JPPT | Single Center, Retrospective Quality Assurance Study

Implementation of Interprofessional Rounds Decreases Neonatal Abstinence Syndrome Length of Stay

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OBJECTIVE Neonatal abstinence syndrome (NAS) occurs due to abrupt discontinuation of chronic fetal exposure to substances used by the mother during pregnancy. As the incidence of NAS continues to increase, medical teams are evaluating strategies to reduce length of stay (LOS). Increased LOS contributes to poorer mother-infant bonding and neurodevelopmental outcomes as well as increased health care cost. As part of an ongoing quality improvement project, the objective of this study was to determine if formal interprofessional rounds affected LOS for infants with NAS.

METHODS This was a retrospective analysis at a single hospital system to determine if interprofessional rounds had an impact on NAS LOS. On February 5, 2016, introduction of formal weekly interprofessional NAS-specific rounds occurred in addition to daily patient care rounds. Every patient with opioid exposure undergoing Finnegan scoring, treated with weight-based morphine, and >35 weeks gestation was included. Data were collected on LOS and length of therapy for eligible patients. This study evaluated the impact of interprofessional rounds on LOS 17 months after its implementation compared with 13 months immediately preceding.

RESULTS Among the 119 infants (51 pre and 68 post) meeting inclusion criteria, the median LOS for the postrounds group was significantly shorter than the pre-rounds group (13 vs 16 days, p = 0.001). The median length of therapy (morphine with or without clonidine) was also significantly shorter in the post-rounds versus the pre-rounds group (8 vs 12 days, p = 0.001).

CONCLUSIONS Formal weekly interprofessional NAS rounds decreased LOS and length of therapy.

ABBREVIATIONS LOS, length of stay; LOT, length of therapy; NAS, neonatal abstinence syndrome; NCH, Nationwide Children's Hospital; NICU, neonatal intensive care unit; QI, quality improvement

KEYWORDS clinical protocol; duration of therapy; interdisciplinary communication; interprofessional; length of stay; morphine; neonatal abstinence syndrome

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Introduction

Neonatal abstinence syndrome (NAS) occurs due to abrupt discontinuation of chronic fetal exposure to substances that were used or abused by the mother during pregnancy. Signs typically manifest 48 to 72 hours after birth but may not occur until 14 days after birth. Opioid exposure is the most common cause of NAS and the most commonly treated pharmacologically. Withdrawal signs in these infants can include central nervous system irritability (e.g., tremors, seizures, excessive crying), gastrointestinal disease (e.g., vomiting, diarrhea, poor feeding), and autonomic signs (e.g., fever, nasal stuffiness, yawning, sweating).¹⁻⁵

Neonatal abstinence syndrome accounts for a large and growing number of hospitalized patients each year.⁶ In 2015, the National Survey on Drug Use and Health reported that in the month prior to the survey, 4.7% of pregnant women and 12.5% of non-pregnant women of childbearing age used illicit drugs.⁵ In Ohio, the number of infants with NAS grew from 20 per 10,000 live births in 2006 to 155 per 10,000 live births in 2015. This contributed to over \$133 million in hospital charges and an average length of stay (LOS) 4 times higher than all other Ohio infants.⁷ As the incidence of NAS continues to increase, medical teams are evaluating strategies to reduce LOS. Increased LOS contributes to poorer mother-infant bonding and neurodevelopmental outcomes as well as increased health care cost.^{8,9} In the setting of an ongoing public health crisis, many NICUs, newborn nurseries, and pediatric hospitals are considering measures to reduce the LOS for infants affected by maternal drug use.

