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Addressing Neonatal Abstinence Syndrome: Current Interventions and Future Perspectives

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Neonatal Abstinence Syndrome (NAS) is a condition that affects newborn babies exposed to drugs in utero, resulting in withdrawal symptoms shortly after birth (Stanford Medicine, n.d.). Approximately 80 babies are born every day with NAS, equaling one baby every 19 minutes (Centers for Disease Control and Prevention [CDC], 2025). The number of babies born with NAS is rising. In fact, between 2010 and 2017, cases of NAS surged by 82% nationwide. These increases were seen across the US, in nearly every state and regardless of demographic group (CDC, 2025). In 2019, 7% of mothers reported that they were using prescription opioids during pregnancy. Of that 7% of expectant mothers, 1 in 5 disclosed that the prescription medication they were using was not prescribed by a physician (CDC, 2025). Noteworthy, these figures are from self-reported data, which suggests that the number of expectant mothers using and abusing prescription pain medication during the gestation period could be significantly higher. Despite most NAS cases being caused by opioids, this condition can also sometimes be caused by other substances like antidepressants, barbiturates, benzodiazepines, or marijuana (March of Dimes, 2019).

Neonatal abstinence syndrome has a range of symptoms, primarily affecting the nervous system and the gastrointestinal system. Symptoms range from mild to severe and can include, but are not limited to, fever, high respiratory rates, sweating, weight loss, projectile vomiting, poor feeding, loose or watery stools, tremors, sleep disturbances, myoclonic jerks, and seizures

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(McQueen & Murphy-Oikonen, 2016). The signs of NAS and the severity of the condition depend on factors such as how much of the drug was used during pregnancy, how long the drug was used, how the mother's body breaks down and responds to the drug, and the gestational age at which the baby is born (March of Dimes, 2019). The withdrawal symptoms in the baby can appear as soon as 24 hours after birth but may not show until up to 10 days after birth (Stanford Medicine, n.d.). NAS can be attributed to other complications like low birth weight, jaundice, sudden unexpected infant death syndrome (SUIDS), preterm delivery, and abnormal heart patterns. In severe instances of NAS, the baby may need to be admitted into a newborn intensive care unit (NICU) (McQueen & Murphy-Oikonen, 2016).

It is imperative to treat NAS immediately following the birth of a baby; therefore, timely diagnosis of the condition is vital. The most common way to assess the severity of NAS is through verbal disclosure from the mother; however, this method is not always plausible. Sometimes, testing of the infant is necessary to determine the prevalence of NAS and the extent of the risk. The Finnegan Neonatal Abstinence Scoring System (FNASS) is the most widely adopted assessment scoring for NAS. This assessment scores 21 signs and symptoms of NAS, divided into three categories (Mehta et al., 2013). Though FNASS has been modified and improved several times, the assessment still has limitations, such as inter-rater variability, as some of the scored signs are subjective (Anbalagan & Mendez, 2022). Since the creation and adaptation of FNASS, other scoring tools have been created, like the Neonatal Withdrawal Inventory (NWI) and the Neonatal Narcotic Withdrawal Index (NNWI). Although these other measures have addressed the shortcomings of FNASS, they have not been widely implemented in hospitals nationwide for unknown reasons (Grossman & Berkwitt, 2019; Mehta et al., 2013).

The treatment for NAS can vary but will typically include medications to morphine, alleviate withdrawal symptoms (e.g., methadone, and buprenorphine), IV fluids to prevent dehydration (from excessive vomiting or diarrhea), and feeding the baby higher-calorie baby formula (March of Dimes, 2019). Neonatal mortality because of NAS is low, and most babies will recover within 5 to 30 days. However, some drugs, like heroin, can cause withdrawal symptoms in the baby for up to 4-6 months (March of Dimes, 2019; Stanford Medicine, n.d.). Most babies born with NAS have to stay in the hospital for 11 days on average, compared to two days for babies born without the condition. This extended stay in the hospital can make the cost of the stay nearly eight times the price of a standard newborn hospital stay—on average, the price of a hospital stay with a newborn with NAS is around \$8,000. In contrast, a hospital stay for newborns without NAS is around \$1,100 (CDC, 2025).

