

Neonatal Opioid Withdrawal Syndrome: A Developmental Care Approach

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The purpose of this article is to discuss the use of developmental care approaches for infants with neonatal abstinence syndrome and describe the need for more research in this area.

Accepted for publication
February 2019

ABSTRACT

Tens of thousands of infants are impacted yearly by prenatal opioid exposure. The term *neonatal opioid withdrawal syndrome* (NOWS) is now replacing the more familiar term *neonatal abstinence syndrome* (NAS). Ongoing debate continues related to standard regimens for treatment of this oftentimes perplexing condition. Historically, treatment has focused on pharmacologic interventions. However, there is limited research that points to nonpharmacologic methods of treatment as viable options, whether alone or in addition to pharmacologic interventions. This article, utilizing a review of pertinent literature, outlines the physical aspects of NOWS, including its pathophysiology and the resulting physical clinical signs. In addition, we present an overview of how age-appropriate, nonpharmacologic interventions, centered on developmental care, may be a valuable approach to organize and prioritize routine care for these infants, their families, and the health care team facing the challenges of NOWS. Finally, the need for further research to better define evidence-based standards of care for these infants and their families is discussed.

Keywords: addiction; fetal; infant neurodevelopment; in utero exposure; NAS; neonatal abstinence syndrome; nonpharmacologic care; opioid; withdrawal

OPIOID ADDICTION IS ONE OF THE most alarming epidemics of this century in the United States. According to the Centers for Disease Control and Prevention (CDC), opioid use particularly affects women of reproductive age,¹ partially because problems such as chronic pain are often treated with opioid prescriptions.² Opioid intake during pregnancy can

be harmful not only to the health of the mother, but also to the health of the newborn. Neonatal opioid withdrawal is one of the most common results of intrauterine opioid exposure, with an incidence of 75–90 percent in exposed infants.^{3–6}

The constellation of clinical signs associated with newborn opioid withdrawal has been termed “neonatal abstinence

syndrome” (NAS)³; more recently, the term “neonatal opioid withdrawal syndrome” (NOWS) is being used.⁷ Other names used for this condition are neonatal drug withdrawal syndrome,⁸ neonatal drug withdrawal,³ and neonatal withdrawal syndrome.⁹ It should be noted that NOWS can occur through either maternal opioid use leading to intrauterine exposure or therapeutic administration of opioids for infant symptom control related to other clinical situations, such as sedation with intubation.

This article focuses on NOWS that results from abrupt discontinuation of chronic fetal exposure to opioid substances used or abused by the mother during pregnancy.^{10,11} The pertinent literature from 2000 through February of 2019 was identified via PubMed and MEDLINE searches and synthesized into this article. NOWS is a generalized multisystem disorder that predominantly involves the central and autonomic nervous systems, and the gastrointestinal tract.^{10,11} Improved identification of infants at risk for NOWS and standardized treatment could greatly mitigate its effects and the associated health care burdens.^{1,12}

A GROWING CRISIS

Over the last 15 years, prescription and illicit opioid use, abuse, addiction, and overdose have increased dramatically. This ongoing opioid crisis is affecting countless families and the health and well-being of both adults and children. Drug use statistics reported by the Substance Abuse and Mental Health Services Administration (SAMHSA)’s National Survey on Drug Use and Health (NSDUH) are striking; in 2016 more than 11 million people misused prescription opioids, 1 million used heroin, 2.1 million had an opioid use disorder caused by prescription opioids or heroin, and at least 64,000 died of a drug overdose. These are the highest numbers ever recorded in the United States. Of women aged 15–44 years who filled prescriptions for opioid medications, 28 percent were covered under private health insurance and 39 percent were covered through Medicaid.¹³ Opioid overdose deaths among women in this age group increased five-fold between 1999 and 2010.¹

Before 1970, NOWS was generally linked to either maternal morphine or heroin use during pregnancy. Today, NOWS cases are attributed to a broader range of illicit and prescription opioids and may be secondary to the use of morphine, heroin, methadone, buprenorphine, other prescription opioid analgesics, antidepressants, anxiolytics, and/or other substances.^{10,11,14,15} Because opioid cessation and withdrawal during pregnancy increases risk of complications,¹⁵ it is recommended that pregnant women with opioid addiction be converted to and treated with long-acting opioids such as methadone or buprenorphine.¹⁶ Currently, methadone, buprenorphine, or buprenorphine/naloxone are recommended by the American College of Obstetricians and Gynecologists for treatment of opioid dependency in pregnant women. These medications are administered in the context of medication-assisted

treatment programs, which also provide comprehensive care that includes prenatal care, psychosocial support, and cognitive behavioral therapy. Maternal use of these drugs still can cause clinical signs of withdrawal in the newborn infant,¹⁷ but with considerably lower risk than maternal opioid withdrawal during pregnancy.

