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Assessing the Burden of Neonatal Abstinence Syndrome: Validation of *ICD-9-CM* Data, Florida, 2010-2011

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Abstract

Context: On October 1, 2015, the United States transitioned from using the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) to *ICD-10-CM.* Continuing to monitor the burden of neonatal abstinence syndrome (NAS) after the transition presently requires use of data dependent on *ICD-9-CM* coding to enable trend analyses. Little has been published on the validation of using *ICD-9-CM* codes to identify NAS cases.

Objective: To assess the validity of hospital discharge data (HDD) from selected Florida hospitals for passive NAS surveillance, based on *ICD-9-CM* codes, which are used to quantify baseline prevalence of NAS.

Design: We reviewed infant and maternal data for all births at 3 Florida hospitals from 2010 to 2011. Potential NAS cases included infants with *ICD-9-CM* discharge codes 779.5 and/or 760.72 in linked administrative data (ie, HDD linked to vital records) or in unlinked HDD and infants identified through review of neonatal intensive care unit admission logs or inpatient pharmacy records. Confirmed infant cases met 3 clinician-proposed criteria. Sensitivity and positive predictive value were calculated to assess validity for the 2 *ICD-9-CM* codes, individually and combined.

Results: Of 157 confirmed cases, 134 with 779.5 and/or 760.72 codes were captured in linked HDD (sensitivity = 85.4%) and 151 in unlinked HDD (sensitivity = 96.2%). Positive predictive value was 74.9% for linked HDD and 75.5% for unlinked HDD. For either HDD types, the single 779.5 code had the highest positive predictive value (86%), lowest number of false positives, and good to excellent sensitivity.

Conclusions: Passive surveillance using *ICD-9-CM* code 779.5 in either linked or unlinked HDD identified NAS cases with reasonable validity. Our work supports the use of *ICD-9-CM*code 779.5 to assess the baseline prevalence of NAS through 2015.

Keywords

hospital discharge data; maternal opioid use; neonatal abstinence syndrome; surveillance; validation

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Neonatal abstinence syndrome (NAS) is a constellation of clinical signs observed in newborns consistent with withdrawal from antenatal exposure to certain illicit or prescription drugs.[1] Almost invariably, NAS occurs in the setting of maternal opioid use.[2] Physiological and neurobehavioral signs of opioid withdrawal in infants include excessive high-pitched crying, irritability, sleep-wake disturbances, alteration in infant tone and movement, feeding difficulties, gastrointestinal disturbances, autonomic dysfunction, and failure to thrive.[3]

The use of prescription opioids has markedly increased in the United States. More than a third of reproductive-aged women insured by Medicaid and more than a quarter with private insurance filled a prescription for opioid pain medication between 2008 and2012.[4] Moreover, between 1999 and 2010, deaths among women due to overdose from prescription opioids increased by more than 400%.[5] The incidence of newborns afflicted with NAS has risen in parallel by nearly 5-fold from 2004 to 2014. In 2014, 8.0 per 1000 hospital births in the United States were diagnosed with NAS.[6]

Drug abuse and misuse, along with the corresponding increase in NAS cases, have become prominent public health problems in Florida.[7] Among pregnant women, opioid use disorder has increased 13-fold in the state, compared with 4-fold in the nation, from 1999 to 2014.[8] Neonatal abstinence syndrome incidence in Florida increased from 0.4 per 1000 hospital births in 1999 to 6.3 per 1000 hospital births in 2013, with an annual incidence rate change of 0.6 per 1000 births.[9] Statewide data from 2011 to 2013 suggest that the incidence of NAS has plateaued at rates between 6.67 and 6.99 per 1000 live births.[10]

The Florida Department of Health added this condition to the *List of Reportable Diseases and Conditions* to facilitate passive NAS surveillance.[7] To date, the most successful examples of statewide NAS surveillance implementation come from states, such as Tennessee, which have established a “near real-time” surveillance system for NAS based on electronic case reporting by providers and hospitals.[11]