Although the condition has a very high survival rate, it is important to know that the long-term effects of NAS are still unknown. It is thought that NAS could lead to developmental delays (i.e., motor issues or behavioral issues), nutritional or growth issues, hearing or vision impairment, or both (March of Dimes, 2019). Additionally, babies with NAS are more likely to misuse and abuse harmful substances as they grow older into adulthood. Numerous societal and environmental factors can explain potential long-term effects, so more research needs to be done to pinpoint the exact long-term effects of NAS. However, it is recommended that all babies who had NAS receive routine follow-up exams with physicians to be able to determine any side effects after recovery (McQueen & Murphy-Oikonen, 2016).

Extent of the Problem and Need for Action

NAS within the United States is not a new discovery. The first case of NAS dates to 1875, shortly after the introduction of opium in the country. The term opioid was not introduced in the United States until the late 1950s, and it was used to refer to synthetic narcotics in general (Gomez-Pomar & Finnegan, 2018). Since the introduction of opioids in the country, the use and subsequent abuse of the substance have been on the rise. The use of opioids has also been increasing for pregnant women, too. In the 15 years between 1999 and 2014, the use of opioids during pregnancy increased by 333%, and, as a result, the number of cases of NAS has increased, too (Anbalagan & Mendez, 2022).

Today, the number of babies born with NAS is incredibly concerning, especially because the condition is preventable. The only way to prevent NAS is for the baby not to develop the addiction while in the womb; thus, the mother needs to stop using substances before pregnancy or immediately after she finds out she is pregnant (Stanford Medicine, n.d.). It is important to note, though, that it is not easy, nor is it recommended, for mothers to stop taking the medication. Rather, expectant mothers should consult with a medical professional to discontinue the drug safely to protect the well-being of both the mother and baby (March of Dimes, 2019).

Every state in the United States has cases of NAS; however, not every state has laws mandating NAS occurrence reporting (Jilani et al., 2022). As of 2018,

only Arizona, Florida, Georgia, Kentucky, Tennessee, and Virginia have laws that mandate NAS case reporting (Jilani et al., 2019). NAS reporting is advantageous in identifying problem areas within each state where cases are especially high and determining the effects of NAS on the community (Jilani et al., 2022). Despite the lack of laws mandating reporting, many states still take count of NAS incidences. A study of 47 states revealed that cases of NAS were most prevalent in Maine, Delaware, West Virginia, Vermont, and Kentucky (Hirai et al., 2020). Unfortunately, because reporting of NAS is not standard across the country, it is difficult to target areas where it occurs specifically. It is recommended that further research and standardization be done across the country to identify and respond to cases of NAS accurately. Research regarding NAS is being conducted globally but is concentrated within the United States (Zyoud et al., 2022).

Although NAS has been a global concern for decades, it remains understudied and continues to rise in prevalence. Because of the uncertain longterm effects of the condition on children and its preventable nature, it is crucial to address it by focusing on reducing opioid and other substance abuse among expectant mothers. Failure to address the issue jeopardizes the lives of more newborns.

Social Ecological Model

The social-ecological model approaches public health holistically, emphasizing the multiple factors that can influence public health and specific public health issues. The model encompasses physical, mental, and social wellbeing when conceptualizing health (CDC, 2022b). It has gained widespread acceptance across various disciplines, with many state, national, and international public health organizations utilizing this framework in their policymaking (Golden & Earp, 2012). The core principles of the social ecological model (Lee et al., 2017) include:

(1) there are multiple influences on an individual's behaviors, including factors at the intrapersonal level, interpersonal level, with increasing influence at levels of organization, community, and public policy; (2) influences interact across these different levels or spheres of influence; (3) use of this model should be applied to specific behaviors; and (4) multilevel approaches can be the most effective interventions for changing behaviors. (p. 299)

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The social ecological model has five levels. The first level of the model is the individual level, which identifies biological and personal historical factors that may contribute to the health problem (e.g., age, race, gender). Next, the interpersonal level includes the support system surrounding the individual, like friends and family members. Third, the organizational level addresses the entities that regulate a person or group of people. The community level is the fourth, which constitutes the relationships between organizations. Finally, the fifth level is public policy, which refers to the laws that government organizations enact.