Nationwide Children's Hospital (NCH) in Columbus, Ohio has a robust quality improvement (QI) initiative regarding LOS in NICU patients. A subset of this project focuses on patients with NAS, and this QI initiative has been ongoing since 2009. LOS has decreased substantially by implementing pharmacologic protocols and re-training nursing staff on Finnegan scoring. However,

Table 1. Interprofessional NAS Rounds Patient Rounding Template			
1	Bedside nurse presents pertinent NAS-related information about the patient Name Date of birth Post-menstrual age and days of life Date of admission Does the patient have consults for music, massage, OT, PT, lactation (if applicable) Current formula Date that medication for NAS started What phase the patient is in: initiation, escalation, stabilization; weaning; backslide; adjunct What is the current dose of NAS medication(s) What were the NAS scores for the last 24 hours		
2	Advanced practice provider presents objective data Weight Ins and outs Laboratory studies		
3	Other team members present Social worker and nurse care coordinator: disposition plan Dietitian and lactation: changes to feeding regimen OT, PT, music, and massage: feedback about how sessions are going		
4	Pharmacist presents Reviews overall course Recommends pharmacologic plan		
5	Physician, advanced practice provider, and pharmacist develop patient-specific plan Pharmacologic plan is documented in the electronic medical record by the pharmacist		

NAS, neonatal abstinence syndrome; OT, occupational therapy; PT, physical therapy

our team identified a knowledge gap in the effects of interprofessional care for patients with NAS.

The use of interprofessional rounds has decreased LOS in several adult patient populations such as trauma patients, cardiac transplant patients, and patients with either acute myocardial infarction, congestive heart failure, or pneumonia.^{10–12} Limited information assessing interprofessional rounds and LOS exists for pediatric and neonatal populations. A QI project showed that implementing weekly interprofessional rounding meetings in medically complex patients in the NICU decreased the average LOS by 6.5 days. Patients included in that study were diagnosed with conditions that are typically excluded from studies in patients with NAS, such as hypoxic ischemic encephalopathy, chronic lung disease, congenital diaphragmatic hernia, or multiple congenital anomalies.¹³ The purpose of this study was to determine if the development of formal interprofessional NAS rounds had an impact on LOS for patients with NAS. The primary objective was to compare the LOS of patients with NAS before and after implementation of interprofessional NAS rounds. The secondary objective was comparing length of therapy (LOT) between patients treated before implementation of interprofessional NAS rounds compared with patients treated after.

Materials and Methods

Data were collected as part of a continuing QI project

focusing primarily on decreasing LOS in patients with NAS. Data were de-identified for analysis to examine the effects of interprofessional NAS rounds.

Study Design. This was a retrospective analysis at a single hospital system to determine if interprofessional rounds had an impact on NAS LOS. Patients were enrolled into 2 groups: pre-rounds (patients admitted between January 1, 2015, and February 4, 2016) and post-rounds (patients admitted between February 5, 2016, and June 30, 2017). Interprofessional NAS rounds initiated Feb 5, 2016. Patients were included if they were exposed to an opioid in utero, underwent Finnegan scoring, treated with intermittent weightbased morphine for NAS, and admitted to a NCH NICU between January 1, 2015, and June 30, 2017. Patients who required adjunct treatment with clonidine and/or phenobarbital were included. Patients were excluded if they were <35 weeks gestation at birth, did not complete the entire morphine course at NCH, or had medical conditions with high likelihood to confound either proper Finnegan scoring or LOS outcomes. These conditions included the following: neurological impairment, respiratory distress, infection, or feeding intolerance not related to NAS.

Finnegan Scoring. Nurses performed modified Finnegan scoring every 3 to 4 hours to assess all patients with NAS. Nurses were re-educated on the Finnegan scoring tool annually. As a part of maintaining interrater reliability, each patient with NAS had 2 nurses independently score the patient at the same time once per shift as well as any time a patient was assigned a Finnegan score of 9 or higher. These dual scoring times were recorded on a dual-score compliance sheet per unit policy. In the event that the dual scores differed, the nurses discussed the discrepancies and assigned a final score together, which was then recorded in the electronic medical record.

