased from 416.7 to 847.1 per 100,000 live births.



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This slide shows the treated neonatal abstinence syndrome (NAS) rate (per 100,000 live births) in the State of Michigan, 2010-2015.

Treated NAS was identified by any diagnosis of ICD-9 (779.5) or ICD-10 (P96.1).

From 2010 to 2015, the overall rate of infants with treated NAS increased from 416.7 to 847.1 per 100,000 live births. The treated NAS rate was 416.7 per 100,000 live births in 2010; 578.1 per 100,000 live births in 2011; 635.3 per 100,000 live births in 2012; 741.2 per 100,000 live births in 2013; 828.2 per 100,000 live births in 2014; and 847.1 per 100,000 live births in 2015.

## Results

- Comparisons of infant and maternal characteristics and health outcomes for infants with and without treated NAS for the state of Michigan, 2010-2015, are shown in Table 2.
- Compared to infants without NAS, treated NAS infants were more likely to be male, have Medicaid as their hospital payment source, have Caesarean-section delivered, be low birthweight, be premature or have NICU admission.
- Compared to mothers whose infants were not diagnosed treated NAS, mothers of treated NAS infants were more likely to be white, have less than high school education, have smoked during pregnancy, have an inadequate Kotelchuck index, or be unmarried. Mothers of treated NAS infants were less likely to be black or other race, be <21 years old, have gestational diabetes during pregnancy, or have gestational hypertension during pregnancy.

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This slide shows some additional results from this study.

# Results

Table 2. Comparisons of infant and maternal characteristics by treated neonatal abstinence syndrome diagnosis, Michigan, 2010-2015

	Infants with Treated NAS (n=4,604)*			Infants without Treated NAS (n=664,662)*			P-value
	N	%	95% CI	N	%	95% CI	
<b>Infant demographics/ outcomes</b>							
Male	2,473	53.7	(52.3, 55.2)	340,242	51.2	(51.1, 51.3)	<0.05
Mode of delivery Caesarean-section	1,882	40.9	(39.5, 42.3)	217,908	32.8	(32.7, 32.9)	<0.05
Low birthweight (<2500 g)	1,081	23.5	(22.3, 24.7)	55,045	8.3	(8.2, 8.4)	<0.05
Premature (<37 weeks)	985	21.5	(20.3, 22.7)	65,296	9.8	(9.8, 9.9)	<0.05
NICU admission	667	28.3	(26.4, 30.3)	18,648	5.5	(5.4, 5.6)	<0.05
<b>Maternal demographics/health variables</b>							
White	3,939	85.6	(84.6, 86.6)	483,607	72.9	(72.8, 73.1)	<0.05
Black	454	9.9	(9.0, 10.7)	125,608	19.0	(18.9, 19.0)	<0.05
Other race	202	4.4	(3.8, 5.0)	53,166	8.0	(8.0, 8.1)	<0.05
Medicaid hospital payment source	3,539	77.4	(76.2, 78.6)	294,341	44.4	(44.3, 44.5)	<0.05
<High school graduate	1,176	26.0	(24.7, 27.3)	88,256	13.4	(13.3, 13.4)	<0.05
Age at delivery <21 years	230	5.0	(4.4, 5.6)	78,532	11.8	(11.7, 11.9)	<0.05
Unmarried	3,451	75.1	(73.8, 76.3)	283,521	42.7	(42.6, 42.8)	<0.05
Inadequate Kotelchuck index	1,579	36.7	(35.2, 38.1)	82,823	13.1	(13.0, 13.2)	<0.05
Smoking during pregnancy	3,427	75.4	(74.1, 76.6)	138,087	20.9	(20.8, 21.0)	<0.05
Gestational diabetes during pregnancy	154	3.4	(2.9, 3.9)	34,074	5.2	(5.1, 5.2)	<0.05
Gestational hypertension during pregnancy	196	4.3	(3.7, 4.9)	34,224	5.2	(5.1, 5.2)	<0.05

