J Perinat Neonat Nurs
Vol. 24, No. 4, pp. 366–372

Identifying Infants at Risk for Neonatal Abstinence Syndrome

A Retrospective Cohort Comparison Study of 3 Screening Approaches

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Objective: The main objective of this study was to analyze the consistency in using a standardized newborn toxicology screening protocol to identify infants at risk of developing neonatal abstinence syndrome (NAS). **Design:** A retrospective cohort comparison design was approved by the institutional review board at the regional hospital and used to gather data from the infants' medical records during the study period. **Setting:** The data were collected for a period of 1 year from a regional hospital serving 100 000 patients per annum. **Patients/Participants:** Data were based on expectant mothers who delivered between March 2006 and March 2007. **Method:** Data of maternal self-reported substance use, and urine toxicology results and meconium results were obtained through retrospective chart review of infants exhibiting signs of NAS as noted by nurses on the Finnegan Scoring Tool. **Results:** In the absence of accurate prenatal screening, this study lends positively to support the use of toxicology screening protocols at birth to adequately assess and treat infants exposed to illicit substances. Toxicology screening in not intrusive and despite emotional discomfort experienced by mothers of the infants tested, the benefits of attaining accurate information regarding substance exposure is critical for the well-being of the infant. **Conclusion:** The use of a toxicology screening protocol at birth appears beneficial in determining the need for identifying infants with NAS. Early detection of substance exposure in newborns leads to timely assessment for NAS and subsequent treatment to reduce symptoms in newborns. **Key words:** *infants*, *meconium screening*, *neonatal abstinence syndrome*, *self-report*, *toxicology screening*, *urine screening*

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The authors thank Lakehead University for the financial support of the Practice Based Research Program.

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Several studies have explored the impact of intrauterine exposure to illicit substances on neonatal outcomes[1–4] with a consistent conclusion that the use of illicit substances in pregnancy not only affects the health of the pregnant woman directly, but such behaviors also directly affect the health of the neonate. Among the consequences of substance use by a

Submitted for publication: May 6, 2010
Accepted for publication: August 30, 2010

pregnant woman is the increased risk for the infant to develop a substance-withdrawal condition known as neonatal abstinence syndrome (NAS). *Neonatal abstinence syndrome* is defined as a constellation of symptoms in the newborn experiencing withdrawal from drugs of addiction such as opiates, barbiturates, and methadone.[5] According to the American Academy of Pediatrics Committee on Drugs, neonatal withdrawal occurs in 55% to 94% of infants born to women on opiates and heroin, and in up to 85% of infants born to women on methadone.[6(p1079)]

Chasnoff et al[7] reported that substance use by pregnant women is one of the most frequently missed diagnoses in perinatal medicine. A main concern in providing care to infants with NAS is the inability for practitioners to accurately identify substance exposure. This inability to detect a mother's substance use during the prenatal period can lead to delayed treatment of symptoms in newborns. In addition, the inaccurate detection of substances used during pregnancy can put the neonate at risk of receiving prophylactic pharmaceuticals at birth. For example, if an infant is born with respiratory depression to a mother who has used but not disclosed narcotic use during pregnancy, the infant may be administered an opiate antagonist, which can result in severe consequences. As described by Wagner and coresearchers,[8] this may precipitate an acute withdrawal reaction in the newborn, including neonatal seizures. This highlights the importance of obtaining an accurate list of medications or substances used during pregnancy.

Intrauterine substance exposure is associated with prematurity, low birth weight, depression at delivery as measured by low Apgar scores, weight loss after delivery, certain birth defects,[9,10] premature rupture of membranes, small-for-gestational age, congenital cardiac defects, asphyxia, placental hemorrhage, perinatal hypoxia, and sepsis,[10] In an attempt to decrease the immediate and long-term risks to infants, several approaches have been undertaken to screen for substance exposure in pregnancy and the immediate postpartum period. Urine toxicology screening detects substance exposure in utero within 24 to 72 hours prior to testing, primarily based on the half-life of the drug.[11] Meconium screening offers a more longitudinal assessment of maternal substance use in pregnancy-detecting substances used since the beginning of the second trimester.[12] Infant hair analysis can also be used to detect substance exposure in utero, with the ability to detect possible exposure from the third trimester.[13] While each method has value and limitations, there is a lack of standardization of screening to aid in diagnosis and treatment of newborns.