INCIDENCE AND COST

More than 10,000 infants are affected by NOWS annually, with a significant increase in incidence since 2004.¹⁸ The estimated cost of hospitalization increased from \$190 million in 2000, to \$720 million in 2009,¹⁹ to \$1.5 billion in 2013—with 80 percent paid by Medicaid.⁶ The escalation in the NOWS rate prompted the United States Congress to pass the Protecting Our Infants Act of 2015, which specifically calls for a critical review of current NOWS treatment options and development of better therapies and strategies to reduce the incidence of NOWS.¹⁷ Individual states continue to grapple with the etiology of opioid use²⁰ and the burden that the opioid crisis and NOWS has placed on Medicaid.²¹ Many states have adopted mandatory reporting requirements for a NOWS diagnosis.²²

CLINICAL SIGNS OF NEONATAL OPIOID WITHDRAWAL

Opioid withdrawal is a complex biological phenomenon and the pathophysiology of NOWS is not completely understood.^{10,11} Opioid withdrawal is more complex in neonates as a result of immature neurologic development, impaired neurologic processing, and complex materno-feto-placental pharmacokinetics.^{10,11} The process of opioid withdrawal in the neonate is characterized by a cluster of clinical signs that depend on a number of factors including the type(s) of opioid(s) used, the timing and most recent exposure to the opioid, total opioid exposure, maternal use of other drugs and substances, maternal metabolism, amount of drug transferred to the placenta, and the infant’s ability to metabolize and excrete the substance(s).^{3,10,11,23} Premature newborns tend to have less severe clinical signs of withdrawal than full-term newborns due to decreased overall exposure to opioids, decreased body fat (some drugs, such as methadone accumulate in fat tissue), decreased transmission across the placenta (placental transmission of opioids increases with gestational age), as well as decreased development and sensitivity of opioid receptors.²⁴

At the cellular level, opioid receptors are inhibitory G-coupled protein receptors, meaning that the presence of the ligand or opioid either deactivates or inhibits the activation of adenylate cyclase and downstream proteins. The lack of opioids after termination of chronic exposure increases the activity of the opioid receptors and results in the superactivation of adenylate cyclase and its downstream proteins. This leads to a potent release of neurotransmitters that manifest as NOWS clinical signs.^{10,11}

Because opioid receptors are found primarily in the central nervous system, peripheral nervous system, and gastrointestinal tract, clinical signs tend to be associated with dysregulation of the nervous system and gut. Common clinical signs of withdrawal in affected newborns are shown in Table 1. A 2001 study showed that the most prominent signs of NOWS were disturbed sleep (77 percent), excessive sucking (57 percent), tachypnea (56 percent), loose stools (53 percent), tremors (48 percent), and increased tone (41 percent).²⁵ Another study reported a high incidence of skin injuries among these infants, with 44.4 percent having diaper dermatitis, 18.5 percent having self-inflicted scratches, and 13.9 percent having excoriations.²⁶

Clinical signs of opioid withdrawal generally appear 24–72 hours after birth. For some infants, however, clinical signs are delayed up to seven days or later, which is generally after hospital discharge. NOWS may include a short but intense initial phase lasting for one to two weeks and consisting of tremors, seizures, irritability, feeding problems, vomiting, diarrhea, hyperthermia, and other systemic clinical signs.^{10,11,15} This initial phase may be followed by a long chronic and relapsing course lasting for weeks or months that includes hyperirritability, sleep disturbances, hyperphagia, and other neurologic and autonomic signs.^{10,11,15}

In general, full-term infants with good birth weight, poly-drug exposure, or with slower metabolism are at higher risk of experiencing severe and extended withdrawal.^{10,11} Heroin exposure results in earlier onset (within 24 hours after birth) and faster resolution of withdrawal when compared to

long-acting opioid agonists such as methadone or buprenorphine, which result in later onset (24–72 hours after birth or later) and longer duration of withdrawal.³ In the case of buprenorphine exposure, higher doses and concurrent use of barbiturates and benzodiazepines have been correlated with late onset of clinical signs.^{27–29}