Florida’s Agency for Health Care Administration is responsible for collecting patient discharge data from all licensed acute care hospitals within the state in accordance with state statute 408.061.[12] These data are collected for financial and condition/disease reporting. To improve reporting, the United States transitioned from using the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD- 9-CM)* to the Tenth Revision *(ICD-10-CM)* on October 1, 2015. With this transition, the number of diagnostic codes increased from 14 025 *ICD-9-CM* codes to 68 069 *ICD-10-CM* codes. It will take time for professional coders, physicians, and hospital staff to become familiar with the new system. Even with the transition, there are still no diagnostic codes that are specific for NAS cases. Additional diagnostic variation results, in part, to the absence of a standardized NAS case definition. Consequently, these issues create challenges for using administrative data to conduct analyses, including NAS trend analyses. Recommendations exist for reporting statistics using data that include both *ICD-9-CM* and *ICD-10-CM* codes.[13] However, only 1 study[14] has examined the accuracy of administrative *ICD-9-CM* coding for NAS. Thus, additional research is needed to support the use of *ICD-9-CM* codes for NAS in future posttransition studies that aim to use *ICD-9-CM* data as baseline data for trend analyses.

This investigation addressed the following questions: (1) What are the sensitivity and positive predictive values (PPVs) for *ICD-9-CM* codes indicative of NAS?; (2) Does the passive identification of NAS cases using hospital discharge data (HDD) linked to vital records differ from using unlinked HDD?; and (3) What combination of *ICD-9-CM* codes in HDD records will identify confirmed cases of NAS with greatest sensitivity and lowest false-positive rate?

Methods

Data sources

We invited 6 hospitals in 2 Florida counties with higher volumes of NAS cases than other Florida counties to participate in this study. Only 3 hospitals could participate; the other 3 were unable to obtain all the necessary data for this investigation.

We examined the use of 3 *ICD-9-CM* codes for NAS (779.5 [drug withdrawal syndrome in a newborn], 760.72 [narcotics affecting fetus or newborn via placenta or breast milk], and 304.1 [sedative, hypnotic, or anxiolytic dependence]) for surveillance purposes using 2 HDD data sets:

- Infant and maternal HDD linked to infant vital records (revised birth certificate and infant death certificate data), herein referred to as "linked HDD."
- Infant and maternal HDD not linked to vital records, herein referred to as "unlinked HDD."

To identify all NAS cases at the 3 facilities, the examination also used an "alternative case ascertainment method," which was used in a previous study.[15] Specifically, we examined infant and maternal hospital medical records, including neonatal intensive care unit (NICU) admission logs and infant inpatient pharmacy records. Hospital staff used infant inpatient pharmacy records to identify infants treated with morphine, methadone, or clonidine during the 2-year period. These medications are among the most common treatment options for NAS[1] and were used as primary or adjunctive treatments for NAS at the 3 hospitals. While morphine was the most common pharmacologic therapy used for NAS at the 3 hospitals, phenobarbital was also frequently used.[15] Not including phenobarbital in the list of medications used to identify infants treated for NAS did not invalidate our findings because phenobarbital was used at these hospitals as an adjunctive treatment when opioids (ie, morphine or methadone) alone were not sufficient for controlling withdrawal signs.[1] Hospital staff also identified infants admitted to the NICU for NAS treatment, based on documentation in NICU admission logs. The alternative case ascertainment method might be expected to identify additional potential NAS cases than the method based on *ICD-9-CM* codes, as it likely includes exposed babies admitted for observation for NAS but who did not develop the clinical syndrome.

Electronic medical records were pulled using a unique patient identification number from the hospitals. Three investigators each reviewed and abstracted a third of the medical records for the infants and their mothers. The standardized data abstraction form included data elements on infant demographic and clinical characteristics, pharmacologic therapy for NAS, feeding history, infant and maternal *ICD-9-CM* discharge diagnosis codes, maternal drug use history, and services received by the mother during the birth hospitalization. Before the abstraction, the investigators pilot-tested the collection form in the field among a random sample of 10% of infants with NAS and their mothers on 3 selected questions that were key to the investigation such as "Was NAS diagnosed?" Responses where either "yes" or "no." The 3 investigators were comparable on 73% to 96% of their responses. Discrepancies were

discussed and the form was then revised to facilitate improved interpretation and recording of medical record information.