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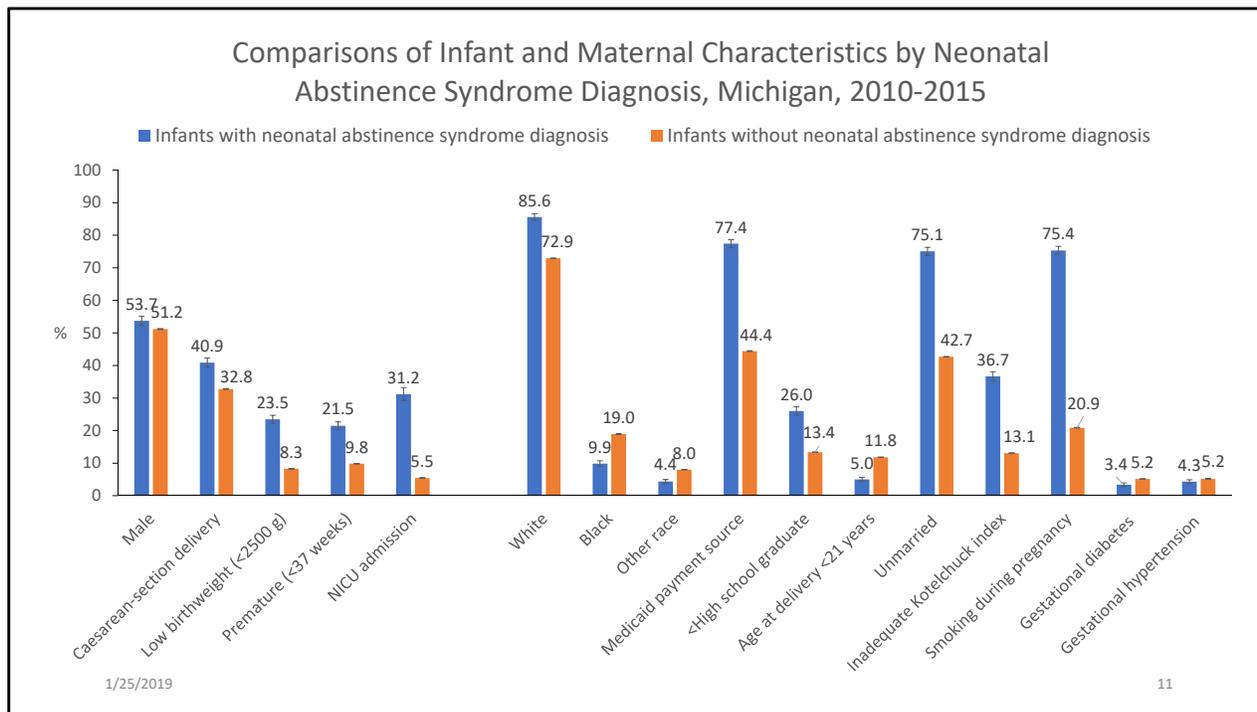
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\*In all calculations for percentages, missing values were excluded from the calculation in both the numerator and denominator. NAS, neonatal abstinence syndrome. NICU, neonatal intensive care unit.

This slide shows the comparisons of infant and maternal characteristics and health outcomes by treated neonatal abstinence syndrome (NAS) diagnosis for the State of Michigan, 2010-2015.

Compared to infants without treated NAS, treated NAS infants were more likely to be male (53.7% vs. 51.2%), Caesarean-section delivered (40.9% vs. 32.8%), low birthweight (23.5% vs. 8.3%), premature (21.5% vs. 9.8%), and have NICU admission (28.3% vs. 5.5%). The p-values for all tests of differences in the percentage of specific variable between infants with treated NAS and infants without treated NAS were <0.05.

Mothers of treated NAS infants were more likely to be white (85.6% vs. 72.9%), have Medicaid insurance (77.4% vs. 44.4%), have less than high school education (26.0% vs. 13.4%), smoke during pregnancy (33.5% vs. 14.9%), have inadequate Kotelchuck index (36.7% vs. 13.1%), be unmarried (75.1% vs. 42.7%), and were less likely to be black (9.9% vs. 19.0%) or other race (4.4% vs. 8.0%), <21 years old (5.0% vs. 11.8%), have gestational diabetes during pregnancy (3.4% vs. 5.2%), and have gestational hypertension during pregnancy (4.3% vs. 5.2%), compared to mothers whose infants were not diagnosed treated NAS. The p-values for all tests of differences in the percentage of specific variable between infants with treated NAS and infants without treated NAS were <0.05.