While several studies have used meconium screening, urine toxicology, and hair analysis as methods to detect in utero substance exposure,[13,14] the most frequent method of screening is the mother's self-report.[15] This approach is implicitly flawed because of the stigma and perception of the mother to the risks of disclosing accurate information. Fear of the child welfare system,[16] guilt and shame associated with substance use,[15] and an innate fear of the legal system[13] each limit the possibility to promote truthful dialogue between the mother and the healthcare provider. Given the health needs of the substance-exposed infant, establishment of accurate and reliable identifiers of maternal antenatal substance exposure are critical. With knowledge of fetal substance exposure, the neonatal care team is able to appropriately intervene to enhance positive neonatal outcomes.

The researchers had 2 primary goals within this study. Given the lack of standards applied to neonatal screening for substance exposure, the team sought to analyze whether the consistent use of a standardized newborn toxicology screening protocol would identify infants at risk of developing NAS. Subsequent to the analysis of the efficacy of the screening protocol, the secondary goal of the team was to compare the sensitivity of maternal self-report, urine toxicology screening, and meconium screening in an attempt to identify infants at risk of developing NAS and also to determine the most reliable means of detection of substance exposure.

BACKGROUND

As part of a larger study on the impact of a clinical practice guideline on infants with NAS, a toxicology screening protocol was developed to assist in identification of infants at risk for developing NAS. The protocol was developed for a regional hospital's neonatal intensive care unit that services the needs of high-risk infants in a midsized Canadian city with a population of approximately 120 000. With observed increases in addiction within the general population and the addition of 3 methadone clinics in the community and several others in the region, a protocol to standardize identification of at-risk infants was developed.

The protocol outlined criteria for screening infants at risk of developing NAS. These criteria outlined the priority method of screening, such as urine toxicology screening for recent maternal substance use and meconium toxicology screening for a more longitudinal exploration of maternal substance use during

Table 1. Clinical criteria for urine toxicology testing

Mothers at risk for substance use/abuse
Identified by primary or obstetrical caregivers
Engaged in high-risk behavior (use of street drugs)
Identified by child protection agencies or other community agencies
Who disclose illicit drug use in pregnancy
Who act in an intoxicated manner on admission or during office visits
Positive for a history of alcohol or illicit substances, including methadone

pregnancy. The clinical criteria used in the urine toxicology testing are demonstrated in Table 1.

When one of the identified criteria is evident, urine toxicology screening is initiated on the infant, per a medical directive. Additional testing may be required. The protocol also identifies criteria for meconium testing as noted in Table 2.

Without a medical directive in place, meconium screens are completed on order from a physician. Given that collection of the sample of meconium is time sensitive, meconium is collected according to the clinical criteria and stored in the hospital laboratory for a maximum of 5 days. The storage period allows time for assessment of the newborn and acquisition of physician orders to initiate testing. Prior to the development of the toxicology screening protocol, screening was inconsistent and based solely on individual physician practice. However, it was anticipated that the addition of the screening tool would introduce a consistent approach to screening among all physicians at the regional hospital.

METHODS

A retrospective cohort comparison design was approved by the institutional review board at the regional hospital and used to gather data from the infants' medical records during the study period of March 11, 2006, to March 12, 2007. All 1476 infants born at the regional hospital during this time period were screened for inclusion in the study. Neonates were included in the study if they received at least 1 neonatal abstinence score from the nursing staff according to the Finnegan Scoring Tool,[1] The Finnegan Scoring Tool is the most frequently used assessment tool of NAS symptoms ranging from central nervous system excitation to metabolic, respiratory, and gastrointestinal symptoms.[1] Despite its widespread use, the psychometric properties of the Finnegan tool have not been published.

Table 2. Clinical criteria for meconium testing

When any of the criteria are identified in Table 1
When a urine toxicology screen is negative and substance use is suspected on the basis of 1 of the criteria from Table 1
When a urine toxicology screen is positive and there is a need to test for longitudinal drug/alcohol use
When the meconium screen is required by a physician for further assessment and/or treatment of newborn

A total of 91 infants were identified with signs of NAS and included in the study. The introduction of the newborn toxicology screening policy did not take place until September 12, 2006. The time line allowed for comparison of toxicology screening in a preintervention group and a postintervention group. The preintervention group was screened for substances on the basis of individual physician practice, while the postintervention group utilized the specific criteria for toxicology screening with a medical directive in place to expedite urine testing immediately following the birth.