Linked HDD

Linked HDD provide more information on patient characteristics than HDD alone[16]; however, approximately 8% of Florida birth certificates cannot be linked to an HDD record. The linked HDD file used for this analysis excluded infants who were adopted or transferred from another birth facility, as well as infants born to non-Florida residents and undocumented immigrants. Personal identifiers used for linkage include patient social security number and date of birth. We restricted our analytic sample according to guidance from the National Committee for Quality Assurance for identifying live birth deliveries.[17] No infants with *ICD-9-CM* codes V39.1 (liveborn, unspecified whether single, twin or multiple, born before admission to hospital) or V39.2 (liveborn, unspecified whether single, twin or multiple, born outside hospital, and not hospitalized) were included in any of our analyses. Infants diagnosed with NAS in the linked HDD (n = 179) were combined with an additional 124 infants identified by the alternative case ascertainment method (ie, present in NICU logs or inpatient pharmacy records), yielding a total of 303 unduplicated cases (see Figure, Supplemental Digital Content 1, available at http://links.lww.com/JPHMP/A534, which presents a flowchart of this sample).

Unlinked HDD

Data from the unlinked HDD were also restricted to birth hospitalizations, using the same methodology as that for the linked HDD. Data for infants with a NAS diagnosis identified in the unlinked HDD (n = 203) were combined with data from an additional 103 infants identified by the alternative case ascertainment method (ie, present in NICU logs or inpatient pharmacy records), yielding a total of 306 unduplicated infant records that were eligible for inclusion in this investigation. We excluded 3 infants from the unlinked HDD for whom information necessary for the confirmed case definition (see later) could not be obtained from the alternative case ascertainment method data; thus, 303 infants were included in the final sample (see Figure, Supplemental Digital Content 2, available at http://links.lww.com/JPHMP/A535, which presents a flowchart of this sample). Therefore, all patients captured by the 2 types of HDD and the alternative case ascertainment method (n = 303) are the same but are distributed differently between the linked and unlinked HDD.

Potential NAS case definition

Infants with any of the following 3 *ICD-9-CM* discharge diagnosis codes were considered potential NAS cases: 779.5 (drug withdrawal syndrome in a newborn), 760.72 (narcotics affecting fetus or newborn via placenta or breast milk), or 304.1 (sedative, hypnotic, or anxiolytic dependence). In addition, all infants identified by the NICU admission logs or inpatient pharmacy data were considered potential NAS cases.

NAS case definition

Currently, no standardized approach for NAS diagnosis exists in the United States. We consulted with neonatologists to develop for this investigation a case definition for a

confirmed NAS case. The definition of confirmed NAS required all 3 of the following criteria (as abstracted from the medical record):

- Presence of a constellation of clinical signs consistent with NAS (defined as a documented NAS Finnegan score of >8), not explained by another etiology.[18,19]
- Documented history of maternal use of prescription/illicit drugs associated with NAS during pregnancy[1] and/or laboratory confirmation of recent maternal drug use or fetal exposure to such drugs.
- A level of severity of clinical signs that resulted in prolonged (>2 days) neonatal hospitalization.

Infants who do not meet all 3 criteria were not classified as confirmed NAS in this study. Based on the NAS case definition, cases of possible iatrogenic withdrawal were excluded.

Statistical analyses

We assessed the quality of the 2 types of HDD by calculating the sensitivity and PPV with 95% confidence intervals (CI) using the binomial exact method. Sensitivity was calculated as the number of confirmed NAS cases in the HDD divided by the total number of confirmed NAS cases, multiplied by 100. Positive predictive value was defined as the number of confirmed NAS cases in the HDD divided by the total number of potential NAS cases detected in the HDD, multiplied by 100. For both types of HDD, analyses were completed separately for the following *ICD-9-CM* code combinations: (1) 779.5 and/or 760.72,(2) 779.5, and (3) 760.72. No infants with potential or confirmed NAS were assigned an *ICD-9-CM* code of 304.1 in the linked or unlinked HDD. However, there was 1 mother present in the unlinked HDD, and not in the linked HDD, who had the 304.1 code. In a sensitivity analysis, estimates were examined after removal of this mother and her infant from our analytic sample.

Data were analyzed using STATA v.14.0. The Florida Department of Health Institutional Review Board deemed this a nonresearch public health investigation exempt from review.

Results

Linked HDD

We identified 303 infants with potential NAS (179 from the linked HDD with any *ICD-9-CM* code combination and an additional 124 from the alternative case ascertainment method) (Table 1). Of 303 potential cases, 157 met the definition for a confirmed NAS case. Given that 134 infants with confirmed NAS were identified in the linked HDD, 23 of 157 confirmed cases were missed and 45 false positives were included.