Epidemiology of NAS

To understand what causes NAS, we must look first at its root cause, which is substance (opioid) abuse during pregnancy. If we address NAS as a public health issue, we must examine the reasons and circumstances that lead mothers to abuse opioids and investigate the factors that contribute to the continuation of this abuse throughout their pregnancy. Precursors of NAS are discussed below.

Socioeconomic and Environmental Conditions

Recent literature shows a link between socioeconomic challenges and NAS in infants. Specifically, individuals in rural or unsafe neighborhoods often face limited quality healthcare. Patrick et al. (2019) found that inadequate access to mental health services increases the risk of drug abuse during pregnancy, subsequently heightening the risk of NAS in newborns. Without adequate access to mental health services, expectant mothers are struggling to take proper care of themselves, which increases the likelihood of engaging in harmful behaviors that affect both themselves and their babies. Enhanced access to mental healthcare could encourage better utilization of services, ultimately improving maternal health and birth outcomes.

Furthermore, lower-income expectant mothers typically rely on government programs, like Medicaid, for healthcare. Women of childbearing age and pregnant women under Medicaid more frequently fill opioid prescriptions compared to those not covered under the program (Moore et al., 2018). They are more likely to abuse the drug during their pregnancy, thus putting them at a higher risk of their infant being born with NAS. Approximately 80% of NAS births are covered under Medicaid (Winkelman et al., 2018). However, treatment outcomes for NAS under Medicaid have shown to be less successful. Winkelman et al. (2018) found that infants born and treated under Medicaid were more likely to be transferred to another hospital and stay longer than those covered under private insurance.

Living and Working Conditions

A study by Patrick et al. (2019) found that babies born in areas with higher long-term unemployment rates were at higher risk of being born with NAS. This finding highlights the impact of socioeconomic struggles and the lack of adequate healthcare. Mothers who give birth to an infant with NAS are also more likely to be living in unstable housing, which is further exacerbated by the higher rates of sexual abuse that mothers with opioid abuse behaviors experience (Substance Abuse and Mental Health Services Administration, 2016).

Living and working conditions for expectant mothers with opioid abuse history are subpar and pose significant risks for both maternal and infant health. Addressing socioeconomic and environmental factors is essential for improving outcomes during pregnancy and delivery.

Family, Social, and Community Influences

Regardless of socioeconomic background or personal history, expectant mothers with opioid use disorders are at a greater risk of having a poor support system. Additionally, pregnant women with opioid use disorders are at a greater risk of experiencing interpersonal violence—whether from a spouse, family member, or close friend (Substance Abuse and Mental Health Services Administration, 2016). With better support systems in place, expectant mothers may be more motivated to seek treatment for their substance abuse, thereby reducing the risk of their infants developing NAS. Understanding interpersonal influences is especially important when assisting the mother and baby in the gestation period and the postpartum stage. By intervening and providing mothers with reliable sources of support, we can reduce the risk of substance abuse and relapse.

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Individual Lifestyle Factors

Expectant mothers with a substance abuse history face a societal stigma. Because of this stigma, they are less likely to seek treatment for their substance abuse. The stigma can be traced back to poor social support but also the history of treating drug addicts as less than others within society. We must reduce the stigma surrounding substance abuse to empower these women to seek treatment. Intervention is necessary to motivate pregnant women at risk of continued substance abuse to take action to improve the health of themselves and their babies, regardless of existing stigmatization.

Additionally, pregnant women with an opioid abuse history are at a greater risk of poor nutrition. Nutrition is just one way expectant mothers can be mindful of their habits to improve birthing outcomes; however, it is often neglected. Those with a lower income typically have fewer resources and, as a result, they are more likely to make more unhealthy choices. Interventions to promote a healthy diet among mothers may motivate them to take better care of themselves through their pregnancy and into the postpartum stage.