Women's self-reported substance use was measured through verbal reports to labor and delivery nursing staff during the completion of the obstetrical history. The patient history chart is completed for every patient admitted to labor and delivery and recorded on a paper chart of each individual patient. This history taking was consistent in the pre- and postintervention groups. Questions related to alcohol consumption are asked of patients independent of questions directly related to substance use.

Urine toxicology screens were completed on infants meeting the criteria in Table 1. Nursing staff collected urine samples from at-risk infants using sterile cotton balls placed in the diaper of the newborn. The urine-saturated cotton balls were sent to the laboratory for analysis. Infant urine screens were completed without parental consent. Although it is encouraged to inform parents of testing, hospital protocol indicates that when a physician suspects that an infant is at risk of substance exposure, parental consent is not required for newborn drug analysis[17] for the purposes of determining appropriate treatment.[18] The meconium samples were obtained from infants identified at-risk as stated in Table 2. A 5 mL sample of meconium is collected by the nursing staff and stored in the laboratory for up to 5 days to allow for assessment and an order from a physician to complete meconium toxicology screening. Once a physician order was received, the meconium samples were sent

to an external laboratory for analysis of substance exposure.

Both the urine and meconium samples are collected within the first 24 hours of life. It is ideal to obtain the first urine and meconium sample, as this provides the most reliable results.[14] Urine samples are analyzed immediately in the hospital laboratory for infants that have known or suspected in utero substance exposure while meconium samples are collected and stored for up to 5 days in the hospital laboratory to be later sent to an external laboratory for analysis. Mothers of potential substance-exposed infants are encouraged to remain in hospital for 48 hours to assess the infant for symptoms of NAS. If symptoms do not present, the infant is discharged with follow-up arranged.

DATA COLLECTION

Data of maternal self-reported substance use, and urine toxicology results and meconium results were obtained through retrospective chart review of infants exhibiting signs of NAS as noted by nurses on the Finnegan Scoring Tool. The data were entered into a customized data analysis program located on a secure server external to the institution (hospital). SAS (the Statistical Analysis System, Version 9, Cary, North Carolina) was used to evaluate the maternal self-reports of any illicit or prescribed substance use, and data from the urine toxicology and meconium screening results for opiates, barbiturates, methadone, tricyclics, amphetamines, benzodiazepines, cocaine, methylphenidate, SSRI (selective serotonin reuptake inhibitor, a class of antidepressant medications), and cannabinoids.

RESULTS

During the 1-year period of study (March 11, 2006, to March 12, 2007), a total of 91 infants exhibited symptoms of NAS as detected through nurses' record of symptoms using the Finnegan Scoring Tool. The regional hospital reported 1476 childbirths during this time period, with 6.1% of these infants affected by symptoms of NAS.

In an effort to analyze the efficacy of the toxicology screening protocol to identify infants at risk, the sample was separated into 2 groups: (1) infants who were born prior to the implementation of the standardized toxicology screening ($n_1 = 21$) and (2) those born after the toxicology screening protocol was implemented ($n_2 = 70$). Homogeneity of variance between the 2 groups of infants was tested with the Levene's test for average weight ($n_1 = 19$, $\text{mean}_{\text{wtkg}} = 3.18 \pm 0.60$ versus $n_2 = 71$, $\text{mean}_{\text{wtkg}} = 3.53 \pm 0.69$). The results indicate that the 2 groups were similar for weight ($P = 0.38$). However, the same statistical test applied to feeding type revealed that the 2 groups were not homogenous in their method of nutrition ($P = 0.02$). This is consistent with findings that indicate more mothers formula-fed than breast-fed. Table 3 outlines the demographics of infants in the preintervention and postintervention groups.

Table 3. Demographic characteristics of the infants, categorized by group

	Group 1 ($n_1 = 21$)	Group 2 ($n_2 = 70$)
Males, %	43	54
Females, %	57	46
Average weight, g	3203 ± 592	3530 ± 699
Feeding type, %		
Breast	28.5	13.0
Formula	38.1	59.4
Combination	33.3	27.5

Homogeneity of variance between the 2 groups of pregnant women was tested for the variables—maternal age, smoking status and alcohol consumption, attendance in prenatal care, and attendance in prenatal classes—using Levene's Test. The results indicate that the 2 groups were similar for age ($P = 0.82$), smoking status ($P = 0.08$), prenatal care (0.92), and attendance at prenatal classes ($P = 0.82$), but not for alcohol consumption ($P = 0.02$). The descriptive estimates for women in each group are presented in Table 4.