Using codes 779.5 and/or 760.72, the linked HDD identified 134 of 157 infants with confirmed NAS (sensitivity = 85.4%, 95% CI: 78.8%–90.5%) (Table 2). Among the 179 potential NAS cases identified by the linked HDD, 134 had confirmed NAS (PPV = 74.9%, 95% CI: 67.8%–81.0%). Compared with the use of both codes 779.5 and 760.72, the single code 779.5 had a similar sensitivity of 84.1% (95% CI: 77.4%–89.4%) but a greater PPV of

86.3% (79.8%–91.3%). The single code 760.72 performed poorly with a sensitivity of 4.7% (1.9%–9.4%) and a PPV of 20.6% (8.7%–37.9%).

Unlinked HDD

The unlinked HDD identified 200 infants with potential NAS who when paired with an additional 103 from the alternative case ascertainment method yielded 303 total infants with potential NAS (Table 3). Of note, 21 of these infants were not found in the linked HDD. The majority of the 21 infants were adoption cases who were excluded from the linked HDD. Among the potential cases, 157 met the definition for a confirmed NAS case. Given that 151 infants with confirmed NAS were identified from the 200 infants in the unlinked HDD, 6 of 157 confirmed cases were missed and 49 false positives were included.

In the entire analytic sample, 151 of 157 infants with confirmed NAS were identified using unlinked HDD (sensitivity = 96.2%, 95% CI: 91.9%–98.6%) (Table 2). Of the 200 infants with potential NAS identified by the unlinked HDD, 151 had confirmed NAS (PPV = 75.5%, 95% CI: 68.9%–81.3%). Compared with the use of both codes 779.5 and 760.72, the single code 779.5 had a similar sensitivity of 94.9% (90.2%–97.8%) but a greater PPV of 86.1% (80.1%–90.9%). The single *ICD-9-CM* code 760.72 exhibited both a poor sensitivity of 5.4% (2.4%–10.3%) and a poor PPV of 22.2% (10.1%–39.2%).

In the sensitivity analysis, the infant of the mother with diagnostic code 304.1 had only a 779.5 code and was a confirmed case. Removal of this dyad pair from our analytic sample did not appreciably change our results. All PPV and sensitivity values were the same except for the PPV for 779.5 and/or 760.72: 75.5% before the exclusion and 78.5% after.

Discussion

Continuing to monitor the burden of NAS after the nation transitioned to *ICD-10-CM* coding presently requires use of data dependent on *ICD-9-CM* coding to enable trend analyses. To date, little has been done to assess the accuracy and validity of *ICD-9-CM* codes to capture NAS cases. In this study, the use of the single *ICD-9-CM* code 779.5, in both linked and unlinked HDD, resulted in the best profile of sensitivity and PPV. However, compared with linked HDD, unlinked HDD included more confirmed NAS cases and had greater estimated sensitivity (94.9% vs 84.1%) but had a similar PPV (86.1% vs 86.3%).

Our results for the linked HDD were consistent with those from a pilot study conducted in Tennessee that examined the accuracy of administrative coding for NAS (779.5 code only) from 2009 to 2011 using outpatient prescription Medicaid claims data linked to vital statistics and hospital outpatient data.[14] Specific elements of their standard NAS case definition that they used as a reference, however, were not reported. Sensitivity and PPV were 88.1% (95% CI: 83.3%–91.7%) and 91.2% (86.8%–94.2%), respectively, in the study by Patrick et al[14] versus 84.1% (77.4%–89.4%) and 86.3% (79.8%–91.3%), respectively, in our linked HDD. In our study, the PPV for code 779.5 used alone was higher than that for 779.5 and/or 760.72 (86.3% vs 74.9%). Typically, based on the experience of clinicians in our investigation team, providers used code 779.5 for infants with signs of NAS and reserved 760.72 for babies who might have been exposed but did not develop signs of NAS. Taken

together, our results with the experience of clinicians on our investigative team demonstrate that passive NAS surveillance identified NAS cases with reasonable validity using *ICD-9-CM* code 779.5 alone.