Mothers of babies born with NAS are more likely to have a history of unpredictable parenting models, which puts the infant at an increased risk after birth. It is imperative to intervene to address proper parenting techniques and habits to ensure the baby's safety. Educating mothers and highlighting the importance of care for the baby can make them better equipped to manage parenting challenges. Furthermore, pregnant women with opioid use disorders frequently face co-occurring psychiatric disorders, complicating treatment (Substance Abuse and Mental Health Services Administration, 2016). They can be in denial about the need for treatment or resist treatment altogether (Substance Abuse and Mental Health Services Administration, 2016). Educating them about the importance of seeking help could change health behavior and improve health outcomes.

These lifestyle factors, if not managed, can lead to greater access to illicit drugs and, thus, a greater chance of the infant developing NAS. Additionally, with access to illicit drugs comes a fear of legal repercussions. These mothers are at a heightened risk of facing legal consequences because of consuming these substances. In some situations, if an expectant mother already has children, she could be at risk of losing custody of her children.

Innate Factors

The severity of NAS is influenced by genetic variants in opioid receptor and stress response genes (Wachman & Farrer, 2019). The genetic response can determine how long the recovery time and hospital stay for NAS is. Additionally, the infants of White women most experience NAS. A 2015 study showed that per 1,000 births, the rate of non-Hispanic White women giving birth to an infant with NAS was 10.1. This rate is nearly five times higher than any other race or ethnicity (Healthcare Cost and Utilization Project, 2015).

Interventions

Current interventions for NAS target preventing or treating drug addiction in the mother before the baby is born. Pharmacotherapy for opioid use in pregnant women has been the most successful intervention. The standard of care for over 20 years has been methadone treatments (National Consensus Development Panel on Effective Medical Treatment of Opiate Addiction, 1998). More recently, however, buprenorphine has shown promising results. A clinical trial conducted between 2005 and 2008 demonstrated that babies born with NAS whose mothers received treatment of buprenorphine compared to methadone required shorter treatment duration, shorter hospital stays, and less medication themselves (Substance Abuse and Mental Health Services Administration, 2016). Still, these two drugs are considered Category C5 drugs by the FDA, meaning there are not sufficient studies demonstrating how these drugs impact pregnant women.

Though pharmacotherapy has shown itself to be beneficial for both the mother and baby, it is not without its limitations. Some women who undergo pharmacotherapy will want to try a medically supervised withdrawal. However, this approach is not recommended. Remaining on pharmacotherapy will produce the best outcomes for both the mother and baby. This is the recommended method as, should a mother choose to taper off or withdraw, even with medical supervision, there is a high failure rate, and these expectant mothers often return to misusing drugs during their pregnancy (American Society of Addiction Medicine, 2015; Jones et al., 2008).

Additionally, despite the success of pharmacotherapy, many mothers still face an unmet need for long-term care and recovery from the addiction (Chang et al., 1992). Still, despite the limitations of pharmacotherapy, the success of the intervention keeps it at the forefront. It is noteworthy that pharmacotherapy

does not necessarily ensure that the baby will be born without NAS. The intervention, however, will reduce the severity of the baby's condition. Patient-provider communication during this intervention is vital to ensure that mothers follow the appropriate care plan. Reassurance of safety is necessary as the dosage of the pharmacotherapy will be altered throughout the intervention. It is important to remind mothers that the dose of the pharmacotherapy will not affect the incidence or degree of NAS for the baby (Substance Abuse and Mental Health Services Administration, 2018). Aside from pharmacology, non-pharmacologic approaches have been considered, but only to treat chronic pain for the general population more broadly (Agency for Healthcare Research and Quality, 2022).