Several NOWS assessment tools are available to quantify the severity of clinical signs of withdrawal and aid in therapeutic decision making. The most commonly used tool in the United States is the modified Finnegan's Neonatal Abstinence Scoring System (FNASS),³ based on the original published in 1975³⁰ and modified to reduce tool complexity and increase compliance and reliability.³¹ Infants are assessed for 21 clinical signs spanning three major categories. Scoring of infants after feedings and at three- to four-hour intervals when the infant is awake is recommended to accurately represent infant status at the time of assessment and during the preceding period. This scale is recommended for full-term infants, not premature infants, and can be used to assess withdrawal from a number of other substances in addition to opioids.^{10,11} Other NOWS assessment tools include the Narcotic Withdrawal Score or Lipsitz Score,³² which was designed to establish a clinical threshold for treatment of only opioid-exposed infants. The Neonatal Narcotic Withdrawal Score, along with the Neonatal Withdrawal Inventory, were developed in the 1980s and 1990s and are noted to have low inter-rater variability and high specificity for diagnosis of NOWS.^{33,34} Recently, novel assessment tools and approaches have been published.^{35,36}

Additional clinical signs have been identified with co-exposure to opioids and gabapentin,³⁷ which is widely used as a nonopioid treatment for neuropathic pain but has become a popular substance of abuse.³⁸ As rates of poly-abuse and numbers of novel substances of abuse—like kratom and flakka—continue to grow, differential effects of in utero exposure to specific combinations of neuroactive substances may expand the list of neurologic, metabolic, and gastrointestinal symptomatology associated with NOWS.

TABLE 1 ■ Common Clinical Signs of Withdrawal in Infants with NOWS

Associated with the central nervous system
High-pitched cry
Decreased sleep
Tremors
Increased muscle tone
Hyperactive Moro reflex
Seizures
Gastrointestinal dysfunction
Difficulties in feeding
Vomiting
Loose/watery stools
Associated with the autonomic nervous system
Sweating
Hyperthermia
Frequent yawning and sneezing
Increased respiratory rate
Nasal congestion

Abbreviation: NOWS = neonatal opioid withdrawal syndrome.

Adapted from: Ko JY, Wolicki S, Barfield WD, et al. CDC grand rounds: public health strategies to prevent neonatal abstinence syndrome. *MMWR Morb Mortal Wkly Rep.* 2017;66(9):242-245. doi:10.15585/mmwr.mm6609a2.

STANDARDS AND GUIDELINES OF CARE

Care for these infants—including assessment and management—varies widely in the United States, and existing guidelines are based on minimal supporting data.^{39,40} Obstetric care best practices also vary.⁴¹ No large, high-quality, randomized, controlled trials have evaluated nonpharmacologic treatment of NOWS.²³ No medications are currently approved by the Food and Drug Administration (FDA) for treatment of NOWS, and data supporting any one particular treatment is lacking.³⁹ As a result, management of infants with NOWS—including both pharmacologic and nonpharmacologic interventions—varies across hospitals and health care providers.³⁹

The American Academy of Pediatrics (AAP) has recommended that each nursery adopt a protocol for evaluation and

management of neonatal opioid withdrawal and train staff in the correct use of an abstinence assessment tool.³ The AAP has also suggested nonpharmacologic care as the preferred treatment option, with subsequent administration of pharmacologic treatment only if improvement is not observed or if the infant develops severe withdrawal.^{10,11}

In lieu of definitive research findings, evidence-based standards, or guidelines for care of infants with NOWS,^{40,42} this review of current literature focused on recommended nonpharmacologic interventions⁴³ that are “easily acceptable, less expensive, and less controversial.”^{10(p.e553)} In addition, there is growing support for the positive impact this type of care offers to infants with NOWS.^{44,45} Reports of long-term adverse behavioral control outcomes for some children exposed to opioids prenatally⁴⁶ suggest detrimental effects on frontal regions of the brain and impacts on executive function. The extent to which these effects reflect early neurodevelopmental impacts of in utero opioid exposure or is reflective of the post-hospitalization environment is unclear. According to Kocherlakota, excellent, continuous, supportive care can help avoid pharmacologic intervention and may lead to earlier hospital discharge.^{10,11}