Approximately 8% of birth certificate records in Florida are not linked to an HDD record because of a variety of factors, including the birth having occurred out-of-state, at home, at a birthing center, or at another facility type without a hospital identification number.[16] In addition, births in which the primary source of payment was "self-pay," and births to women who did not have a high school diploma, who were foreign born, and who self-identified as "Hispanic" experienced greater odds of not linking their birth certificate to an HDD record.[16] Undocumented immigrants and non-Florida residents are also excluded. Thus, the infants captured in the linked HDD might not be representative of all infants living in the state. Because of this limitation, we hypothesized that unlinked HDD would perform better at identifying NAS cases than the linked HDD. This held true for both potential and confirmed NAS cases ascertained using HDD: the unlinked HDD captured 173 potential and 149 confirmed NAS cases for code 779.5 whereas the linked HDD identified 153 potential and 132 confirmed NAS cases. Moreover, based on the experience of data analysts in Florida, unlinked HDD are timelier with only a 5-month lag for data acquisition compared with the 18-month lag for the linked HDD. Overall, unlinked HDD appear to be better for providing the number, rate, and some limited clinical and birth hospitalization characteristics of NAS-diagnosed infants born in Florida. Vital records add more maternal and infant demographic and clinical information, which can be used to better understand factors contributing to women's use of opioids during pregnancy and to identify specific groups of women for targeted interventions. If a state can link HDD with vital statistics records and if the time needed for such linkages is not critical, then the purposes of surveillance may determine whether linked versus unlinked HDD are optimal. Of note, our results also indicate that an alternative case ascertainment method is necessary to identify all cases of confirmed NAS while excluding false positives.

This report has some limitations. Our findings reflect reporting practices in only 3 hospitals in 1 area of Florida. These hospitals could provide all necessary information for the alternative case ascertainment method (inpatient pharmacy records and NICU logs) and their practices may not reflect the situation in all delivery hospitals in the community or state. This possibility could be assessed in a statewide investigation. During the 2-year study period, NAS scoring tools were not routinely included in electronic medical records at the participating hospitals and therefore some infants with NAS Finnegan scores greater than 8 might have been missed if documentation were present elsewhere in the medical record or the information was not well captured. The 3 hospitals were able to provide only inpatient pharmacy data based on the medication dispense date rather than infant's date of birth. Consequently, infants born near the end of 2011 might not have been identified by the alternative case ascertainment method if pharmacologic treatment for NAS was dispensed in 2012. Also, since NAS can be treated with a variety of pharmaceuticals, some of which were not incorporated into our NAS case finding, the number of infants with NAS may have been slightly underestimated. At the time of the investigation, *ICD-10-CM* had not been implemented as the new standard diagnostic tool and therefore we cannot determine with certainty whether our results based on *ICD-9-CM* codes (779.5 and 760.72) would be

equivalent to results using the *ICD-10-CM* codes for NAS (P96.1 and P04.49, respectively). Also, this study does not formally validate *ICD-9-CM* data as a baseline measure for NAS in analyses that also include *ICD-10-CM.* Biases in the 2 classification systems may differ somewhat even though both will use a single *ICD* code. Changes in prevalence over time could still be due to changes in coding. Instead, this study specifically validates *ICD-9-CM* data, which are integral to the published work of others who have examined NAS trends. Validation of *ICD-10-CM* data is currently being completed and will be the subject of a subsequent report. Finally, passive surveillance using unlinked HDD restricted to the single code 779.5 slightly overestimated the number of real NAS cases (n = 157) because the number of false-positive NAS cases (n = 24) among the 173 potential cases exceeded the number of missed cases of NAS (n = 8) for an overestimation rate of 10.2% = [(173–157)/157].

Our study has several strengths. We applied a strong methodologic approach to investigating the accuracy of reporting through searching multiple hospital databases with verification by chart audit. These methods would also be essential for assessing *ICD-10-CM* codes. Clinical experts developed our NAS case definition and 3 experienced clinicians conducted the medical record reviews. Furthermore, our sample was restricted to birth hospitalizations, given our interest in identifying NAS cases at birth, which helped exclude NAS cases diagnosed after birth or duplicate cases. Our unique examination of different *ICD-9-CM* code combinations and comparison of linked and unlinked HDD in addition to the use of a proposed NAS case definition can inform and guide state efforts to conduct passive surveillance of NAS.