The Substance Abuse and Mental Health Services Administration (SAMHSA) created a model in which interventions are implemented at each stage to reduce the risk and potential harm of substance abuse exposure in the prenatal and postpartum stages. The Substance-Exposed Infants (SEI) outlines five stages in which intervention should occur: pre-pregnancy, prenatal, birth, neonatal, and throughout childhood and adolescence. The pre-pregnancy stage focuses on education. This stage includes promoting awareness to women of childbearing age and their families about the dangerous effects that substance use during pregnancy could have on infants. In the prenatal stage, interventions include screening pregnant women for signs of substance use and referring them to specific treatment centers if needed. For the birth stage, healthcare providers should be testing newborns for prenatal substance exposure immediately after delivery. Tests such as FNASS can be used to test for NAS. Next, routine assessments can be conducted in the neonatal stage to ensure the infant meets all the developmental indicators. This stage should also provide services for the newborn and the family, and interventions should ensure the family uses these services to promote healthy behaviors. In the final stage, throughout childhood and adolescence, interventions include continuing needed services for the child and their family. Each stage represents a critical point where interventions should be implemented. The SEI framework demonstrates the need for collaboration amongst organizations to support atrisk infants and families (Substance Abuse and Mental Health Services Administration, 2016).

The Children and Recovering Mothers Collaborative (CHARM) program is one example of the successful use of the SEI model. This was a multi-step intervention program based out of Burlington, Vermont. Within this program, 10 organizations collectively provide care for pregnant women with opioid disorders across Vermont. These programs provide services such as pharmacologic treatment, neonatal assessment and treatment, parent education, individual and group substance abuse treatment, residential care for mothers and infants, parent and family support, child safety assessments, child welfare services, healthcare for women in the corrections system, supplemental nutritional programs (e.g., WIC), and nurse home-visiting programs. One study tested the effectiveness of the CHARM program and found that out of the 106 CHARM infants studied, 94% were within normal limits on all developmental parameters at an eight-month check-up (Meyer et al., 2012).

Since NAS primarily affects the infant, it is particularly noteworthy to discuss interventions used immediately after birth to treat the newborn. One intervention with continuous promising results includes focusing on sensory support. Specifically, creating a quiet, soothing environment, and avoiding excessive environmental stimulation has shown to be helpful for infants with withdrawal symptoms (Sublett, 2013). Despite experts recommending placing a newborn with NAS in a dimmed, quiet space for the best outcomes, many infants with NAS are unable to receive this treatment as NICU spaces can quickly become crowded and loud, and there are seldom protected, designated spaces for neonates who may be experiencing withdrawals (Casper & Arbour, 2014). Intertwined with sensory support is the importance of swaddling. Research has demonstrated that tight swaddling is important in assisting neonates with NAS as it can prevent the infant from sudden and erratic movements, which exacerbate the withdrawal symptoms. Swaddling has also been shown to decrease the crying time for those with NAS and increase sleep quality and duration (Casper & Arbour, 2014).

Additional interventions for neonates with NAS include nutritional support. Specifically, breastfeeding can be especially helpful for both the mother and infant when available. Breastfeeding assists with bonding between the mother and infant, which can de-stress the mother while providing nutritional benefits to the baby. Also, breastfed babies with NAS are less likely to experience abuse (Sublett, 2013). Breastfed babies with NAS have also been shown to decrease the hospital stay and treatment duration. One study reported that breastfed neonates with NAS had almost 10% length of stay when compared to infants with NAS who were formula-fed (Cook & Fantasia, 2019). Unfortunately, women with a history of substance use have much lower rates of breastfeeding, usually because of time away from their infants for treatment

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and less support from friends and family to encourage breastfeeding once released from the hospital (Cook & Fantasia, 2019). Many health care providers are hesitant to encourage women who had substance use to breastfeed, too; however, women who had pharmacologic intervention (e.g., methadone or buprenorphine) are safe to breastfeed as there is little risk of transmission of the drug to the infant (Sublett, 2013).

Another intervention that has gained more attention recently is the use of alternative medicine to treat infants with NAS. More specifically, one treatment that has been tested is laser acupuncture. A study by Raith et al. (2015) demonstrated that neonates who received acupuncture and morphine received less morphine and were released from the hospital sooner than infants who were only given morphine. Notably, studies like this often have a small sample size, so the results are usually not generalizable. More research needs to be done before laser acupuncture is recommended as an effective intervention.