DEVELOPMENTAL/NEUROPROTECTIVE CARE AND NOWS

Terms such as neuroprotective, developmental,^{47–49} trauma-informed, and age-appropriate care are used to describe a developmental concept that recognizes the physiologic, neurobiological, and psycho-emotional aspects of the infant’s experience. The framework counters the effect of trauma and distress and supports normal infant growth and development through evidence-based, age-appropriate care—including family integrated care.⁵⁰ Because the clinical signs of NOWS are often signs of discomfort and stress in the infant, key interventions are organized according to a system of developmental/neuroprotective care focus areas (Figure 1).⁵⁰

Healing Environment

Initial treatment of infants who develop early signs of withdrawal is directed at minimizing environmental stimuli (both light and sound) by placing the infant in a dark, quiet environment.^{3,10,11,51} One hospital unit shared that they created an environment of low lighting and low noise, with trained and dedicated staff along with community volunteers who were specially trained to hold and rock neonates when family members were not available.⁵²

Pain and Stress Assessment and Management

Responding promptly to infant signals³ using nonpharmacologic care techniques can prevent the infant from becoming overstimulated and stressed. Specific methods of decreasing infant stress include holding, cuddling, and manual rocking,^{10,11} as well as coordinated, clustered care to allow for more uninterrupted quiet time.⁵¹ Therapeutic handling techniques (such as gentle tucking and flexing of the infant in

a contained manner similar to the position they experienced in utero) have been reported to produce calming effects in neonates⁵² by preventing autostimulation and supporting infant self-regulation.⁵¹

Pharmacologic Care

Pharmacologic therapy⁵³ is indicated to relieve moderate-to-severe NOWS clinical signs and to prevent complications such as hyperthermia, weight loss, and seizures in infants who do not respond to nonpharmacologic support.³ However, administration of pharmacologic treatment should be carefully assessed because it will prolong drug exposure and may increase length of hospital stay to the possible detriment of maternal–infant bonding.³ The only clearly defined benefit of pharmacologic treatment is the short-term amelioration of clinical signs.³ Studies have not addressed whether long-term morbidity related to neonatal drug withdrawal is decreased by pharmacologic management of affected infants, or whether continued postnatal drug exposure augments the risk of neurobehavioral and other morbidities.³ Kocherlakota notes that medications are only required when supportive therapy fails to control signs and symptoms and when withdrawal scores remain high, serious signs such as seizures are observed, or when withdrawal is associated with severe dehydration as a result of diarrhea and/or vomiting.^{10,11}

Once the health care team considers the infant’s response to nonpharmacologic measures, his or her degree of clinical signs of withdrawal, and determines that pharmacologic interventions are indicated—even with the risks of that therapy—there is no consensus on standard practice.²³ Recent evidence suggests that the use of a standardized protocol for pharmacologic treatment of NOWS may be more important than the choice of drug.²³ Bagley and colleagues recommended that nurseries adopt standard protocols including the use of published assessment tools and accepted NOWS treatments such as morphine and methadone, as well as training of all staff members involved in infant care.³⁹ Although several pharmacologic treatment regimens have been published,^{10,11} no medications are currently FDA-approved for use in NOWS management.³⁹

Protected Sleep

Swaddling reduces stimulation, decreases crying time, and promotes more sustained sleep.⁵⁴ Kangaroo care and nonnutritive sucking may also help calm infants.^{10,11,51} As previously indicated, it may be especially important to remain alert for early signs of newborn irritability.^{10,11} If parents or volunteers are immediately available, they can calm and soothe these infants to prevent the cycle of irritability, excessive crying, poor feeding, and lack of sleep.^{10,11}

Family-Centered Care

Kocherlakota noted that active maternal participation is the most effective form of nonpharmacologic care.^{10,11} However,

FIGURE 1 ■ Developmental/neuroprotective care of infants with NOWS.



Abbreviation: NOWS = neonatal opioid withdrawal syndrome.

preparation for infant neurobehavioral dysregulation is critical.⁵⁵ Infant withdrawal symptoms can produce feelings of guilt and anxiety in mothers and family members, which can lead to substance abuse relapse, maternal–infant communication failure, and subsequent maladaptive developmental trajectories in infants. It is also important to prepare the mother to identify her feelings about having an infant with NOWS and to practice emotional responses that will enable her to fully support the infant’s recovery.⁵⁵

Bagley and colleagues suggested that because infant treatment does not occur in isolation from the mother, it is crucial to consider and treat the infant with NOWS as part of an infant–mother dyad. They went on to state that creating a more secure, compassionate, and comfortable environment for the dyad will likely optimize outcomes for both mother and infant.³⁹ A caring, nonjudgmental approach by health care providers may be effective in encouraging maternal participation.^{10,11}