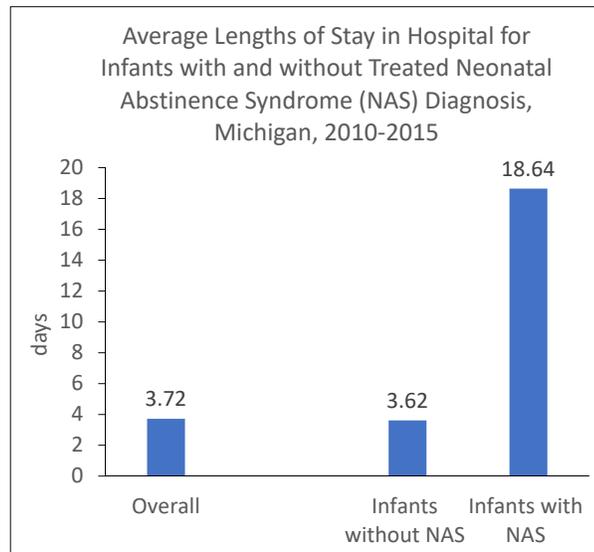
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Compared to mothers whose infants were not diagnosed treated NAS, mothers of treated NAS infants were more likely to be white (85.6% vs. 72.9%), have Medicaid insurance (77.4% vs. 44.4%), have less than high school education (26.0% vs. 13.4%), have smoked during pregnancy (33.5% vs. 14.9%), have an inadequate Kotelchuck index (36.7% vs. 13.1%), or be unmarried (75.1% vs. 42.7%). Mothers of treated NAS infants were less likely to be black (9.9% vs. 19.0%) or other race (4.4% vs. 8.0%), be <21 years old (5.0% vs. 11.8%), have gestational diabetes during pregnancy (3.4% vs. 5.2%), or have gestational hypertension during pregnancy (4.3% vs. 5.2%).

## Results

The average hospital LOS for those with treated NAS was 5.15 times longer than that for infants without treated NAS (95% CI=5.02, 5.29).



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This slide shows the average hospital length of stay (LOS) for infants with and without treated neonatal abstinence syndrome (NAS) diagnosis for the State of Michigan, 2010-2015.

From 2010 to 2015, the average hospital LOS for all infants in the State of Michigan was 3.72 days.

The average hospital LOS for infants without NAS was 3.62 days, however, the average hospital LOS for those with treated NAS was 18.64 days.

The average hospital LOS for those with treated NAS was 5.15 times longer than that for infants without NAS (95% CI=5.02, 5.29).

# Results

Table 3. Unadjusted and adjusted incidence rate ratios of hospital length of stay for infants with treated neonatal abstinence syndrome, Michigan, 2010-2015

	Unadjusted			Adjusted *		
	IRR	95% CI		IRR	95% CI	
<b>Overall</b>	5.15	5.02	5.29	5.54	5.43	5.65
<b>Maternal Race</b>						
White	5.34	5.19	5.49	5.56	5.45	5.68
Black	4.69	4.27	5.15	4.87	4.53	5.23
Other race	6.73	6.00	7.55	6.24	5.70	6.84
<b>Mode of delivery Caesarean-section</b>						
No	6.81	6.61	7.02	6.62	6.46	6.79
Yes	3.48	3.33	3.63	4.07	3.94	4.20
<b>Low Birthweight</b>						
No	7.05	6.94	7.17	6.86	6.74	6.97
Yes	1.40	1.30	1.51	1.59	1.47	1.72
<b>Gestational diabetes during pregnancy</b>						
No	5.22	5.08	5.37	5.56	5.44	5.67
Yes	4.05	3.50	4.70	5.13	4.60	5.72

N=669,266. The referent is infants without neonatal abstinence syndrome.

\*Adjusted for maternal race(white, black, other); Caesarean-section delivery; low birthweight; inadequate Kotelchuck index; maternal smoking during pregnancy; Medicaid; marital status; gestational diabetes during pregnancy; and gestational hypertension during pregnancy.

IRR=Incidence rate ratio; 95% CI=95% Confidence interval.