Recommendations

Prioritizing research is essential to address the shortcomings in the treatment and response to NAS. Firstly, there is no standardized or mandated reporting of NAS incidence across the United States. Mandating NAS incidence reporting in all 50 US states is imperative to identify states with continuously high NAS rates. Furthermore, once incidence reporting becomes mandatory, it must also be standardized. Standardized reporting will allow us to identify areas with low rates of NAS, prompting a closer examination of the effective interventions in those regions. Further interventions cannot be implemented until more research is conducted to better understand NAS incidence in high and low-incidence areas and their respective current interventions.

Once more research has been conducted on this condition, access to healthcare facilities should be increased in needed areas. Many communities, especially in rural or underserved urban areas, face healthcare deserts, where access to these vital services is limited or nonexistent. Addressing these gaps is crucial for improving health outcomes and ensuring all individuals have equal access to quality care. In addition, it is important to have mental health resources available. Because substance abuse is often intertwined with psychological disorders, there should be mental health care facilities easily accessible for expectant mothers who need treatment before the baby is impacted. For mothers with a history of substance use, timely intervention and support are crucial. The lack of accessible mental health and addiction services can increase the likelihood of NAS, leading to long-term health challenges for the baby. Healthcare providers must prioritize early screening and ensure that expectant mothers have access to resources for substance use treatment to prevent NAS and promote healthier outcomes for both mother and child.

Another much-needed recommendation is to increase training for nurses surrounding substance use and abuse. Currently, nurses often lack specific training in recognizing addiction behaviors, particularly in expectant mothers. By providing training for both current and future nurses on identifying addiction and substance abuse behaviors, they would be better equipped to recognize these signs during prenatal appointments, which could lead to timely interventions. These interventions can offer support to these mothers so that they can have a healthier pregnancy and safer delivery.

Specific to the after-birth stage, neonates with NAS need specialized spaces in the NICU where there are few environmental stimuli. Current research and previous interventions have demonstrated the need for quiet, dimmed spaces for babies with NAS to be able to recover; however, in most NICUs, there is not a designated space like this, which exposes these infants to unnecessary stimuli that prolongs their treatment time. If there is a space dedicated within NICUs across the country, NAS babies and babies born with other conditions that need a quiet space for treatment can make use of this area, which will increase the likelihood of a shorter stay in the hospital for treatment.

Looking more holistically at why and how NAS occurs, it is important that we address the needs beyond substance use. When substance abuse occurs, there are overlapping issues, like socioeconomic issues, mental health issues, or interpersonal relationship issues. If we can target areas where substance abuse is high, we can learn more about the difficulties of those who are experiencing it. The opioid and other substance crisis within the United States needs more dedicated and careful attention. Still, specific to pregnant women who abuse substances, there is often a desperate need for further interventions beyond just treating the NAS in the baby. If not carefully monitored and without adequate support, the chance of the mother returning to substances after discharge from the hospital remains alarmingly high, which demonstrates the need for further work to be done. Typically, not one single thing or event leads to a substance use disorder, so we must pay closer attention to mothers' needs beyond treating substance abuse disorders, as their health and safety could be impacted in numerous ways.

Finally, it is important to implement an individualized approach to care. While this is much easier said than done, it is vital that healthcare providers actively try to improve patient-provider interactions to improve health outcomes as a result. By listening to patient's needs, healthcare providers can tailor interventions and treatments. Each mother-baby dyad has its own specific set of needs to maintain a healthy lifestyle. With an individualized approach to care, mothers and babies can utilize specific interventions that target their needs following treatment from the hospital. An individualized approach to care begins with training healthcare professionals on the importance of patientprovider interactions and ways that providers can probe to reach a deeper understanding of their patients individually.

Conclusion

Addressing NAS requires a multifaceted approach that combines current interventions with innovative future perspectives. The growing prevalence of NAS underscores the urgent need for responsive care and comprehensive strategies to mitigate its impact. By leveraging recent national data and exploring new avenues for treatment, healthcare providers can better support affected infants and their families. As opioid use in pregnancy remains underreported and often undertreated, it is crucial to enhance awareness, improve reporting mechanisms, and develop targeted interventions that address both immediate and long-term needs. Through continued research and collaboration, we can pave the way for more effective solutions and ultimately improve outcomes for newborns facing NAS.

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