Nurses working with babies with NOWS and their families are in a unique position to impact this mother/child bond. By educating oneself about substance use and mental

health, being supportive, controlling biases, and providing clear communication, nurses can not only care for the baby’s needs, but they can also help foster this relationship, potentially driving positive behavioral changes and improving long-term outcomes for the mother/child dyad.^{56(p207)}

Two key ways to help support the infant–mother dyad and to improve maternal satisfaction are through breastfeeding assistance and education and rooming-in.²³ In addition, both breastfeeding and rooming-in can provide an opportunity to normalize the postpartum process for women who may feel vulnerable and stigmatized because of their opioid use history.³⁹ Johnson also noted that staff consistency increases a sense of comfort and trust in mothers.⁵⁶ Collaboration with other disciplines, such as social work, physical therapy, and child life is also important in providing resources and support to both mother and infant.^{55,56}

Feeding

An activity of daily living, breastfeeding is generally recommended for infants exposed to opioids in utero if the mother is enrolled in a substance abuse treatment program³⁹

and the infant continues to gain weight.³ Breastfeeding is contraindicated if the mother is actively using illicit drugs, has polydrug abuse, or is infected with human immunodeficiency virus (HIV).^{10,11} If breastfeeding is indicated, it is important to determine the level of residual opioid in the breast milk.

Breastfeeding may mitigate the severity of Nows,⁵⁷ and has also been shown to improve outcomes by reducing length of hospital stay and reducing Nows assessment scores.³⁹ In addition to health benefits for the infant, breastfeeding increases maternal confidence and encourages maternal participation in infant care.^{10,11} Schiff and associates have recently published a review of the breastfeeding dynamics between hospital staff, opioid-addicted mothers, and their infants.⁵⁸

Although it is the preferred nutritional option,⁵⁹ in the event that breastfeeding is contraindicated frequent high-density feedings may be needed to ensure adequate weight gain due to increased energy use and to prevent gastroesophageal reflux, emesis, and diarrhea.⁵¹ Infants who remain calm and content expend less energy, potentially leading to more calories available for growth.

Positioning

Age-appropriate positioning techniques with the infant contained and tucked can soothe the infant, increase comfort, and decrease irritability. However, there has not been a systematic study to determine optimal infant positioning to reduce stress from Nows, as there has been for premature neonates.

Skin Care

Aside from providing overall comfort and support to the infant with Nows, developmental/neuroprotective care may also help improve infant skin health by decreasing neurological irritability and thus decreasing the potential for skin injury related to repetitive movement.²⁶ Skin care is one of the often overlooked aspects in the clinical management of a Nows infant, but is clinically important.⁶⁰ Scratches in the sacral area and extremities, sucking blisters, and skin excoriation frequently result from neurologic irritability in infants with Nows.²⁶ Nonpharmacologic interventions such as swaddling in a flexed position, gentle rocking in a vertical manner, nonnutritive sucking, hand containment, and skin-to-skin care can comfort the infant and decrease irritability to help prevent these skin lesions.

An increased incidence of diaper dermatitis has also been reported in infants with Nows.⁶¹ Diaper dermatitis can cause severe infant discomfort and distress among parents and caregivers. Consequently, care practices that prevent onset of dermatitis in the perianal region, alleviate clinical signs, and promote skin healing are imperative. The Association of Women's Health, Obstetric, and Neonatal Nurses guidelines for prevention of diaper dermatitis suggest optimal perianal skin care through frequent diaper changes, gentle cleansing of skin to remove urine and feces, and the use of a protective barrier cream.^{62,63} Fast-absorbing, breathable diapers

are recommended to reduce skin overhydration, as are pH-balanced, low-friction formulated baby wipes.