Treatment Protocol. For treatment of NAS, 4 of the 7 NICU locations within the NCH Neonatal Network used the same weight-based morphine protocol. Two locations used a non-weight-based morphine protocol, and 1 location initially used a methadone protocol and then changed to a morphine protocol. The weightbased morphine protocol used morphine dosing every 3 hours. Once a patient had stable scores for 48 hours, morphine weans occurred every 24 hours unless there were 2 consecutive Finnegan scores 9 or higher. Patients were monitored for at least 48 hours off morphine (or clonidine) before discharge. Adjunct medication (clonidine or phenobarbital) could have been added if the patient initially required a high morphine dose, had 2 consecutive weaning failures, or made no progress by day 14 of therapy. For specifics about the treatment protocol, please refer to the supplemental material.

Interprofessional NAS Rounds. Prior to February 5, 2016, patients with NAS had a bedside nurse, advanced practice provider (e.g., nurse practitioner, physician assistant), attending physician, nurse care coordinator, and dietitian consistently rounding as a part of routine care of a hospitalized neonate. A clinical pharmacist and other support services were available for questions. Initiation of interprofessional NAS rounds arose to increase communication among care team members, improve NAS protocol adherence, and decrease variability in LOS. The complete care team for interprofessional NAS rounds included the patient's family, bedside nurse, advanced practice provider or medical resident, attending physician, nurse care coordinator, clinical pharmacist, dietitian, lactation consultant, massage therapist, music therapist, occupational therapist, physical therapist, and social worker. At least once weekly, the complete health care team used the NAS rounds template (Table 1), to round on patients with NAS. Discussion took place regarding successes and challenges for each patient, and plans for both non-pharmacologic and pharmacologic care were developed and documented in the electronic medical record. Interprofessional NAS rounds occurred in addition to routine daily rounds.

Outcomes. The primary outcome was LOS. The secondary outcome was LOT. Of note, LOT included therapy with morphine and clonidine. Phenobarbital adjunct treatment was also an option; however, patients could be discharged on this medication. Counter-balance measures were days of last medica-

tion dose (of morphine or clonidine) to discharge and 30-day readmissions.

Data Collection. We collected the following maternal factors: race and exposure. Exposure was determined via maternal urine toxicology screen at delivery, maternal report, or by toxicology screen performed on infant (urine, meconium, or cord) at or shortly after birth. Infant variables included gestational age, birth weight, and sex. We also collected data on admission and discharge date as well as first and last dose of morphine, clonidine, and phenobarbital. LOS was measured in days, from admission date to discharge date. LOT was measured by the difference between the date and time of first morphine dose to the date and time of the last morphine or clonidine dose (whichever occurred later), rounded to the nearest full day. This information was obtained from the electronic medical record.

Statistical Analysis. The data were analyzed for normality with Shapiro-Wilk test. Student *t* test was used for normally distributed data while Mann-Whitney *U* test was used for non-parametric data. Chi-square test was used for categorical data. Statistical tests were 2-sided and at a significance level of $\alpha = 0.05$. Analyses were performed using IBM SPSS Statistics version 24.0.

Results

From January 1, 2015, to June 30, 2017, there were 179 infants who met the inclusion criteria. A total of 60 patients were excluded: 10 were <35 weeks gestational age at birth, 30 had another medical condition not related to NAS, 17 did not have access to full morphine course, and 3 were excluded for other reasons. Of the infants who were excluded for "other" reasons, 2 infants were excluded because they had been discharged from a birth hospital and were readmitted to the NICU with signs of NAS and 1 infant was excluded because there was no opioid exposure in utero. This left 119 patients to analyze, of which 51 patients were in the pre-rounds group and 68 patients were in the post-rounds group. No patients had morphine treatment that was started in the pre-rounds time frame and continued into the post-rounds time frame.

The study infants were predominantly male (n = 66, 55%) with a median (IQR) gestational age of 38.9 weeks (38–39.4) and birth weight of 2996 g (2704–3174). Baseline demographics were similar between groups, including maternal exposure (Table 2). When comparing medications used for treatment, the pre-rounds group had significantly more use of adjunct medication than the post-rounds group (p = 0.009).