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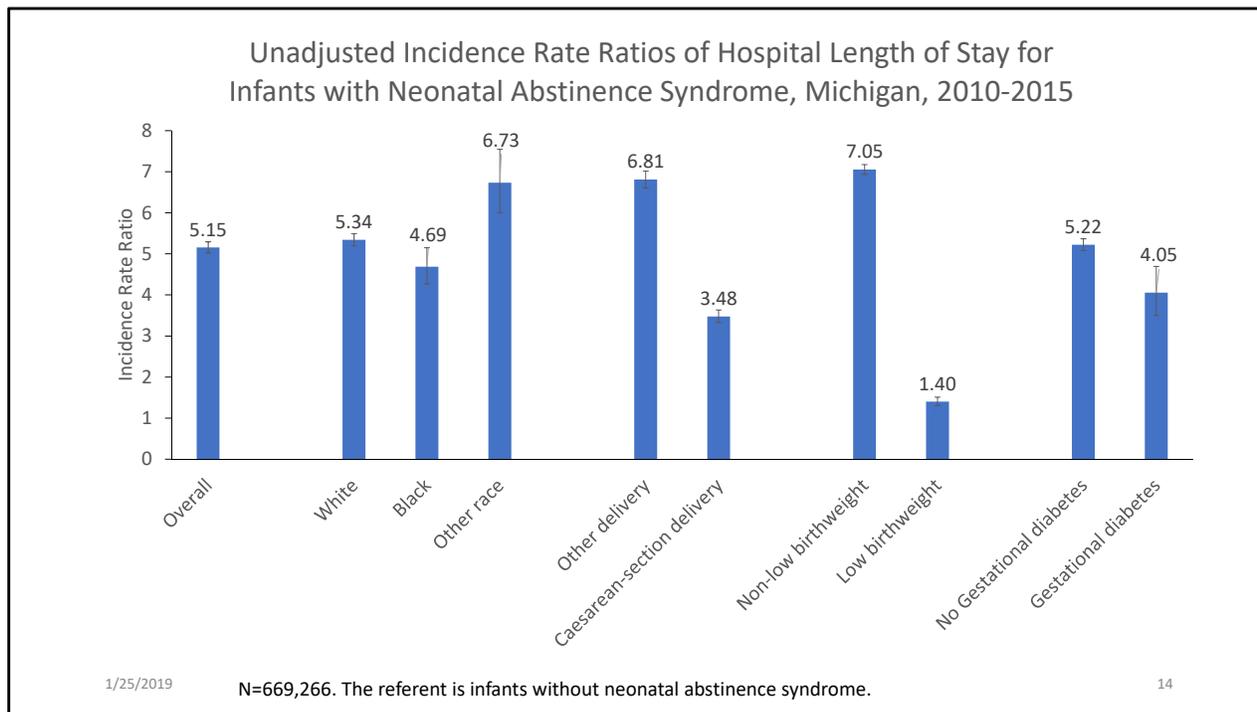
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This slide shows the unadjusted and adjusted incidence rate ratios (IRRs) of infant hospital length of stay (LOS) for interactions between treated neonatal abstinence syndrome (NAS) status and maternal race, mode of delivery, low birthweight, and parents acknowledged on birth certificate for the State of Michigan, 2010-2015.

In the unadjusted model, the average LOS of treated NAS infants was **5.15** times longer than that of infants without NAS (95% CI=5.02, 5.29). For infants born to white women, the average LOS for treated NAS infants was 5.34 times longer than that of infants without NAS (95% CI=5.19, 5.49). For infants born to black women, the average LOS for treated NAS infants was 4.69 times longer than that of infants without NAS (95% CI=4.27, 5.15). For infants born to other race, the average LOS for treated NAS infants was 6.73 times longer than that of infants without NAS (95% CI=6.00, 7.55). For infants without Caesarean-section delivered, the average LOS for treated NAS infants was 6.81 times longer than that of infants without NAS (95% CI=6.61, 7.02). For infants with Caesarean-section delivered, the average LOS for treated NAS infants was 3.48 times longer than that of infants without NAS (95% CI=3.33, 3.63). Among infants with normal birthweight those with treated NAS had 7.05 times longer LOS than those without NAS (95% CI=6.94, 7.17). Among low birthweight infants, the LOS for those with treated NAS was 1.40 times longer than that for those without NAS (95% CI=1.30,

1.51). Among infants whose mother did not have gestational diabetes during pregnancy those with treated NAS had 5.22 times longer LOS than those without NAS (95% CI=5.08, 5.37). Among infants whose mother had gestational diabetes during pregnancy, the LOS for those with treated NAS was 4.05 times longer than that for those without NAS (95% CI=3.50, 4.70).

