

A Quality Improvement Project to Reduce Length of Stay for Neonatal Abstinence Syndrome

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abstract

BACKGROUND AND OBJECTIVE: Neonatal abstinence syndrome (NAS), a self-limiting condition, is associated with clinical symptoms that may require pharmacological intervention. Optimal treatment of NAS remains undetermined, but the hospital length of stay (LOS) for patients with NAS is partially dependent upon a standard treatment protocol used. Prolonged LOS for patients with NAS can lead to adverse patient harm, impaired maternal–infant attachment, and significant health care costs. Therefore, we conducted a quality improvement study to reduce the LOS for infants with NAS.

METHODS: In 2009, a multidisciplinary NAS Taskforce was created to implement a standardized treatment protocol, discuss the strengths and weaknesses of the current medical and nursing management, and improve communication among staff. Infants with NAS that required pharmacological intervention were followed throughout their hospitalization. Readmission within 30 days of hospital discharge was tracked as a balancing measure.

RESULTS: Ninety-two infants were eligible for the project including 23 infants from a baseline period (January 2007–August 2009). Reliable monitoring of symptoms and the administration of a standardized morphine protocol effectively reduced LOS from 36 days to 18 days by June 2012. This improvement was sustained through December 2012. No patients were readmitted for NAS treatment.

CONCLUSIONS: The most effective interventions that impacted LOS for infants with NAS were the development of a staff NAS education program and the implementation of a standard treatment protocol. The formation of the NAS Taskforce was also essential because it facilitated communication and the dissemination of vital treatment information among all clinical staff.

On average, 10.7% of nonpregnant women of childbearing age and 5.9% of pregnant women reported illicit drug use in the month before the survey.^{1,2} In utero drug exposure, followed by an abrupt cessation of illicit substances at birth, may result in withdrawal symptoms, known as neonatal abstinence syndrome (NAS).^{2,3} Maternal use of opioids (eg, methadone, heroin, and codeine) is the most common cause of NAS, but other

psychoactive drugs may also cause withdrawal symptoms.^{3,4} Drug withdrawal is a self-limiting process,³ but severe cases may require pharmacological intervention to reduce these clinical signs. Withdrawal symptoms develop in 55% to 94% of infants exposed to opioids in utero.^{3,5} Presentation of withdrawal symptoms are variable and dependent upon the type of drug, amount of last maternal dose, timing of the last maternal

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dose,^{3,6} and infant and maternal metabolism.³ NAS is characterized by central nervous system irritability, including tremors, seizures, and excessive crying; gastrointestinal dysfunction, including vomiting, diarrhea, dehydration, and poor feeding; and autonomic instability, including fever, nasal stuffiness, and sweating.³

The American Academy of Pediatrics recommends drug-specific therapy from the same class as the addictive drug causing NAS symptoms.² However, the initiation of drug therapy should be based on the severity of the symptoms. A standardized symptom severity scoring system is essential for reliable assessment of withdrawal and communication among caregivers.³ Although most clinicians use morphine or methadone therapy,^{3,5} there is high variability among practitioners because the best course of treatment of NAS has not been determined.^{7,8} Additionally, few studies have investigated hospital length of stay (LOS) for infants with NAS. The reported LOS required for treatment can vary between 6 and 79 days.^{2,8-11} LOS is dependent upon numerous factors, including the treatment path, severity of the symptoms,¹² and maternal opioid dose.¹³ Long stays in the hospital can be detrimental to the infant-mother bond and developmental outcome,^{8,14} even when mothers are encouraged to spend time with their infants during the hospital stay. Furthermore, costs associated with caring for NAS infants with long hospital stays are extensive.^{15,16}

From 2004 to 2008, Nationwide Children's Hospital (NCH) in Columbus, Ohio, experienced a sixfold increase in infants with NAS. These infants were exposed in utero to maternal opioid, in particular methadone, heroin, and/or hydrocodone. Treatment of NAS was at the discretion of the attending physician. Average LOS of patients with NAS exceeded 36 days but

varied extensively. In this report, we describe our efforts to standardize the management of NAS and reduce the average LOS by using the Model for Improvement.¹⁷ An initial intervention using a methadone protocol appeared to lower the LOS in 2009 to 31 days. To further lower LOS for patients with NAS, we initiated a quality improvement project whose aim was to reduce the LOS for patients with NAS admitted to our main campus NICU baseline of 31 days to 24 days by December 31, 2010, and to sustain improvement through December 2012.