Conclusions

This study supports the use of HDD and *ICD-9-CM* codes to establish baseline data on NAS prevalence through 2015. Our results from 3 Florida birth facilities are promising, but we suggest that they should be furthered by a statewide investigation that examines *ICD-10-CM* codes as a means of passive NAS surveillance. The methodology used in this article to assess the validity of NAS-related *ICD-9-CM* codes could serve as the basis for such a study. Confidence in case ascertainment and surveillance strategies is key to designing the best state-based NAS surveillance system from which appropriate interventions can be developed, monitored, and evaluated.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Hudak ML, Tan RC. Neonatal drug withdrawal. Pediatrics. 2012;129(2):e540–e560. [PubMed: 22291123]
2. 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; 307(18):1934–1940. [PubMed: 22546608]
3. Jansson LM, Velez M. Neonatal abstinence syndrome. Curr Opin Pediatr. 2012;24(2):252–258. [PubMed: 22227786]
4. Ailes EC, Dawson AL, Lind JN, et al. Opioid prescription claims among women of reproductive age —United States, 2008–2012. MMWR Morb Mortal Wkly Rep. 2015;64(2):37–41. [PubMed: 25611168]
5. Centers for Disease Control and Prevention. Vital signs: overdoses of prescription opioid pain relievers and other drugs among women—United States, 1999–2010. MMWR Morb Mortal Wkly Rep. 2013;62(26):537–542. [PubMed: 23820967]
6. Winkelman TNA, Villapiano N, Kozhimannil KB, Davis MM, Patrick SW. Incidence and costs of neonatal abstinence syndrome among infants with Medicaid: 2004–2014. Pediatrics. 2018;141(4):pii: e20173520.
7. Florida Office of the Attorney General. Statewide task force on prescription drug abuse & newborns: February 2013 final report. Published 2013. http://myfloridalegal.com/webfiles.nsf/WF/RMAS-94LJPF/$flle/Statewide_Task_Force_on_Prescription_Drug_Abuse_and_Newborns_Final_Report.pdf. Accessed December 20, 2016.
8. Haight SC, Ko JY, Tong VT, Bohm MK, Callaghan WM. Opioid use disorder documented at delivery hospitalization—United States, 1999–2014. MMWR Morb Mortal Wkly Rep. 2018;67(31): 845–849. [PubMed: 30091969]
9. Ko JY, Patrick SW, Tong VT, Patel R, Lind JN, Barfield WD. Incidence of neonatal abstinence syndrome—28 States, 1999–2013. MMWR Morb Mortal Wkly Rep. 2016;65(31):799–802. [PubMed: 27513154]
10. Anjohrin S, Cavicchia P, Bailey M, Correia J, Watkins S. Neonatal Abstinence Syndrome Data Summary: Maternal Characteristics Among Live Births From 2011 Through 2013. Tallahassee, FL: Florida Department of Health; 2015.
11. Warren MD, Miller AM, Traylor J, et al. Implementation of a statewide surveillance system for neonatal abstinence syndrome—Tennessee, 2013. MMWR Morb Mortal Wkly Rep. 2015;64(5): 125–128. [PubMed: 25674995]
12. Agency for Health Care Administration. Office of data collection and quality assurance. http://ahca.myflorida.com/schs/DataCollection/DataCollection.shtml. Published 2016. Accessed December 20, 2016.
13. Elixhauser A, Heslin KC, Owens PL. Healthcare Cost and Utilization Project (HCUP) Recommendations for Reporting Trends Using ICD-9-CM and ICD-10-CM/PCS Data. Rockville, MD: US Agency for Healthcare Research and Quality; 2017
14. Patrick SW, Dudley J, Martin PR, et al. Prescription opioid epidemic and infant outcomes. Pediatrics. 2015;135(5):842–850. [PubMed: 25869370]
15. Lind JN, Petersen EE, Lederer PA, et al. Infant and maternal characteristics in neonatal abstinence syndrome—selected hospitals in Florida, 2010–2011. MMWR Morb Mortal Wkly Rep. 2015;64(8): 213–216. [PubMed: 25742381]
16. Salemi JL, Tanner JP, Bailey M, Mbah AK, Salihu HM. Creation and evaluation of a multi-layered maternal and child health database for comparative effectiveness research. J Registry Manag. 2013;40(1):14–28. [PubMed: 23778693]

17. National Committee for Quality Assurance. The healthcare effectiveness data and information set. Prenatal and postpartum care. http://www.ncqa.org/portals/0/prenatal%20postpartum%20care.pdf. Published 2015. Accessed April 4, 2017.

18. Finnegan LP. Neonatal abstinence syndrome: assessment and pharmacotherapy In: Rubaltelli FF, Granti B, eds. Neonatal Therapy: An Update. Amsterdam, New York, Oxford: Elsevier Sciences Publishers BV; 1986.

19. Zimmermann-Baer U, Notzli U, Rentsch K, Bucher HU. Finnegan neonatal abstinence scoring system: normal values for first 3 days and weeks 5–6 in non-addicted infants. Addiction. 2010;105(3):524–528.