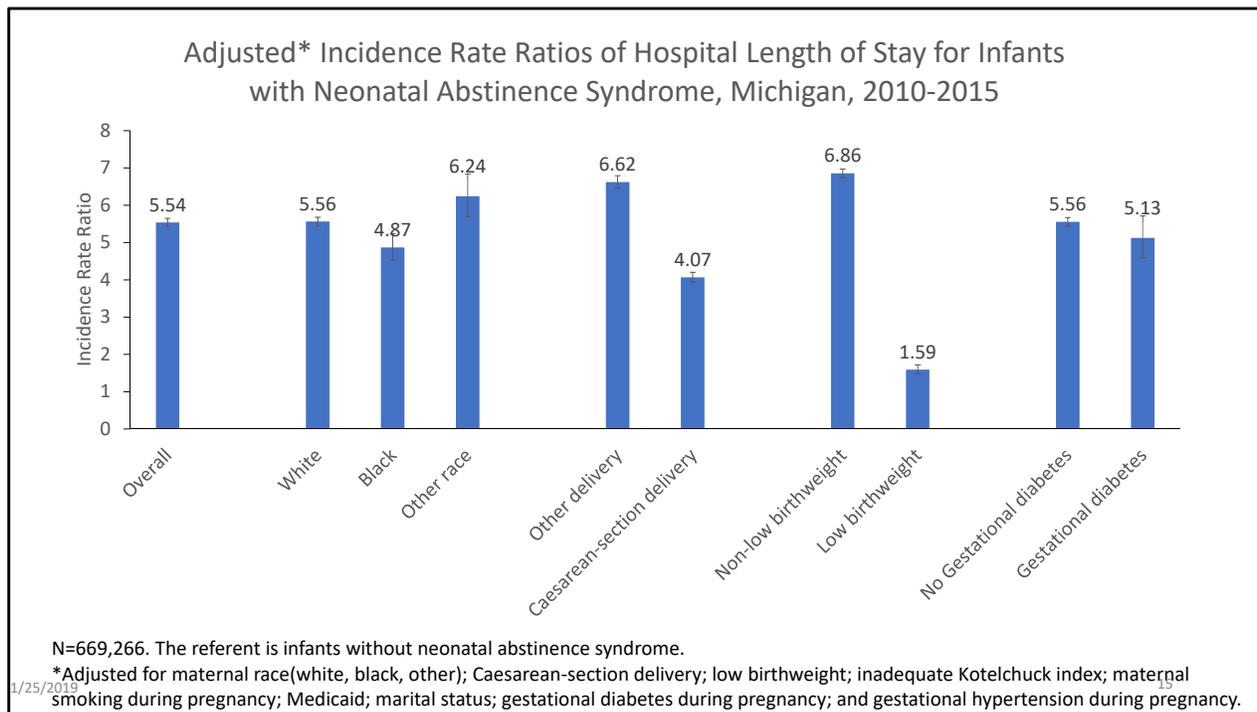
In the model adjusted for maternal race (white, black, other); Caesarean-section delivery; low birthweight; inadequate Kotelchuck index; maternal smoking during pregnancy; Medicaid; marital status; gestational diabetes during pregnancy; and gestational hypertension during pregnancy, the average LOS for treated NAS infants was **5.54** times longer than that of infants without NAS (95% CI=5.43, 5.65). For infants born to white women, the average LOS for treated NAS infants was 5.56 times longer than that for infants without NAS (95% CI=5.45, 5.68), after controlling for maternal and infant factors. For infants born to black women, the average LOS for treated NAS infants was 4.87 times longer than that for infants without NAS (95% CI=4.53, 5.23), after controlling for maternal and infant factors. For infants born to other race, the average LOS for treated NAS infants was 6.24 times longer than that for infants without NAS (95% CI=5.70, 6.84), after controlling for maternal and infant factors. Among infants with normal birthweight those with treated NAS had 6.86 times longer LOS than those without NAS (95% CI=6.74, 6.97), after controlling for maternal and infant factors. Among low birthweight infants, the LOS for those with treated NAS was 1.59 times longer than that for those without NAS (95% CI=1.47, 1.72), after controlling for maternal and infant factors. For infants with Caesarean-section delivered, the average LOS for treated NAS infants was 4.07 times longer than that for infants without NAS (95% CI=3.94, 4.20), after controlling for maternal and infant factors. For infants without Caesarean-section delivered, the average LOS for treated NAS infants was 6.62 times longer than that for infants without NAS (95% CI=6.46, 6.79), after controlling for maternal and infant factors. Among infants whose mother did not have gestational diabetes during pregnancy those with treated NAS had 5.56 times longer LOS than those without NAS (95% CI=5.44, 5.67), after controlling for maternal and infant factors. Among infants whose mother had gestational diabetes during pregnancy, the LOS for those with treated NAS was 5.13 times longer than that for those without NAS (95% CI=4.60, 5.72), after controlling for maternal and infant factors.