METHODS

Setting

Neonatal Services, a joint venture between NCH and 5 maternity hospitals in central Ohio, is 1 of the largest neonatal intensive care programs in the United States. In 2012, there were 191 beds in 6 level III NICUs and 2 level II special care nurseries. NCH manages the nurseries and leases the nursing staff from the maternity hospitals. Two private practice neonatology groups, 1 academic neonatology group, and an academic pediatric surgery group provide physician coverage. These 8 units admit >2200 neonates per year. Annually, >200 neonates are discharged from NCH intensive care nurseries with NAS.

Ethical Issues

Nearly 40% of patients admitted to NCH nurseries and over 90% of patients with NAS are insured through Partners for Kids, a Medicaid managed care company owned by NCH. NCH is capitated and fully at risk for these Medicaid patients.

This quality improvement work involved implementation of evidence-based interventions or potentially best practices designed to optimize patient outcomes and shorten duration of hospitalization. No interventions involved comparison of multiple devices or therapies, and no

patients were subjected to randomization. Medical records were accessed by quality improvement team members as part of their normal job descriptions. No personal health information was shared outside of NCH. Therefore, the approval by the NCH Institutional Review Board was not required.

Inclusion/Exclusions

In this report, we describe data for patients with NAS admitted to our main campus NICU, an all-referral unit with no inborn population. Among NCH nurseries, this NICU had the longest and most variable LOS. In contrast to infants with NAS born at our affiliated maternity centers, infants admitted to the main campus NICU were often identified and referred for treatment late in their withdrawal process. In addition to admission to the main campus NICU, study patients had to have some clinical or historical evidence of exposure to opioids in utero and require therapy for NAS. Patients with iatrogenic drug withdrawal due to postnatal pain management were excluded. Also excluded from this report were (1) premature infants <35 weeks' gestation, (2) infants admitted to NCH after 6 days of age, (3) infants who received >24 hours of methadone therapy before admission to NCH, (4) infants who died, and (5) infants who required surgical interventions. These infants were excluded because their LOS was believed to be unrelated to NAS.

Key Driver Interventions

We identified several key drivers: (a) communication among medical and nursing staff to facilitate learning, (b) minimization of variability in Finnegan scoring by the neonatal nurses, (c) the development of a standard initiation and weaning protocol, and (d) collaboration with obstetricians-gynecologists and addiction specialists to optimize prenatal management of opioid addicted pregnant women.

Team Communication and Support

To improve communication, education, and support among medical, nursing, and support staff, the NCH NAS Taskforce was established. The NAS Taskforce met monthly and included medical, nursing, and ancillary health care representatives. At taskforce meetings, members reviewed data and listened to a variety of didactic presentations regarding NAS and the problems of substance abuse. Staff also discussed unit problems related to the management of patients with NAS, developed strategies to improve processes, evaluated the interventions, and spread process improvements to other neonatal units.

Variability in Finnegan Scoring

The Finnegan Neonatal Abstinence Syndrome Scoring System (FNASSS) was used by the nursing staff to assess an infant's withdrawal symptoms and need for pharmacologic intervention.¹⁸ Therapy was initiated when FNASSS scores were >8 on 3 consecutive measurements or >12 on 2 consecutive measurements within a 24-hour period. However, excessive variability in the FNASSS scores recorded by the neonatal nurses complicated NAS management. To resolve this issue, we contracted with a nursing expert in the management of patients with NAS and the application of the FNASSS (Karen D'Apolito, PhD, Professor of Nursing, Vanderbilt University). Using an instructional video and a "train the trainer" approach, "super users" were taught how to assign FNASSS scores based on the signs and symptoms of NAS. These super users then trained the remaining nursing staff at each of the NCH nurseries. This training was completed in November 2009.

