

# Improving Care for Infants With Neonatal Abstinence Syndrome: A Multicenter, Community Hospital–Based Study

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**BACKGROUND:** For infants with neonatal abstinence syndrome (NAS) in children’s hospitals, treatment protocols emphasizing nonpharmacologic care have revealed improved hospital outcomes. We sought to improve NAS care within the community hospital setting through the implementation of an Eat, Sleep, Console (ESC) protocol.

**METHODS:** Using a multidisciplinary quality improvement approach, we implemented an ESC protocol at 2 community hospitals. Primary outcomes were to decrease length of stay (LOS) by 20% and decrease scheduled morphine use to <20%. Balancing measures included transfer to a higher level of care and unplanned 30-day readmissions. Data were extracted over 2 years, from 2017 through 2018. Interventions included an emphasis on nonpharmacologic care, the initiation of 1-time morphine dosing, flexible weaning schedules for infants on morphine, and the use of ESC scoring. Data were analyzed by using statistical process control.

**RESULTS:** A total of 304 NAS patients were admitted from January 2017 to December 2018, with 155 during the postintervention period. After implementation, mean LOS decreased from 9.0 to 6.2 days, and morphine use decreased from 57% to 23%, both with special cause variation. There were 2 unplanned readmissions in the postintervention period compared with 1 preintervention and no transfers to higher level of care in either period.

**CONCLUSIONS:** Implementation of a nonpharmacologic care protocol within 2 community hospitals led to significant and sustained improvement in LOS and morphine exposure without compromising safety. In this study, we illustrate that evidence-based practice can be successfully implemented and sustained within community hospitals treating infants with NAS.

## ABSTRACT

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The opioid crisis in the United States has resulted in a dramatic increase in infants experiencing neonatal abstinence syndrome (NAS). Incidence rates for infants with NAS have risen from 1.5 to 20 cases per 1000 live births between 2000 and 2016,<sup>1</sup> representing a major public health crisis.<sup>2</sup> Infants affected by NAS have historically required lengthy hospitalizations for monitoring and treatment of symptoms caused by the abrupt cessation of opioids received in utero.<sup>3,4</sup> Prolonged hospital stays for NAS are often costly,<sup>4</sup> contribute to financial stress and work absenteeism for families,<sup>5</sup> and can lead to overmedicalization of the infant.<sup>6</sup>

Recently, authors of studies using newer methods to assess withdrawal symptoms and providing nonpharmacologic care have demonstrated significant reduction in length of stay (LOS) and morphine use. Holmes et al<sup>7</sup> reported a reduced LOS from 17 to 12 days after adopting a rooming-in model. Grossman et al<sup>8</sup> demonstrated a reduction in LOS from 22.4 to 5.9 days and a decrease in morphine use from 98% to 14% after implementing a quality improvement (QI) approach that was focused on nonpharmacologic therapies and simplified assessment using the Eat, Sleep, Console (ESC) assessment.

Although these studies represent significant advancement in the care for infants with NAS, they were limited to patients admitted to children's hospitals. On a population level, the most rapid increase in opiate use remains in rural settings.<sup>9</sup> Mothers and infants in rural settings are most commonly cared for in community hospitals,<sup>10</sup> yet there are no published reports of studies in which treatment approaches emphasizing these newer strategies in the community hospital setting are implemented. Our aim was to use QI methodology to improve NAS care through the implementation of a protocol emphasizing nonpharmacologic care in community hospitals, specifically to decrease LOS by 20% and morphine use to <20%.

## METHODS

### Context

We conducted a QI initiative at 2 community hospitals in separate counties within the state of Washington. Hospital 1 has

13 pediatric beds and 25 level 3 NICU beds. Hospital 2 has 9 pediatric beds and 13 level 2 special care nursery (SCN) beds. Both hospitals are affiliated with a local children's hospital and are staffed 24 hours, 7 days a week by in-house pediatric hospitalists.