This slide shows the unadjusted incidence rate ratios (IRRs) of infant hospital length of stay (LOS) for interactions between treated neonatal abstinence syndrome (NAS) status and maternal race, mode of delivery, low birthweight, and parents acknowledged on birth certificate for the state of Michigan, 2010-2015.

In the unadjusted model, the average LOS of treated NAS infants was **5.15** times longer than that of infants without NAS (95% CI=5.02, 5.29). For infants born to white women, the average LOS for treated NAS infants was 5.34 times longer than that of infants without NAS (95% CI=5.19, 5.49). For infants born to black women, the average LOS for treated NAS infants was 4.69 times longer than that of infants without NAS (95% CI=4.27, 5.15). For infants born to other race, the average LOS for treated NAS infants was 6.73 times longer than that of infants without NAS (95% CI=6.00, 7.55). For infants without Caesarean-section delivered, the average LOS for treated NAS infants was 6.81 times longer than that of infants without NAS (95% CI=6.61, 7.02). For infants with Caesarean-section delivered, the average LOS for treated NAS infants was 3.48 times longer than that of infants without NAS (95% CI=3.33, 3.63). Among infants with normal birthweight those with treated NAS had 7.05 times longer LOS than those without NAS (95% CI=6.94, 7.17). Among low birthweight infants, the LOS for those with treated NAS was 1.40 times longer than that for those without NAS (95% CI=1.30,

1.51). Among infants whose mother did not have gestational diabetes during pregnancy those with treated NAS had 5.22 times longer LOS than those without NAS (95% CI=5.08, 5.37). Among infants whose mother had gestational diabetes during pregnancy, the LOS for those with treated NAS was 4.05 times longer than that for those without NAS (95% CI=3.50, 4.70).



This slide shows the adjusted incidence rate ratios (IRRs) of infant hospital length of stay (LOS) for interactions between treated neonatal abstinence syndrome (NAS) status and maternal race, mode of delivery, low birthweight, and parents acknowledged on birth certificate for the state of Michigan, 2010-2015.

In the model adjusted for maternal race (white, black, other); Caesarean-section delivery; low birthweight; inadequate Kotelchuck index; maternal smoking during pregnancy; Medicaid; marital status; gestational diabetes during pregnancy; and gestational hypertension during pregnancy, the average LOS for treated NAS infants was **5.54** times longer than that of infants without NAS (95% CI=5.43, 5.65). For infants born to white women, the average LOS for treated NAS infants was 5.56 times longer than that for infants without NAS (95% CI=5.45, 5.68), after controlling for maternal and infant factors. For infants born to black women, the average LOS for treated NAS infants was 4.87 times longer than that for infants without NAS (95% CI=4.53, 5.23), after controlling for maternal and infant factors. For infants born to other race, the average LOS for treated NAS infants was 6.24 times longer than that for infants without NAS (95% CI=5.70, 6.84), after controlling for maternal and infant factors. Among infants with normal birthweight those with treated NAS had 6.86 times longer LOS than those without NAS (95% CI=6.74, 6.97), after controlling for maternal and infant factors.

Among low birthweight infants, the LOS for those with treated NAS was 1.59 times longer than that for those without NAS (95% CI=1.47, 1.72), after controlling for maternal and infant factors. For infants with Caesarean-section delivered, the average LOS for treated NAS infants was 4.07 times longer than that for infants without NAS (95% CI=3.94, 4.20), after controlling for maternal and infant factors. For infants without Caesarean-section delivered, the average LOS for treated NAS infants was 6.62 times longer than that for infants without NAS (95% CI=6.46, 6.79), after controlling for maternal and infant factors. Among infants whose mother did not have gestational diabetes during pregnancy those with treated NAS had 5.56 times longer LOS than those without NAS (95% CI=5.44, 5.67), after controlling for maternal and infant factors. Among infants whose mother had gestational diabetes during pregnancy, the LOS for those with treated NAS was 5.13 times longer than that for those without NAS (95% CI=4.60, 5.72), after controlling for maternal and infant factors.