The Figure presents outcome measures. The median LOS of the post-rounds group was 13 days (IQR, 11–16), which was significantly shorter than the pre-rounds group, which had a median LOS of 16 days (IQR, 14–22; p = 0.001). The median LOT of the post-rounds group was 8 days (IQR, 6–12), which was significantly shorter than the pre-rounds group, which had a median LOT of

Table 2. Characteristics of Mothers and Infants at Baseline				
Characteristic	Pre-Rounds (n = 51)*	Post-Rounds (n = 68)*	p value	
Mothers Opioid exposure, n (%) Buprenorphine Methadone Other opioid (prescribed or illicit) Poly-substance [†] Other exposure, n (%) Nicotine Tetrahydrocannabinol	16 (31) 2 (4) 10 (20) 23 (45) 22 (43) 14 (27)	19 (28) 5 (7) 23 (34) 21 (31) 28 (41) 23 (34)	0.22 0.69 0.70 0.10 0.13 0.85 0.55	
Race/ethnicity, n (%) White Black Hispanic	49 (96) 1 (2) 1 (2)	68 (100) 0 0	0.26	
Infants Gestational age, median (IQR), wk Birth weight, median (IQR), g Male, n (%)	38.7 (37.6–39.3) 2982 (2609–3113) 26 (51)	38.9 (38–39.9) 3022 (2762–3211) 40 (59)	0.19 0.45 0.39	
Medication use, n (%) Morphine alone Morphine plus adjunct therapy	32 (63) 19 (37)	57 (84) 11 (16)	0.009	

* Patients in the pre-rounds group include those admitted between January 1, 2015, and February 4, 2016. Patients in the post-rounds group include those admitted between February 5, 2016, and June 30, 2017.

⁺ Opioid plus benzodiazepine and/or stimulant (e.g., cocaine, amphetamine, methamphetamine).

12 days (IQR, 9–17; p = 0.001). Not only were the median LOS and LOT shorter in the post-rounds group, but there was also decreased variability of these outcome measures in the post-rounds group. The median days from last medication dose to discharge were no different between the post-rounds vs pre-rounds group (1.74 vs 1.75 days, p = 0.82). No readmissions for NAS concerns occurred within 30 days of discharge. However, readmission occurred for 4 infants (3.4%) for non-NAS related complications after treatment for NAS.

Because decreased adjunct use could inherently lead to decreased LOS, we performed a subgroup analysis of morphine-only treated patients. There were 32 morphine-only treated patients in the pre-rounds group and 57 morphine-only treated patients in the post-rounds group. The median LOS of the post-rounds group was significantly shorter than the pre-rounds group (13 vs 15 days, p = 0.045). The median LOT of the post-rounds group was significantly shorter than the post-rounds group (8 vs 11 days, p = 0.038).

Discussion

Weekly interprofessional NAS rounds led to a decrease in LOS of patients with NAS at our institution. The decrease in LOS remained even when analyzing patients treated with morphine alone. Decreased LOS is likely due to increased education opportunity for staff on the NAS protocol used, weekly reminders of the importance of non-pharmacologic intervention, and discussion about adherence successes and failures to the protocol. Improved team communication and collaboration also helped maintain the decreased LOS in our population of patients with NAS by creating a culture shift focused on consistency in following the NAS protocol for both pharmacologic and non-pharmacologic interventions.

This study was a continuation of previous LOS reduction work in patients with NAS done at our institution by Asti et al.³ In 2015, Asti et al³ showed that implementation of a standardized protocol for treatment of NAS in the NICU significantly reduced LOS from 36 to 31 days. In subsequent steps to reduce LOS, Asti et al³ changed the primary treatment medication from methadone to morphine. This resulted in reduction of LOS to 27 days. Lastly, Asti et al³ focused on re-training the nursing staff and improving interobserver reliability. Improved nursing training decreased the LOS to 18 days.³ Of note, the study by Asti et al³ included patients through 2012. Between the end of that study and the beginning of this study, there was a medication protocol update at our institution, which decreased LOS from 18 days to 16 days. Now, with the addition of interprofessional NAS rounds, the median LOS at our institution is 13 days.