During early 2011, all nursing staff received additional training on FNASSS scoring. This training provided staff with a video example of NAS Finnegan scoring, 2 practice

TABLE 1 Oral Morphine Initiation Protocol and Enteral Morphine Protocol for NAS

Protocol should be initiated if an infant has 2 consecutive scores ≥ 8 or 1 score ≥ 12 within a 24-h period (just as was done previously with the methadone taper).
Concentration of Enteral Morphine to Be Used for All Doses: 0.2 mg/mL

Starting dose:
Enteral: 0.05 mg/kg/dose orally q3h
IV: 0.02 mg/kg/dose (IV morphine and enteral morphine doses are not equivalent)

Titration:
Enteral: Increase by 0.025–0.04 mg/kg every 3 h until controlled (NAS <8)
IV: Increase by 0.01 mg/kg every 3 h until controlled (NAS <8)

Rescue Dose: If infant has 1 score of ≥ 12 double the previous dose given (enteral or IV) $\times 1$ and then adjust accordingly:
If NAS score now <12: make the scheduled MD the same as the rescue dose that was just administered. The first higher MD should be given at the next scheduled care/feed.
If NAS score still ≥ 12 : increase next dose by 50%. Continue to do so until score is <12. Once <12, then follow guideline listed above.
If infant requires and is not stabilized on <0.1 mg/kg/dose every 3 h of morphine, consider adding adjunctive therapy (see Table 3).

IV, intravenous; MD, maintenance dose.

examinations, and an instruction manual with the definitions required for proper scoring.¹⁹

Oral Morphine Weaning Protocol

Before the formation of the NAS Taskforce, a standardized oral methadone weaning protocol was implemented in May 2009. This change appeared to lower the average LOS for patients with NAS to 31 days. However, the long half-life of methadone and the variability in nursing assessment complicated the weaning process. Thus, we developed and implemented an oral morphine initiation and weaning protocol in December 2009 (Tables 1, 2, 3, and 4). Compliance with the protocol was monitored weekdays during patient care rounds by a neonatal clinical pharmacist who made

recommendations for dosing adjustments.

The original morphine protocol required 3 FNASSS scores >8 to initiate pharmacologic therapy. Because NCH is a referral hospital, the majority of our infants with NAS are already in withdrawal with high Finnegan scores upon admission. To gain control of these infants' symptoms more rapidly, the morphine protocol was revised in May 2010 to require only 2 scores of ≥ 8 or 1 score of ≥ 12 to begin drug therapy (Table 2). The revision included specifics regarding the use of phenobarbital for treating infants exposed to multiple drugs. Further modifications were made in March 2011 to include the addition of clonidine adjunct therapy if the infant required high-dose morphine or if the

TABLE 2 Oral Morphine Weaning Protocol and Enteral Morphine Protocol for NAS

Wean: Once stabilized on a dose for 72–96 h, use this dose as the starting point of the wean (please note this dose on infant's card). Begin weaning the dose by 10% (of the original dose when the first wean was started) every 24–48 h. Drug may be discontinued when a single dose is <0.02 mg/kg/dose. Please see below for example.

Ad lib infants: Given the shorter duration of action of enteral morphine, it is best suited to be dosed on a q3hr schedule. Infants should be allowed to ad lib feed volumes but kept on a q3hr schedule.

Backslide: If infant's NAS scores become consistently elevated (example, 2 consecutive ≥ 8) during the weaning process, ensure that nonpharmacological measures are optimized (ie, swaddling, holding, decreased stimuli, etc) before going back to previous dose at which patient was stable. If infant's scores continue to be elevated (even after physical examination to ensure nothing else is wrong/bothering the infant), either weight adjust medication and/or continue to back up in a stepwise fashion until patient's scores are <8. Once stabilized on a new dose for minimum 48 h resume 10% wean but consider weaning at longer intervals.

Discharge: Observe in-house \times 48–72 h off of medication before discharge.