In accordance with the goal of testing the effectiveness of the toxicology screening protocol, the results demonstrate a dramatic increase of 29% in the number of infants in the postintervention group screened for NAS. This suggests that the addition of a toxicology screening protocol enhanced the

Table 4. Demographic characteristics of pregnant women

	Group 1 ($n_1 = 21$)	Group 2 ($n_2 = 70$)
Average age of mother at birth, y	27.7 ± 5.8	24.4 ± 5.6
Smoked during gestation, %	86	75
Consumed alcohol during gestation, %	33	10
Received regular prenatal care, %	76	73.5
Attended prenatal classes, %	40	33

Table 5. Frequency distribution for urine screen detection with self-report ($N = 62$)[a]

Drug Type	Frequency of Self-Report and Urine Detection (+)	Frequency of No Self-Report and Urine Detection (+)	Frequency of Self-Report and Urine Detection (−)
Opiates	6	10	8
Barbiturates	2	0	0
Methadone	18	1	3
Cocaine	1	2	2
Cannabinoids	1	3	8

[a]1 patient self-reported SSRI; 1 patient self-reported methylphenidate; amphetamines identified in 1 patient from urine screen; tricyclics were not found in urine screed, nor self-reported for any patients; benzodiazepines were not found in urine screen, nor self-reported for any patients.

frontline detection of neonates with substance exposure from physicians and nurses. The preintervention group (group 1) identified a total of 21 infants with symptoms of NAS, while the postintervention group (group 2) identified 70 infants with symptoms of NAS. Nursing staff, and physicians used the toxicology screening protocol as a guide to initiate appropriate testing of infants.

In an effort to compare the sensitivity of maternal self-report, both urine toxicology screening and meconium toxicology screening were used as means of detecting substance exposure in newborns, A comparison was then made between the self-reports of women obtained from obstetrical histories with identified substances found in infant meconium drug screens and in infant urine drug screens. Infant urine toxicology screens positive for opiates and no other substances were eliminated from the study if opiates were administered in labor (as detected on the record of labor and delivery). A total of 62 urine screens were completed overall, with 11 being eliminated from the study. A total of 40 meconium screens were completed during the 1-year period and included in the study.

Urine toxicology screening has limited benefit for detecting long-term substance exposure. Findings from this study reveal that infant urine toxicology screening offers immediate indication of substances used by pregnant women within 24 to 72 hours of delivery, which could impact withdrawal symptoms in newborns. Table 5 lists all infants having a urine toxicology screen completed. Of the neonatal urine toxicology screens completed during the study period, 27% of mothers had failed to report substances detected in their infant's urine. For example, patient number 052 reported using opiates and methadone, however, cannabinoids were detected in the infant's urine in addition to the substances she reported. Similarly, patient 027 did not report any substance use, however, the infant's urine revealed opiates, barbiturates, and tricyclics. This information outlines some of the inaccuracies that exist in women's self-reported substance use.

In addition to urine toxicology screening, meconium screening also revealed discrepancies between self-reported use from mothers and the results detected in the meconium screen (Table 6). Meconium screening offers a more longitudinal detection period of maternal substance use from the second trimester.[13] While the urine toxicology screen tests for multiple potential substances simultaneously, meconium is only screened for the substances ordered by the physician.

Table 6. Frequency distribution for meconium screen detection with self-report ($N = 39$)[a]

Drug Type	Frequency of Self-Report and Meconium Detection (+)	Frequency of No Self-Report and Meconium Detection (+)	Frequency of Self-Report and Meconium Detection (−)
Opiates	7	5	4
Methadone	3	0	8
Cocaine	1	6	3
Cannabinoids	7	11	2

[a]2 patients self-reported SSRI; 2 patients self-reported methylphenidate; 1 patient self-reported benzodiazepines; barbiturates were not found in meconium screen, nor self-reported for any patients; amphetamines were not found in meconium screen, nor self-reported for any patients; tricyclics were not found in meconium screen, nor self-reported for any patients.

Often, this practice eliminated physician orders for meconium screens of substances previously disclosed in self-report, as those substances are already known to healthcare providers. Given that methadone use was often disclosed by women resulting from their need to attain the treatment while in hospital, methadone was not a substance commonly screened within the physician group.