Implementation of interprofessional NAS rounds led to a 3-day decrease in LOS. With the daily services cost of a NICU stay approximately \$7400 per day, this equates to a savings of about \$22,000 per patient or about \$1.5 million for our institution over the 1.5 year post-rounds **Figure.** Outcomes associated with interprofessional rounds in infants with neonatal abstinence syndrome in a hospital system.*



* Interprofessional neonatal abstinence syndrome rounds initiated on February 5, 2016. Patients in the pre-rounds group (n = 51) include those admitted between January 1, 2015, and February 4, 2016. Patients in the post-rounds group (n = 68) include those admitted between February 5, 2016, and June 30, 2017.

study period. This is a notable cost savings that could be applied to other institutions. As health care continues to be affected by the opioid epidemic, the use of interprofessional NAS rounds could have a significant decrease on the overall health care burden.

Interprofessional NAS rounds have multiple benefits other than shorter LOS. First, active participation of families is encouraged. Next, the presence of ancillary staff on rounds leads to increased use of non-pharmacologic interventions. These interventions are verbally communicated to the team. The involvement of lactation services provides continuing education to families and staff that the use of human milk, in the absence of maternal illicit drug use and a few other contraindications, is acceptable and appropriate in patients with NAS.14 The use of maternal human milk aids in the non-pharmacologic treatment of the infant, decreases use of pharmacologic interventions, and improves mother-infant bonding.9,14 The dietitian helps monitor growth and ensures patients are maintaining adequate caloric needs. If the patient is not receiving human milk feeds, this may include use of a 22 kcal/oz formula due to increased metabolic demands or use of an alternative formula in patients experiencing severe gastrointestinal symptoms. Occupational therapy and physical therapy help implement non-pharmacologic therapies such as swaddling and positioning as well as provide neurodevelopmental monitoring.^{15,16} Music therapy interventions have shown a decrease in NAS scoring severity and are a way to engage parents in nonpharmacologic treatment.^{17,18} Massage therapy is used to soothe patients with NAS and is helpful to assess patient tone as medication weans occur.¹⁹ At NCH, music therapy and massage therapy use different non-pharmacologic

strategies based on protocol phase. The involvement of the pharmacist helps ensure adherence to the NAS protocol consistently from physician to physician and from patient to patient. In previous years when a pharmacist was not physically present on rounds, decreased adherence to protocol occurred. The pharmacist has provided extensive education to the interprofessional team and family regarding medication therapy for NAS. In addition, the pharmacist documents each patient's pharmacologic plan in the electronic medical record. All pharmacists practicing in the NICU follow the NAS protocol, which decreases variability.

Not only do ancillary staff perform essential functions during the admission, but they also educate families regarding non-pharmacologic strategies at home. Dietitians develop a home going plan, including appropriate mixing of feeds, to continue to meet nutritional needs for patients at discharge. Occupational therapy and physical therapy provide education on neurodevelopmental activities appropriate for patients with NAS based on age at discharge.^{15,16} Music therapy and massage therapy educate families on soothing techniques to use after discharge.⁷⁷⁻¹⁹ Improving family education and supporting discharge needs is only one of the benefits provided by interprofessional NAS rounds.

The greatest contribution of interprofessional NAS rounds was a 3-day reduction in LOS compared with prerounds care. The median days from last medication dose to discharge were no different between the post-rounds vs pre-rounds groups, indicating that the difference in LOS was due to decreases in LOT; not that discharges were occurring more quickly. We included patients on morphine with and without adjunct therapy (i.e., clonidine and/or phenobarbital) and LOS still decreased.