TABLE 3 Adjunctive Therapy for Patients With NAS

Phenobarbital	
Consider starting phenobarbital if polysubstance exposure is suspected or confirmed or if majority of NAS score is due to CNS disturbances (hyperactive reflexes, tremors, increased muscle tone, presence of jerks, etc).	
Loading dose (up to physician's discretion if needed): 10 mg/kg/dose orally q12h × 2 doses	
Enteral formulation contains a high percentage of alcohol. Recommend dividing dose to decrease risk of emesis and/or sedation.	
Maintenance dose: 5 mg/kg/dose orally once daily, preferably in the evening. Dose may be divided BID if concern for excess sedation. Do not routinely weight adjust.	
Weaning: Recommend discharging infant home on phenobarbital with subsequent weaning to be done either in neonatal follow-up clinic or by infant's primary care physician.	
Phenobarbital Levels: Drug levels should not be needed for this indication unless the infant experiences seizures or seizurelike activity. If suspected, a phenobarbital level and/or a neurology consult may be warranted at that time.	
Clonidine	
Consider starting clonidine if the majority of NAS score is due to autonomic overstimulation (sweating, fever, yawning, mottling, sneezing, etc) and if infant is requiring >0.1 mg/kg/dose of morphine q3h and is still not stabilized.	
Maintenance dose (0.1 mg/mL suspension):	
Given that the infant will be receiving morphine on a q3hr basis, for ease of administration recommend 1 μg/kg/dose orally every 6 h (range: 4–6 μg/kg/day divided q4–6h)	
Side effects of clonidine include bradycardia, hypotension upon initiation, and then rebound hypertension when drug is discontinued.	

BID, twice daily; CNS, central nervous system.

majority of their NAS symptoms were due to autonomic overstimulation (Table 3). Additionally, methadone therapy was indicated if the infant was unable to be weaned after 30 days of oral morphine. (Additional details of the pharmacologic and nonpharmacologic management of NAS are available from the author [Dr McClead J.]

Collaboration With Obstetricians–Gynecologists and Addiction Specialist

Recognizing that maternal addiction and resultant NAS is a community-wide problem, the NCH NAS Taskforce was expanded to include members from all maternity centers and addiction treatment specialists in central Ohio.

Statistical Analyses

LOS, the primary outcome metric, was measured as the time from admission to the NCH main campus NICU to discharge. LOS and the impact of improvement interventions were monitored by using statistical process control charts.²⁰ Baseline data were determined from patients admitted from January 2007 to August 2009. A Ln(x) transformation was used to calculate appropriate control limits.

RESULTS

From January 2007 to December 2012, 199 infants with NAS were admitted to the main campus NICUs. Of these, 92 (47%) met inclusion criteria including 23 infants admitted

during a baseline period from January 2007 to August 2009. The study infants were mostly boys ($n = 52$, 59%) and on average had a mean birth weight of 2985 g (range, 2017–4204) and an estimated gestational age of 38 weeks (range, 35–41).

Training of the neonatal nursing staff in the application of the FNASSS score for NAS was completed in November 2009, and the oral morphine protocol was initiated in December 2009. After implementation of the oral morphine protocol, the average LOS decreased to 27 days. This improvement was sustained through 2010 and 2011. In June 2012, the average LOS decreased to 18 days with a further narrowing of the upper and lower control limits (Figs 1 and 2). This improvement in LOS was associated with retraining of nursing staff on Finnegan scoring.

Of the study infants admitted to the main campus NICUs from 2010, none were readmitted within 30 days of follow-up due to NAS symptoms. However, 9 (12.7%) infants discharged from an NCH nursery after treatment of NAS were readmitted: 3 for bronchiolitis symptoms, 4 for feeding issues unrelated to NAS, and 2 for respiratory failure unrelated to NAS. One of these infants had a Rhinovirus infection; the other had respiratory symptoms that led to the diagnosis of cystic fibrosis.

DISCUSSION

Several key interventions were associated with an improvement in the LOS of infants with NAS admitted to the main campus NICUs. A standard treatment protocol for infants with NAS was developed and as treatment knowledge increased, protocol revisions were implemented to improve the overall outcome of patients with NAS. Compliance with a standardized protocol may be more important than the specific pharmacologic intervention because we saw decreased LOS when

TABLE 4 Quality Improvement Intervention Timeline

Implementation Date	Quality Improvement Interventions
May 2009	Methadone protocol trial
November 2009	FNASSS training of nursing staff
December 2009	Morphine protocol initiated
January 2010	NAS LOS project begins
May 2010	Protocol revised to decrease morphine initiation criteria and phenobarbital therapy
March 2011	Protocol revised to add clonidine therapy and criteria for change to methadone therapy
March 2012	Nursing re-education regarding FNASSS