In this study, meconium screening results were compared with the self-reported substance use of women. The results indicated a discrepancy in self-reports and biological meconium screening with 24% of meconium screens detecting additional substances than those disclosed on the self-reports of expectant mothers from March 2006 to March 2007. Due to the longitudinal nature of the meconium screening results, women who received analgesics in labor were not removed from the total sample of infants screened for meconium. Table 6 provides an example of the discrepancy of meconium testing and self-report. For example, patient number 038 reported using opiates and methadone while opiates, cannabinoids, and cocaine were found in the infant's meconium. Similarly, patient number 027 did not report substance use, while cannabinoids and opiates were found in the infant's meconium. These findings are consistent with previous studies that suggest the underreporting of illicit substance use.[12,14,15] Most importantly, the absence of accurate information related to substance exposure in newborns can preclude infants from receiving the care they need for withdrawal symptoms.

DISCUSSION

While retrospective knowledge of maternal substance exposure in utero is useful in guiding treatment for infants who develop NAS, toxicology screening of infants at birth does not allow for prevention and possible treatment for women who use substances in pregnancy. Ideally, sensitive and nonthreatening screening of substance use would be most effective for both mother and baby if achieved during the course of pregnancy. Prenatal screening can potentially serve the dual purpose of preventing NAS and long-term effects in infants, while assisting pregnant women in accessing counseling and support services to assist with treatment and healthier lifestyle choices.

However, in the absence of accurate prenatal screening, this study supports the use of toxicology screening protocols at birth to adequately assess and treat infants exposed to illicit substances. With a 29% increase in the number of urine screens completed from the preintervention group to the postintervention group, a guideline for testing potentially at-risk newborns has proven to be useful in guiding appropriate nursing and medical interventions. Toxicology screening in newborns is not intrusive, and the benefits to the neonate in attaining accurate information are substantial. That being said, the toxicology screening should be used to guide treatment, not as a punitive measure for the perception of inadequate parenting.

Consistent with other research comparing screening methods,[13–18] this study revealed the inaccuracies of substance detection by method of screening. Women's self-reports, while easily attained, are far from accurate. Substance-using women face fears and concerns not experienced by women who do not use drugs in pregnancy. For the substance-using mother, fear of the consequences of substance use prevents full and accurate disclosure. This is coupled with inconsistent approaches to verbal screening for substance use by nursing and medical professionals. Some mothers may perceive different personal styles within the medical profession as blaming or punitive for the mother's poor judgment in using substances during the prenatal period. Although the results demonstrate inaccuracies of self-report, this study is limited by the approach taken by different nursing staff. There was no evidence of the efficacy of other tools used to inquire about substance use and are thus unable to report on the efficacy of self-report by various methods of inquiry.

While urine toxicology screening and meconium screening were found to be more sensitive than self-report, these tests are not without limitations. Urine screens have short detection periods of 24 to 72 hours[11] depending on the half-life of the drug. This small window of detection could yield inaccurate findings if the mother did not use substances within the few days preceding the birth. Similarly, meconium testing has limitations as well. Although the detection period is longitudinal with detection of substances used from the second trimester,[11] the inability to collect a sample in a timely way is a concern for healthcare providers, and the requirement of testing only for specific substances leaves room for error in accurately determining the substances to screen.

CONCLUSIONS

While a variety of approaches exist for detecting substance exposure in newborns, this study lends support to simultaneously utilizing multiple means of detection to obtain the most accurate assessment of

substance exposure. The use of a toxicology screening protocol at birth appears beneficial in identifying infants with NAS. Early detection of substance exposure in newborns leads to timely assessment for NAS and subsequent treatment to reduce symptoms in newborns. As noted, there are multiple barriers to full disclosure from women of substances used during pregnancy. Healthcare providers have a unique opportunity to assist and empower substance-using women to speak honestly about their addictions and seek treatment or counseling for harm-reduction strategies that may serve to keep families together in a safe environment. Healthcare providers must advocate for nonpunitive responses to disclosure of substance use in order to provide women with a feeling of safety. Furthermore, the use of retrospective chart review is important for healthcare providers to evaluate practice and identify opportunities for service improvements for patients. Future research in this area is needed to evaluate different means of acquiring reports from mothers that are sensitive to the contextual issues, which preclude substance-using women from providing full disclosure to healthcare providers.

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