Infants with NAS at hospital 1 are managed in 3 areas: the family maternity center (FMC), the NICU, and the pediatric unit. Infants on the FMC and the pediatric unit are managed by pediatric hospitalists, whereas infants who require a NICU stay are managed by neonatal intensive care providers. When on the FMC or pediatric unit, mothers can room-in with their infants. Infants are observed for 72 hours after delivery for withdrawal, regardless of opiate exposure type. Infants with NAS at hospital 2 are managed in the family birth center and the SCN by pediatric hospitalists. Infants are transferred to the SCN once mothers are discharged. In the preintervention phase, infants were monitored for 5 days for withdrawal postdelivery. Maternal rooming-in at both sites was initiated in 2015, before this QI intervention.<sup>11</sup>

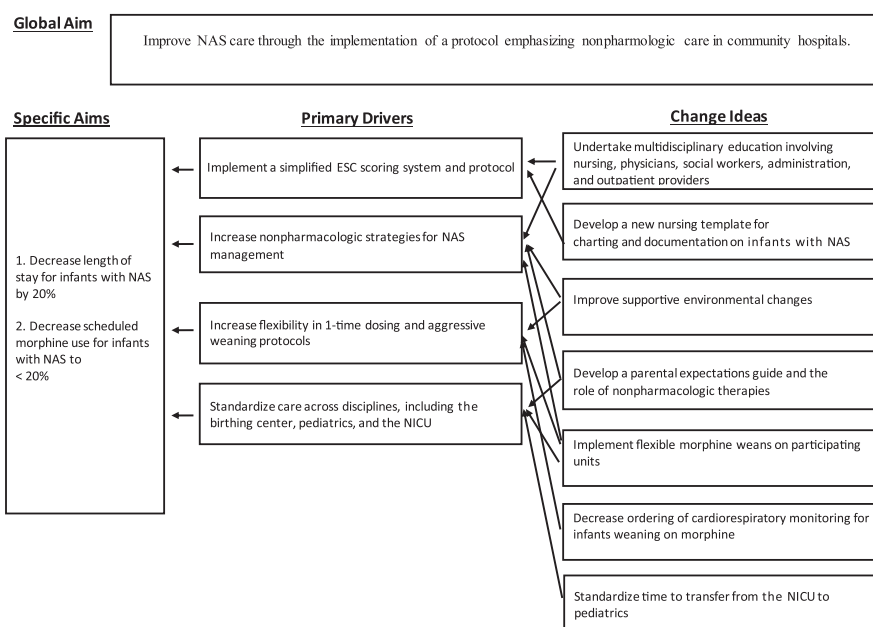
### Interventions

We designed a multimodal intervention, emphasizing nonpharmacologic care for infants with NAS as well as a transition to

an ESC-based withdrawal scoring system.<sup>12</sup> Implementation targeted a multidisciplinary approach from November 2017 through April 2018 with the launch of the ESC protocol in February 2018. Interventions included nonpharmacologic measures, ESC protocol implementation, multidisciplinary education, and a maintenance of certification (MOC) part 4 project (key driver diagram; Fig 1). Timing of the interventions are detailed in Table 1, and developed materials are available in the Supplemental Information.

### Nonpharmacologic Care

Primary emphasis on nonpharmacologic care included clustering cares and assessments around feeding times, low light and sound stimulation, use of soothing techniques (eg, swings, swaddling, and rocking), and decreased use of cardiorespiratory monitoring, with pulse-oximeter monitoring only for infants weaning on morphine. We continued to promote rooming-in with the infant as well as breastfeeding in appropriate cases. For hospital 1, we promoted early transfer of infants from the NICU to pediatrics as soon as possible after maternal discharge because the NICU did not adopt the ESC protocol initially. At hospital 2, we decreased the standard minimum time for NAS



**FIGURE 1** Key driver diagram for community hospital implementation of ESC and a nonpharmacologic-based protocol.

**TABLE 1** Timeline and Summary of Interventions

Intervention	Dates
<b>Nonpharmacologic interventions</b>	
Rooming-in	2015
Clustered care model	January–April 2018
Environmental changes including decreasing light and sound and increasing the use of rockers, pacifiers, and swaddlers	January–April 2018
Shortening the NAS observation period from 5 to 4 d (hospital 2 only)	November 2017
Pulse-oximeter monitoring only for infants weaning on morphine (hospital 1 only)	April 2018
ESC Protocol	
Change to ESC scoring	Hospital 1, April 2018 Hospital 2, February 2018
One-time morphine trials	February–April 2018
Flexible weaning schedules with ability to wean morphine multiple times daily	February–April 2018
Nursing template for nonpharmacologic care documentation Supplemental Information	Preliminary version live February 2018 Revised August 2018
<b>Multidisciplinary education</b>	
Extensive provider and nurse education	November 2017–March 2018
Developed caregiver handouts emphasizing importance of rooming-in and nonpharmacologic care Supplemental Information	Preliminary version live October 2018 Revised August 2018
Outreach to family practice providers, referring clinics, and CPS workers	December 2017–ongoing
MOC part 4	
MOC project involving 9 physicians with monthly case reviews and feedback	July–September 2018

observation from 5 to 4 days. Lastly, through a multidisciplinary approach including parental input, we developed a caregiver handout explaining the nonpharmacologic interventions, expectations for care, and the ESC protocol.