## Results

- Unadjusted and adjusted incidence rate ratios (IRRs) of infant hospital LOS for interactions between treated NAS status and maternal race, mode of delivery, low birthweight, and parents acknowledged on birth certificate are shown in Table 3.
- The average LOS for treated NAS infants was **5.54** times (95% CI=5.43, 5.65) longer than that for infants without NAS after controlling for maternal race (white, black, other), Caesarean-section delivery, low birthweight, inadequate Kotelchuck index, maternal smoking during pregnancy, Medicaid, marital status, gestational diabetes during pregnancy, and gestational hypertension during pregnancy.

This slide details additional summary results from this study.

## Results

- After controlling for maternal and infant factors, LOS was longer for infants treated for NAS than those without NAS by
  - 5.56 times (95% CI=5.45, 5.68) for infants born to white women;
  - 4.87 times (95% CI=4.53, 5.23) for infants born to white women;
  - 6.24 times (95% CI=5.70, 6.84) for infants born to white women;
  - 6.86 times (95% CI=6.74, 6.97) for normal birthweight infants;
  - 1.59 times (95% CI=1.47, 1.72) for low birthweight infants;
  - 4.07 times (95% CI=3.94, 4.20) for infants with Caesarean-section delivered;
  - 6.62 times (95% CI=6.46, 6.79) for infants without Caesarean-section delivered;
  - 5.56 times (95% CI=5.44, 5.67) for infants whose mother did not have gestational diabetes during pregnancy;
  - 5.13 times (95% CI=4.60, 5.72) for infants whose mother had gestational diabetes during pregnancy.

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This slide details further summary results from this study.

For infants born to white women, the average LOS for treated NAS infants was 5.56 times longer than that for infants without NAS (95% CI=5.45, 5.68), after controlling for maternal and infant factors.

For infants born to black women, the average LOS for treated NAS infants was 4.87 times longer than that for infants without NAS (95% CI=4.53, 5.23), after controlling for maternal and infant factors.

For infants born to other race, the average LOS for treated NAS infants was 6.24 times longer than that for infants without NAS (95% CI=5.70, 6.84), after controlling for maternal and infant factors.

Among infants with normal birthweight those with treated NAS had 6.86 times longer LOS than those without NAS (95% CI=6.74, 6.97), after controlling for maternal and infant factors.

Among low birthweight infants, the LOS for those with treated NAS was 1.59 times

longer than that for those without NAS (95% CI=1.47, 1.72), after controlling for maternal and infant factors.

For infants with Caesarean-section delivered, the average LOS for treated NAS infants was 4.07 times longer than that for infants without NAS (95% CI=3.94, 4.20), after controlling for maternal and infant factors.

For infants without Caesarean-section delivered, the average LOS for treated NAS infants was 6.62 times longer than that for infants without NAS (95% CI=6.46, 6.79), after controlling for maternal and infant factors.

Among infants whose mother did not have gestational diabetes during pregnancy those with treated NAS had 5.56 times longer LOS than those without NAS (95% CI=5.44, 5.67), after controlling for maternal and infant factors.

Among infants whose mother had gestational diabetes during pregnancy, the LOS for those with treated NAS was 5.13 times longer than that for those without NAS (95% CI=4.60, 5.72), after controlling for maternal and infant factors.

## Conclusions

- From 2010 to 2015, the overall birth rate of infants with treated NAS increased from 416.7 to 847.1 per 100,000 live births.
- Treated NAS infants had a significantly longer LOS than infants without NAS after adjusting for available maternal and infant factors.
- Study limitations related to validity and completeness of vital statistics and hospital discharge data. Identifying infants that have treated NAS by ICD-9-CM or ICD-10-CM coding alone underestimates the true birth rate<sup>9</sup>.
- The increasing number of treated NAS infants who are more likely to be covered by Medicaid suggests a large public financial burden.
- Appropriate evaluation and treatment are necessary to help decrease substance misuse among women of childbearing age.

1/25/2019

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This slide details the conclusions of this study.

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