Implications for Policy & Practice

- With the transition to using *ICD-10-CM* codes, long-term trend analysis of NAS prevalence will rely upon an assumption that *ICD-9-CM* data are accurate, yet few studies have assessed whether this assumption holds true.
- This study demonstrates that both linked and unlinked HDD perform well at capturing confirmed NAS cases.
- The use of the single *ICD-9-CM* code 779.5 resulted in the best profile of sensitivity and positive predictive value compared with other codes or the combination 779.5 and/or 760.72 code.
- These results can guide other state health agencies on evaluating and interpreting their own NAS surveillance data.

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TABLE 1

Counts for Confirmed NAS Cases and Noncases by Detection in the Linked Hospital Discharge Data Set and *ICD-9-CM* Code Combination, Florida, 2010–2011

	779.5 and/or 760.72 *ICD-9 CM* Codes			**779.5 *ICD-9-CM* Code**			**760.72 *ICD-9 CM* Code**		
	Confirmed NAS[a]			**Confirmed NAS[a]**			**Confirmed NAS[a]**		
Detected in HDD	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
Yes	134	45	179	132	21	153	7	27	34
No	23	101	124	25	101	126	142	107	249
Total	157	146	303	157	122	279	149	134	283

Abbreviations: HDD, hospital discharge data; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; *NAS, neonatal abstinence syndrome.*

[a]Confirmed NAS cases met all 3 of the following criteria: (1) presence of a constellation of clinical signs consistent with NAS, not explained by another etiology, (2) documented history of maternal use of prescription or illicit drugs normally associated with NAS during pregnancy and/or laboratory confirmation of recent maternal drug use or fetal exposure to such drugs, and (3) a level of severity of signs that result in a neonatal hospitalization for more than 2 days.

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TABLE 2

Sensitivity and Positive Predictive Value (With 95% Confidence Intervals) of Hospital Discharge Data Stratified by Hospital Discharge Data Type and *International Classification of Diseases, Ninth Revision, Clinical Modification* Code, Florida, 2010–2011

	Linked HDD			Unlinked HDD		
	779.5 and/or 760.72	**779.5[a]**	**760.72[a]**	**779.5 and/or 760.72**	**779.5[a]**	**760.72[a]**
Sensitivity[b]	85.4% (78.8%–90.5%)	84.1% (77.4%–89.4%)	4.7% (1.9%–9.4%)	96.2% (91,9%–98.6%)	94.9% (90.2%–97.8%)	5.4% (2.4%–10.3%)
Positive predictive value[c]	74.9% (67.8%–81.0%)	86.3% (79.8%–91.3%)	20.6% (8.7%–37.9%)	75.5% (68.9%–81.3%)	86.1% (80.1 %–90.9%)	22.2% (10.1 %–39.2%)

Abbreviation: HDD, hospital discharge data.

[a]ICD-9-CM codes 779.5 and 760.72 are not mutually exclusive of each other.

[b]Sensitivity = (number of confirmed neonatal abstinence syndrome (NAS) cases in the HDD/total number of confirmed NAS cases) × 100 (see Tables 1 and 3)

[c]Positive predictive value = (number of confirmed NAS cases in the HDD/total number of potential NAS cases detected in the HDD) × 100 (see Tables 1 and 3)

TABLE 3

Counts for Confirmed NAS Cases and Noncases by Detection in the Unlinked Hospital Discharge Data Set and *ICD-9-CM* Code Combination, Florida, 2010–2011

	779.5 and/or 760.72 *ICD-9-CM* Codes			**779.5 *ICD-9-CM* Code**			**760.72 *ICD-9-CM* Code**		
	Confirmed NAS[a]			**Confirmed NAS[a]**			**Confirmed NAS[a]**		
Detected in HDD	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
Yes	151	49	200	149	24	173	8	28	36
No	6	97	103	8	98	106	141	106	247
Total	157	146	303	157	122	279	149	134	283

Abbreviations: HDD, hospital discharge data; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; *NAS, neonatal abstinence syndrome.*

[a]Confirmed NAS cases met all 3 of the following criteria: (1) presence of a constellation of clinical signs consistent with NAS, not explained by another etiology, (2) documented history of maternal use of prescription or illicit drugs normally associated with NAS during pregnancy and/or laboratory confirmation of recent maternal drug use or fetal exposure to such drugs, and (3) a level of severity of signs that result in a neonatal hospitalization for more than 2 days.