### *ESC Protocol*

In the preintervention period, both hospitals used the Finnegan scoring system for withdrawal assessment. A score of >8 for 3 sequential scores or a single score of 12 would trigger morphine initiation, and an average score of <8 would indicate the potential for once-daily weaning. Implementation of the ESC protocol involved multiple changes. First, we adopted the ESC scoring system, which focuses on 3 clinically relevant aspects of withdrawal: whether an infant can eat an appropriate amount, sleep for  $\geq 1$  hour, and be consoled within 10 minutes. If all of these occur, then the ESC score is a 3. In addition, we

instituted the use of 1-time morphine trials, flexible weaning schedules for infants on morphine, and incorporation of nursing documentation for ESC assessment into the electronic medical record.

We instituted team huddles based on ESC scores, with any change from a score of 3 to 2 or any 1-time score of 1 or 0 initiating a discussion with the nurse, the hospitalist, and the family when indicated. The discussion was not limited to the initiation of pharmacotherapy; it also included discussion of situational factors (eg, no family present at bedside) and potential mitigating nonopioid interventions (eg, availability of a volunteer to hold the infant, initiation of a diaper cream, or a trial of a dose of simethicone). Because of an emphasis on huddles and discussion around changes in scores, we elected to not order as-needed doses of morphine but instead ordered 1-time trials to facilitate

these huddles and shared decision-making. If an infant required >3 1-time morphine doses within 24 hours, then scheduled morphine was initiated. For infants on scheduled morphine, flexible weaning schedules allowed for 2 to 3 weans per day (often 25 to 50  $\mu\text{g}/\text{dose}$  per wean as dictated by the infant's withdrawal symptoms and not limited to 10% of the maximum dose per wean). With implementation of the ESC assessment, nurses concurrently scored infants with ESC and Finnegan scores. Detailed information on ESC documentation is included in the Supplemental Information.

### *Multidisciplinary Education*

We provided extensive nursing and physician education over a 6-month period with repeat sessions in June 2018 for nursing staff and August 2018 for physicians. Education targeted a literature review on NAS care, practical implementation details, and outcome measures. In addition, we conducted community outreach with family practitioners, obstetricians, a substance abuse treatment center, and local child protective services (CPS) offices.

### *MOC Part 4*

We provided MOC part 4 credit for pediatric hospitalists at both institutions from July to September 2018. The MOC project was focused on ongoing education, review of challenging cases with the ESC system such as late-preterm infants with feeding difficulties, and readmission review.

### *Study of the Intervention*

Infants with NAS were identified through manual pediatric hospitalist billing records and a patient logbook. A diagnosis of NAS was given to infants who showed withdrawal symptoms after known or suspected in utero exposure to an opioid. Data were abstracted through manual chart review by 3 research team members. Demographics and charges were obtained through administrative data after patients were identified through physician billing records. Physician MOC participation was evaluated through a previously published survey used to assess engagement, QI learning, and perceived impact on patient care.<sup>13</sup>

## Measures

Our primary outcome measures were LOS and scheduled morphine use. LOS was calculated as time of birth on day of life 0 until date of discharge. Morphine use included those placed on scheduled morphine, excluding patients who only received 1-time morphine doses. A secondary measure was physician participation through MOC. Our balancing measures included the occurrence of serious safety events (eg, development of seizures or need for transfer to a higher level of care such as the pediatric unit to the NICU or transfer out of the community hospital) and unplanned readmission within 30 days. We compared the measures pre- and postimplementation. There were no additional interventions during this time period to reduce LOS or morphine use in infants with NAS at either hospital.

## Data Analysis

We compared demographic factors, including sex, insurance, race and ethnicity, maternal age, birth weight, and gestational age before and after the launch of our new protocol on February 1, 2018. The *P* values were calculated through *t* tests for continuous variables and Fisher's exact tests and  $\chi^2$  analyses for categorical variables. Pre and post scores using a 5-point Likert scale were assessed for MOC participation, with scores of 1 = strongly agree and 5 = strongly disagree.