Breast milk has been shown to lower the pH of both feces and urine in neonates, which could improve overall skin pH and prevent diaper dermatitis.⁶² Due to the unique needs of infants with Nows and their high incidence of diaper dermatitis, specific guidelines for perianal care in this population are needed. Routine skin rounds, in which trained nurses conduct skin surveillance, are also recommended. Infants with diaper dermatitis should be carefully monitored to ensure the condition is resolving and exclude the presence of an infection such as candidiasis.²⁶

DISCUSSION AND RECOMMENDATIONS

The current widespread opioid crisis impacts the health and well-being of adults who use or abuse these drugs, as well as infants who are exposed to those agents in utero. Opioid addiction also represents a significant financial burden on the health care system to provide care for infants with Nows. McQueen and colleagues suggested that the increased incidence of Nows and dramatic increases in associated health care costs warrant a consistent and comprehensive approach to mitigate negative outcomes for affected infants, their mothers, and the health care system.²³

Few, if any large, high-quality, randomized, controlled trials have explored optimal care for infants impacted by Nows. This lack of supporting data leads to variability in the care of these infants and has led the government, health care professional organizations, and health care providers to call for establishment of evidence-based standards for the care of Nows infants. Bagley and colleagues indicated an urgent need for additional research—some of which should focus on the variations of Nows expression—to ensure the best care for infants with Nows.³⁹ In addition, data are needed to construct a clinically useful model for estimating withdrawal time for any given opioid. This is complicated by the large number of factors that determine withdrawal time and that little of these data are in the literature.

Another area of concern and opportunity for improvement is standardization of Nows assessment tools. Current assessment scales and measures do not accurately reflect—with an acceptable degree of reliability—the clinical condition of the newborn with Nows. Findings support the need for development of an Nows measure based on sound psychometric principles.^{35,64}

According to Grossman and associates, nonpharmacologic interventions seem to “hold the most promising”⁴⁴ therapeutic approach and reflect the potential benefits of developmental/neuroprotective care. Although developmental care has been promoted for several decades, it is still practiced inconsistently.^{40,50} The continuing challenge is to not only provide bedside practitioners with knowledge and tools to consistently apply developmental/neuroprotective care, but also to ensure the application of these practices to all newborn care as appropriate. Resources such as Every Change

Matters,⁶³ the Wee Care Neuroprotective NICU Program,⁶⁵ and recent guidelines by Milette and colleagues provide specific recommendations regarding implementation of developmental and neuroprotective care.^{47,48} Other care modalities such as mother–infant rooming-in,⁶⁶ which is a part of the Family-Centered focus care area, may hold promise in reducing infant stress and length of stay,⁶⁷ and shifting the care focus to nonpharmacologic solutions.⁶⁸

Additional research is also needed to better define the physiologic impact of NOWS on infant skin and to develop appropriate interventions. A recent multicenter retrospective study found that for 1,241 neonatal intensive care admissions, 86 percent of full-term infants with NOWS had documented diaper dermatitis compared with 28 percent of full-term infants without NOWS.⁶¹ Overhydration, skin irritants in urine and feces, friction, increased skin pH, and other factors can lead to diaper dermatitis, impacting overall infant health.⁶⁹ In infants with NOWS, the increased number of watery or loose stools associated with withdrawal also contributes to diaper dermatitis.²⁶ It has also been suggested that the reduced frequency of diaper changes to avoid sleep disturbance in NOWS infants can increase skin exposure to fecal material, leading to greater incidence of diaper dermatitis.⁶¹ Additional research is needed to better understand the causes of diaper dermatitis in this population and inform guidelines for evidence-based care. However, a possible treatment would be to prevent loose or watery stools in NOWS infants. Because stress can negatively impact skin barrier function of even healthy adult skin,^{70–72} upregulation of the stress response in the skin of infants with NOWS could contribute to the higher incidence of skin-related health issues. If so, developmental neuroprotective care could mitigate stress and improve skin health, as well as other clinical signs. More research is needed to explore this topic.

Similar to opioid withdrawal, the use of tobacco or tobacco products during pregnancy can result in neonatal nicotine withdrawal.⁷³ This syndrome shares many common features with NOWS, including symptomology that is dependent on the form and dose of tobacco used⁷⁴ and accumulation of tobacco metabolic products (e.g., nicotine and cotinine) in breast milk.⁷⁵ Only one article in the literature clinically relates the two syndromes in a methodical manner.⁷⁶ Neonatal nicotine withdrawal syndrome newborns will undoubtedly benefit from the developmental and neuroprotective care focus that benefits NOWS infants.

SUMMARY

NOWS is often a hidden outcome of the opioid epidemic¹ and the number of affected infants has increased dramatically over the past decade. As a result, better understanding of NOWS pathophysiology and standardized treatment methods are needed.

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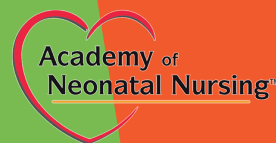
exposure to neuroactive substances. Dr. Davies studies a population that demonstrates high levels of polysubstance abuse and the resulting differential symptomology.

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