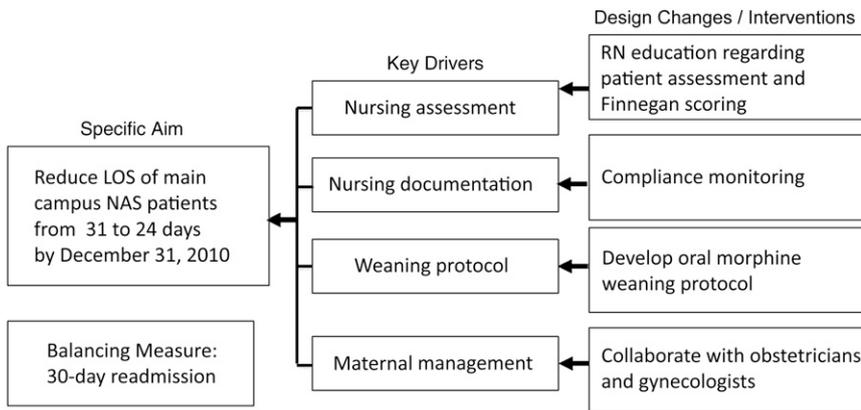


FIGURE 1 Specific aim and key driver diagram developed by the NAS LOS Reduction Taskforce.

a methadone protocol was initiated. A recent report by Hall et al²¹ confirms that a standardized methadone protocol and our morphine protocol give similar results in LOS reduction. The formation of the NAS Taskforce

facilitated communication among the medical and nursing staff; barriers to improvement and possible solutions were identified. A standardized nursing education program for patient assessment and FNASSS

scoring led to improved patient assessment and more reliable information to determine need for initiation and weaning of pharmacologic therapy.

Our study highlights the importance of a standardized treatment protocol. Although the majority of accredited fellowship programs in neonatal-perinatal medicine in the United States use the FNASSS system or some variation thereof, only 70% of programs use a scoring system when determining pharmacological treatment.⁷ A little more than 50% of responding programs have a NAS written policy in place.⁷ This intervention was successful, in part, due to the high vigilance and care provided by the medical, pharmacy, and nursing staff treating these infants. However, not all infants with