We used statistical process control charts to examine variation in outcome measures over time. Statistical process control charts help to distinguish random variation in a process from assignable or identifiable causes. Control limits were set at 3 SDs above and below the mean.<sup>14</sup> We used X-bar charts, a graphical representation of variable continuous data, to assess LOS and charges. We used P-charts, a graphical representation of attribute or classification data, to assess morphine use. All charts were created by using the QI Charts 2.0 add-on for Microsoft Excel.<sup>15</sup>

The study was deemed exempt by the institutional review boards governing both hospitals.

## RESULTS

A total of 304 infants with NAS were admitted to the 2 hospitals from January 2017 to December 2018, with 155 infants during the postintervention period. The overall population was predominately term, female, on public insurance, and white. Mean birth weight was just over 3000 g, and the mean maternal age was 28 years. Demographic variables did not vary significantly between pre- and postintervention periods (Table 2).

An X-bar chart for LOS revealed special cause variation after implementation in February 2018 with sustained perpetuation of the reduction through the end of December 2018 (Fig 2A). LOS preintervention was 9.0 days and decreased to 6.2 days postintervention, a 32% reduction. LOS for NAS symptoms only, excluding additional inpatient days required for administrative holds due to CPS involvement, decreased to 4.9 days. A P-chart for morphine use demonstrated special cause variation in February 2018 with demonstration of sustained improvement (Fig 2B). Scheduled morphine use decreased from 57% to 23% during the study period, a decrease of 60%. Control limits narrowed for each measure after special cause variation was noted. We

also obtained patient charge data, which decreased from \$33 406 preintervention to \$22 775 postintervention. However, because we were unable to calculate actual costs, we deferred any additional statistical analysis.

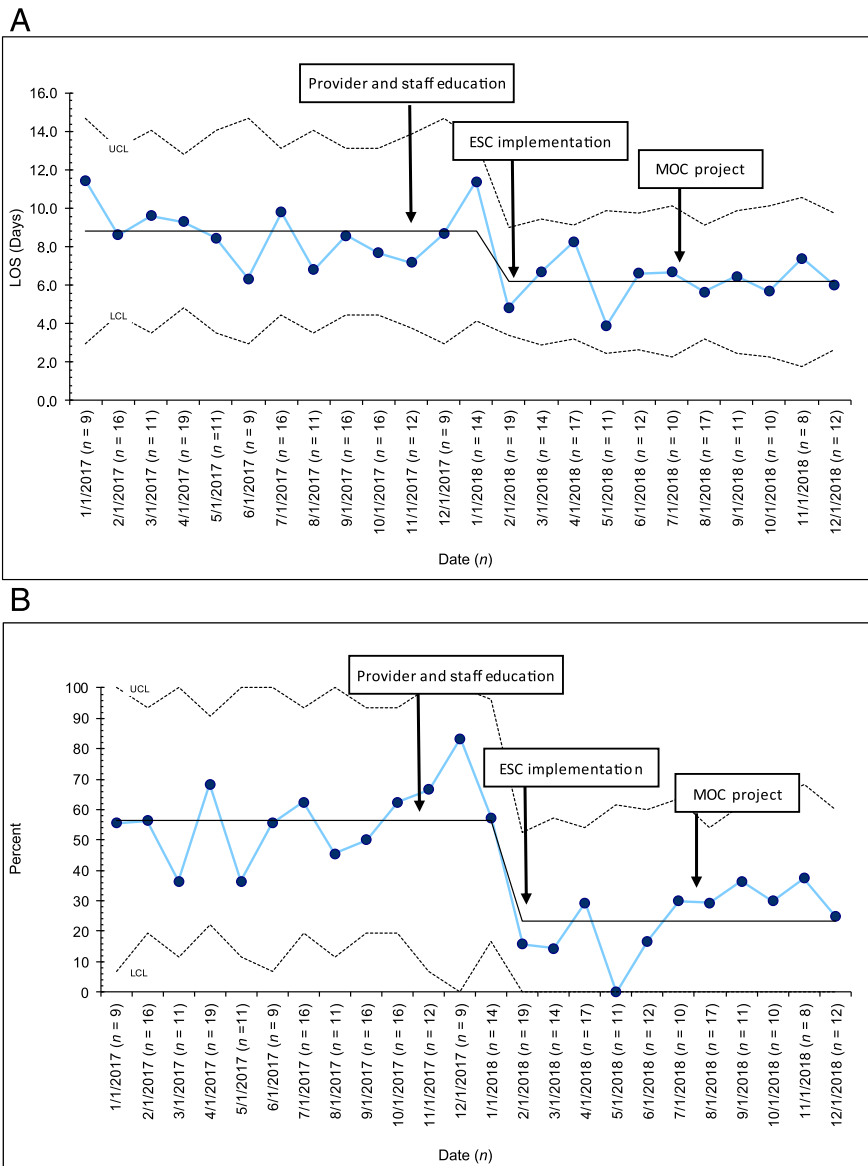
Balancing measures included serious safety events and unplanned readmissions within 30 days. There were no cases of serious safety events. In the preintervention period, there was a single readmission at hospital 1 and 2 within the postintervention period. There were no readmissions at hospital 2 pre- or postintervention. After additional chart review, the readmission preimplementation was at 30 days of life for neonatal fever, found to have a urinary tract infection. In the postimplementation period, the first readmission was a term infant, observed for 72 hours after delivery with ESC scores of 3 and Finnegan scores <6. The infant had a follow-up in an outpatient clinic on day of life 6, where she was noted to be tachypneic to the 90s, retracting, and with concern for increasing NAS symptoms at home. She was directly admitted to NICU, requiring high-flow nasal cannula for 12 hours. An evaluation for serious bacterial infections was performed, and results were negative. Finnegan scores

