Improved family-centered care at lower cost: 
Rooming-in to treat neonatal abstinence syndrome

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Background: The incidence and associated costs of Neonatal Abstinence Syndrome (NAS) have recently risen sharply, with newborns with NAS now occupying 4% of U.S. NICU beds. NICU level care may not be necessary for newborns with NAS.

Keywords: Neonatal abstinence syndrome, roaming-in, family-centered care, overuse, cost savings

SMART Aim: Our primary aim was to decrease the proportion of infants treated pharmacologically with morphine from 50% to 25% between January 2013 and December 2014 using family-centered care with roaming-in. Secondary aims included decreasing use of secondary agents from 15% to under 5%, decreasing LOS from 18 days to under 14 days for those treated with morphine, and halving hospital costs for both all opioid-exposed newborns and those treated for NAS.

Setting: Mother-baby unit, NICU, and inpatient pediatric unit in a rural CHA-member 63-bed/18-basinette children’s hospital within a 396-bed rural academic tertiary care center with approximately 1,300 inborn infants, 450 neonatal critical care admissions (inborn and outborn) and 2,500 pediatric inpatient admissions annually. By 2015, 5% of newborns were opioid-exposed in utero. At project outset, increased levels of observation and all treatment initiation for NAS occurred in the NICU; by project end, all opioid exposed newborns roomed-in on the mother-baby unit or inpatient pediatric unit for both observation and treatment, unless there were other reasons for critical care.

Mechanisms: We used a clinical microsystems approach to implement a coordinated program for NAS including standardized protocols for scoring, initiating and weaning medications, and a calm roaming-in environment, to improve family-centered care, and to decrease both length of stay (LOS) and hospital costs. We eliminated a NICU stay.

Drivers of Change: 1. Perception of different scoring and care processes on different units leads to prolonged stays. 2. Families of opioid-exposed newborns desire to be involved in and informed about care that benefits the newborn.

Methods: We formed an interdisci
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Methods: We formed an interdisciplinary team in early 2013 as part of the VON NAS improvement collaborative; subsets of team members participated in the 2013 and 2014 webinars. We completed 11 PDSA cycles including training nurses in modified Finnegan scoring [PDSA 1], ensuring scoring only after on-demand feeds during skin-to-skin care [PDSA 3], and standardizing physician score interpretation [PDSA 6]. We provided prenatal family education [PDSA 4], increased family involvement in symptom monitoring and non-pharmacologic treatment [PDSA 5], and treated otherwise healthy babies on the inpatient pediatric unit, instead of in the NICU [PDSA 7&9]. We measured outcomes using statistical process control methods.

Measures:

- Proportion of opioid-exposed newborns treated with morphine
- Proportion of opioid-exposed newborns treated with adjunctive agents
- Length of stay for treated newborns
- Hospital costs of both treated and exposed but untreated newborns. We calculated costs by multiplying hospital charges by the annualized cost-to-charge ratio
- 30-day readmission rates, conducted by case finding, for both all-cause and due to NAS symptoms or failure to gain weight

Data/Results: At baseline, 46% of inborn infants at-risk for NAS were treated with morphine; by 2015, this decreased to 27%. Adjunctive use of phenobarbital decreased from 13% to 2% in the
same period. Average LOS for morphine-treated newborns decreased from 16.9 to 12.3 days, average hospital costs per treated infant decreased from $19,737 to $8,755, and costs per at-risk infant dropped from $11,000 to $5,300. There were no adverse events, and 30-day readmission rates remained stable, with 2 to 4 all-cause readmissions per year, and 1 NAS-related readmission each year.

**Discussion:** A coordinated, standardized NAS program safely reduced pharmacologic therapy, LOS, and hospital costs--costs per treated infant decreased from $19,737 to $8,755, and costs per at-risk infant dropped from $11,000 to $5,300. Rooming-in with family and decreased use of NICU beds were central to achieved outcomes.

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**Figure 1:** Key driver diagram for NAS QI project aims and change concepts
**Figure 2:** Analysis of means (ANOM) of percentage of opioid-exposed newborns treated pharmacologically with morphine; Bars that cross the black lines (control limits) represent statistically significant results to 3 sigma.

**Figure 3:** Analysis of means (ANOM) of percentage of opioid-exposed newborns treated pharmacologically with morphine and a second (adjunctive) agent--phenobarbital or clonidine.
Figure 4: Statistical process control (XmR) chart for hospital LOS; each dot represents an infant that was treated pharmacologically. Mean LOS, and the associated control limits shift downward in January 2014, coinciding with both the rooming-in pilot and the change in physician score interpretation. Variability in LOS decreases at the same time.

Figure 5: Statistical process control (XmR) chart for hospital cost; each dot represents an infant that was treated pharmacologically. Mean costs, and the associated control limits shift downward in January 2014, coinciding with both the rooming-in pilot and the change in physician score interpretation. Variability in costs decreases at the same time.