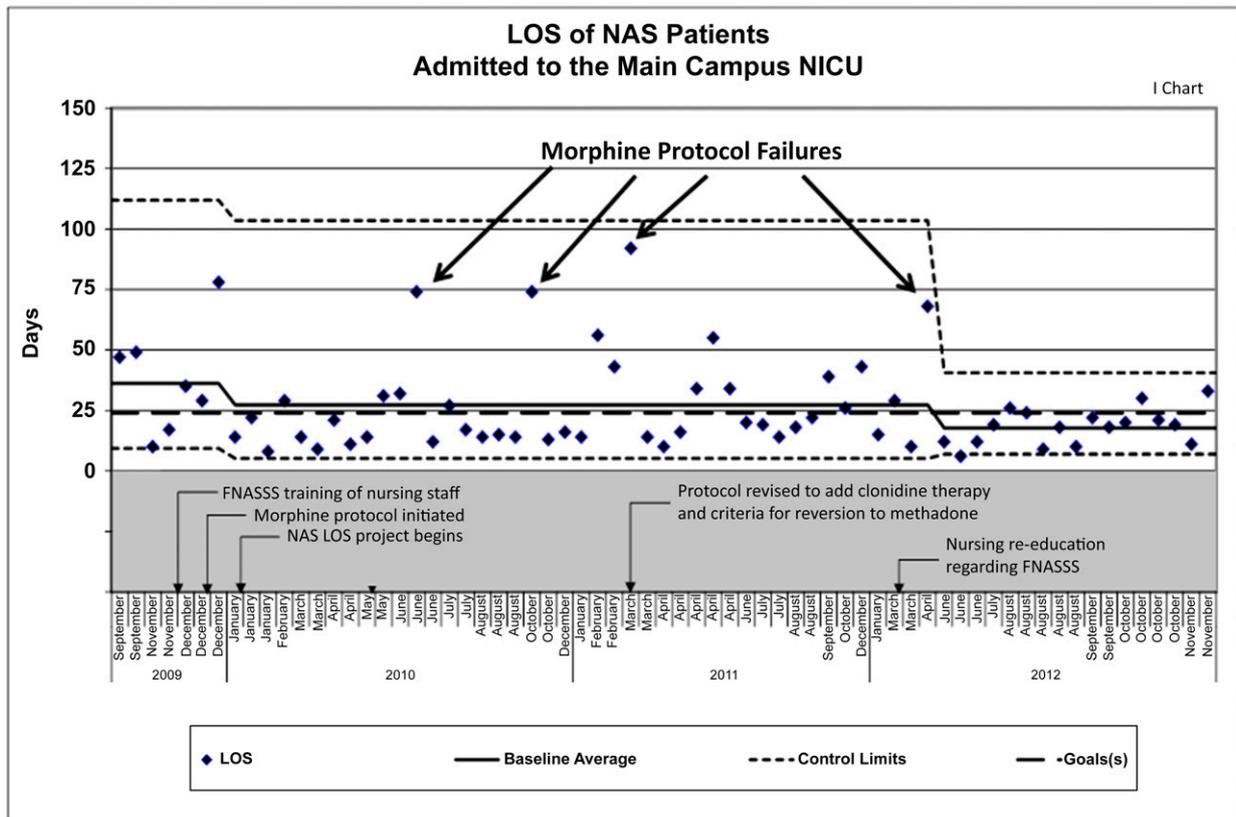


FIGURE 2 Annotated individual control chart (I-Chart)²⁰ with LOS of individual study subjects noted from September 2009 to December 2012. Baseline centerline and control limits were determined from January 2007 to August 2009. These 23 baseline data points are excluded from the figure for clarity of presentation. Dates of interventions are also listed in Table 4. A $\ln(x)$ transformation was used to calculate appropriate control limits. These limits may not be equidistant from the centerline.

NAS responded to the oral morphine weaning protocol. Infants whose mothers received prenatal methadone in excess of 80 mg per day or who were abusing multiple illicit drugs may not respond to oral morphine only and may require adjunctive therapy with phenobarbital or clonidine. Patients with NAS who could not be weaned with oral morphine were switched to a methadone treatment regimen.

Patrick et al¹⁶ reported a shorter LOS for patients with NAS than we describe in our quality improvement project. Their study was based on administrative coding data. From a review of our own patients, we find that it is not uncommon for infants to be coded as NAS (International Classification of Diseases, Ninth Revision, Clinical Modification code 779.0) because they were opiate exposed in utero, but they did not require treatment of NAS. As a consequence, these infants have short LOS, and they are not included in our project. Moreover, only ~20% of the patients with NAS in the Patrick et al¹⁶ study were hospitalized at a children's hospital. Of these, it is not clear as to how many patients with NAS were referred were outborn. Outborn infants may have longer LOS than those patients who are inborn. Infants with NAS born at our affiliated maternity centers and admitted to the onsite intensive care nurseries have LOS that is comparable to that reported by Patrick et al.¹⁶

There are some limitations to this study. The small sample size at an all-referral hospital limits the generalizability. Infants with NAS included in this project often exhibited significant withdrawal symptoms by the time they were admitted to the hospital. This factor may contribute to their longer LOS. Infants with NAS born at the NCH-affiliated maternity centers have an average LOS <20 days. These infants are treated by using a similar oral

morphine protocol, but therapy is initiated soon after NAS symptoms are identified.

Minimizing LOS is important because time spent in a hospital is not beneficial for the infant-parent attachment. Future research should track these children beyond the first year of life for various outcomes, especially neurologic and behavioral factors, but also to determine overall health and whether the children are seeking medical treatment of conditions related to their diagnosis of NAS. Additionally, the developmental outcomes of these infants should be investigated, because the lifelong impacts of early drug exposure are unknown.²² To that end, we refer our patients with NAS to our neonatal developmental follow-up clinic; however, reliable long-term follow-up with these patients remains an issue.

CONCLUSIONS

We used the Model for Improvement methodology to decrease the LOS for infants with NAS admitted to an all-referral NICU. Key interventions included implementation of a standardized oral morphine protocol and formal training of nursing staff in the proper use of the Finnegan scoring system for infants with NAS.

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