Length of stay is an important outcome measure for patients. Multiple studies have recently examined LOS for patients with NAS. McQueen and Murphy-Oikonen² found an average LOS increase from 17 days to 23 days in patients requiring pharmacologic intervention. As we did not have access to information of patients who only required non-pharmacologic management of NAS, all of the patients in our study required pharmacologic intervention for NAS. Despite this, both our baseline LOS and post-rounds LOS were shorter than in the study by McQueen and Murphy-Oikonen.² By using a formal NAS interprofessional rounding approach, institutions may be able to decrease LOS. Holmes et al²⁰ showed a decrease in LOS from 16.9 days to 12.3 days through the use of rooming-in treatment for NAS. This highlights the importance of the mother-infant dyad and parent involvement, which was also a focus of our study. Grossman et al²¹ showed a LOS for NAS patients of 5.9 days, which is shorter than our LOS. However, this study, as well as another study performed by Grossman et al,²² used a different tool for scoring NAS signs, which decreased the need for pharmacologic treatment.^{21,22}

Our study had multiple strengths, including the fact

that our institution has a well-established NAS treatment protocol that is used in a citywide hospital network. Our hospital system encompasses multiple NICUs throughout the city, and 4 of the 7 locations use the same NAS protocol, which creates consistency in managing patients with NAS. Discussion occurs on a monthly basis at an interprofessional QI meeting regarding the successes and challenges of NAS rounds. The QI meetings focusing on improving NAS-related outcomes have been ongoing since 2009. The size of our study population is a strength. Most of the NAS literature compares 2 different pharmacologic treatment strategies, but these studies typically include fewer than 100 patients.^{23,24} Another strength is that we looked at not only LOS but also LOT. Many factors can influence LOS, so looking at LOT provides information about a patient's treatment course prior to discharge. Our LOT included morphine and clonidine treatment, whereas many other studies only report morphine treatment. Despite including morphine and clonidine in our LOT, our LOT is still lower than most of what has been reported in morphine treated patients in the literature.

This study had many limitations. One limitation is the variability in types of rooms patients with NAS are cared for during the hospital stay. Some of our patients with NAS are cared for in open pod settings and others in private rooms. Since one of the mainstays of nonpharmacologic treatment for patients with NAS is a dimly lit, quiet environment, differences in room could have affected need for medication therapy. In addition, the use of adjunct therapy was significantly higher in the pre-rounds group, which could either signify an improved adherence to the NAS protocol in the postrounds group or higher severity of patients in pre-rounds group. There were more poly-substance exposed infants in the pre-rounds group than the post-rounds group, though this was not statistically significant. Per the subgroup analysis, decreased use of adjunct therapy in the post-rounds group did not lead to decreased LOS on its own. Another limitation of the study is that specific data regarding non-pharmacologic interventions were unavailable. The inclusion of ancillary staff to weekly NAS interprofessional rounds was an important step in promoting non-pharmacologic interventions provided by these team members; however, these interventions were verbally communicated and not always documented in the electronic medical record. Given the retrospective nature of this study, we were not able to confirm that non-pharmacologic interventions were increased in the post-rounds NAS rounds group. In addition, given the study was performed at a single hospital system including primarily white patients, the results may not be generalizable to the entire NAS population.

Although our study analyzed LOS of patients treated with morphine, the interprofessional approach could be beneficial for patients with NAS being treated with methadone or buprenorphine as well. Our study used the Finnegan scoring tool, but future studies are needed to determine if there are alternate scoring methods that could contribute to even further decreases in LOS. Our institution will be participating in a study comparing Finnegan scoring to Eat, Sleep, Console scoring.

With the ongoing opioid crisis, further studies are needed on how to determine severity of NAS and when pharmacologic therapy is indicated as well as which pharmacologic treatment provides best benefit-to-risk ratio. Improved long-term follow-up studies are needed to determine neurodevelopmental outcomes of patients treated for NAS as these patients enter school. Research into facilities that provide joint care of the mother-infant dyad in this high-risk population also needs to be performed.

Conclusion

Our institution reduced the LOS for patients requiring pharmacologic treatment for NAS from 16 days to 13 days by implementing weekly interprofessional NAS rounds. This equates to a cost savings of about \$22,000 per patient and about \$1.5 million over the 1.5 year postrounds time period. In addition, we decreased morphine exposure by decreasing LOT.

Article Information

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Ethical Approval and Informed Consent. Given the nature of this study, the institution review board/ethics committee review was not required.

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