**TABLE 2** Patient Demographics for Infants Admitted With NAS

Demographic	Total	Preimplementation	Postimplementation	<i>P</i>
Total infants with NAS, <i>n</i> (%) <sup>a</sup>	304 (100)	149 (49)	153 (51)	—
Female sex, <i>n</i> (%)	149 (54)	70 (49)	79 (58)	.15
Insurance, <i>n</i> (%)				.99
Public	251 (90)	128 (90)	123 (90)	
Private	25 (9)	13 (9)	12 (9)	
Other	2 (1)	1 (1)	1 (1)	
Race and ethnicity, <i>n</i> (%)				.53
White	174 (63)	93 (65)	81 (60)	
American Indian or Alaskan native	31 (11)	17 (12)	14 (10)	
African American	5 (2)	2 (1)	3 (2)	
Hispanic or Latino	12 (4)	5 (4)	7 (5)	
Asian American	3 (1)	2 (1)	1 (1)	
Other or unknown	64 (23)	27 (19)	37 (28)	
Maternal age, <i>y</i> (SD)	28.8 (4.4)	28.5 (4.4)	29.1 (4.3)	.28
Birth wt, <i>g</i> (SD)	3157 (465)	3135 (475)	3172 (460)	.51
Gestational age, <i>wk</i> (SD)	38 6/7 (1 4/7)	38 6/7 (1 5/7)	38 6/7 (1 2/7)	.83

—, not applicable.

<sup>a</sup> Missing demographic data on 26 infants.



**FIGURE 2** Outcome measures for infants with NAS. A, LOS. B, Percentage of infants requiring morphine treatment. LCL, lower control limit; UCL, upper control limit.

during the readmission ranged from 6 to 13 in the NICU. The infant did not receive morphine and was discharged from the hospital after 48 h. The second infant was a term infant, observed for 72 hours, with ESC scores of 3 throughout birth hospitalization and Finnegan scores <8. The infant had a follow-up with the primary care provider on day 8 of life when parents were overwhelmed at home with providing care for the infant. He was readmitted for observation overnight and parental education, with ongoing ESC scores of 3.

Nine physicians participated in the MOC part 4 project. Physician engagement improved from a mean preparticipation of 2.0 to postintervention mean of 1.67, a 23% improvement. Physician QI learning improved from 1.95 to 1.83 (6% improvement), and perception that the MOC project directly improved patient care improved from 1.44 to 1.13 (22% improvement).

## DISCUSSION

Using QI methodology, we implemented multiple interventions to improve quality of

care for infants with NAS at 2 community hospitals. LOS was reduced by 32% from 9.0 to 6.2 days, surpassing the primary outcome goal of a 20% reduction. Morphine use was reduced by 60% from 57% to 23% but did not achieve our goal of <20%. In addition, there were no patient safety events. There were only 2 unplanned readmissions, neither of whom would have likely received morphine on their primary hospitalization preintervention based on review of their Finnegan scores. Our findings reveal that evidence-based care protocols for infants with NAS can be successfully implemented within the community hospital setting.

In this study, our baseline LOS and morphine use are lower than previously described.<sup>7,8</sup> This is likely due to the rooming-in policy at both sites initiated several years previous to the baseline data collection and standard observation times of only 72 hours at hospital 1. Our postintervention outcomes, however, are similar to nationally published data. This reveals 2 things. First, we provided quality care for infants with NAS in the community setting before the ESC system implementation. This is critical because most published quality of care and outcome data comes primarily from children's hospitals.<sup>16,17</sup> Second, our ability to achieve similar outcomes to previously published studies postintervention shows that physicians in community hospitals are dedicated and committed to embracing evolving national practices and can help to lead them.

Treating infants with NAS often involves multiple barriers to providing optimal nonpharmacologic care. These include lack of consistent parental presence, high rates of CPS involvement, and the need for continued hospitalization after a patient is medically cleared for administrative holds. Targeting these barriers, we designed our interventions to promote success. For example, in addition to revising caregiver handouts on NAS, hospitalist teams at both sites emphasized thorough discussions with families early during hospitalization, ideally before the development of NAS symptoms and preferably before the infant was born.

By preparing families in advance for the potential of NAS and educating about optimal nonpharmacologic treatment, we anecdotally observed better adherence to best practices for NAS care, including more rooming-in. Unfortunately, because of the inability to closely track caregiver presence with infants, these data could not be analyzed statistically. In addition, our community outreach efforts included education to family practitioners, obstetricians, a substance abuse treatment center, and local CPS offices. The latter we found helpful in answering questions from caseworkers about anticipated decreased duration of hospital stay and the need for early determination of disposition. Lastly, engaging in this work at community hospitals afforded several advantages, including smaller, more facile teams and relatively quick improvement cycles with the ability to nimbly make changes and adjustments. Although neither hospital has the support of child life or robust infant volunteer programs, we maximized our environmental interventions to support the bandwidth of the nursing staff.

The MOC part 4 project helped to advance and sustain momentum for this project. Although they are improving physician learning and engagement, nationally published data shows that MOC part 4 projects have minimal impact on physician perception of improving patient care.<sup>13</sup> However, our project demonstrated substantial impact within this area, and this was likely critical for success within the community setting. Because many community hospitalists do not have protected scholarly time, a project such as this is directly related to improving patient care and tangible outcomes. The additional use of targeted, patient-relevant MOC projects may provide an ongoing outlet to advance scholarly production within community hospitals while staying relevant to day-to-day care.

We are continuing our QI efforts to advance care for infants with NAS at our 2 institutions. Currently we are engaging in ongoing community outreach, emphasizing education about NAS with expectant mothers, and developing infant cuddler

programs to assist with providing optimal nonpharmacologic care. At hospital 1, we are working with the NICU to launch the ESC-based protocol, a process started in February 2019 driven by our data presented here. We have also had the opportunity to share our experience with other local community hospitals, serving as program mentors for the adoption and implementation of ESC.

There are several limitations to this study. Although we were able to track readmissions at each primary community hospital, we cannot assess if patients were evaluated or admitted to other hospitals. However, given the geographic catchment areas of both hospitals, it is unlikely that many patients would bypass our institutions and directly present at another site. Second, although we were able to pull charge data, we were unable to convert these to costs. Charge data frequently correlates closely with LOS, and our decrease in charges reflects and validates our decrease in LOS. Although we cannot draw specific conclusions regarding cost-savings, the timing of the special cause variation and sustained decrease in charges may serve as a proxy for potential cost-savings. Next, there remains data that we were unable to track, including breastfeeding rates, the amount of time family was present at the bedside, and frequency of 1-time morphine dosing. These represent potential future interventions to further improve care. Lastly, at hospital 1, the NICU did not adopt the ESC protocol, which likely contributed to a higher proportion of children started on morphine than if they were solely managed by pediatric hospitalists. Promotion of early transfer from the NICU to the pediatric unit, regardless of Finnegan scores, after maternal discharge helped to further advance interventions such as rooming-in and flexible weaning schedules.

## CONCLUSIONS

Implementation of a protocol emphasizing nonpharmacologic care through a multisite community hospital QI intervention demonstrated significant and sustained improvement in LOS and morphine use without compromising safety. In this study, we illustrate the significant impact that

evidence-based practice at community hospitals can have on the care of large numbers of children with NAS.

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