### Week 2: Neonatal Health Services Research/Quality Improvement

### NICU QI and Safety I

#### Tuesday, June 16  2:30-4:00 pm EDT

**Moderators**  
Jonathan Swanson  
Ursula Nawab

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*Note: Schedule subject to change based on presenter availability.*
TITLE: Prevention of Necrotizing Enterocolitis (NEC) in Very Preterm Infants: NEC-Free NICU Quality Improvement Initiative

ABSTRACT STATUS: Sessioned

PRESENTER: Belal Alshaikh

AUTHORS (LAST NAME, FIRST NAME): Alshaikh, Belal1; ALBURAKI, WISSAM1; Wood, Christel2; Abou Mehrem, Ayman1; Roy, Meagan A.1

AUTHORS/INSTITUTIONS: B. Alshaikh, W. ALBURAKI, A. Abou Mehrem, M.A. Roy, Pediatrics, University of Calgary, Calgary, Alberta, CANADA;
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CURRENT CATEGORY: Neonatology

CURRENT SUBCATEGORY: Neonatal-Perinatal Health Care Delivery: Quality Improvement

KEYWORDS: Very preterm infants, Narcotizing enterocolitis, Quality improvement.

SESSION TITLE: NICU QI and Safety I |NICU QI and Safety I

SESSION TYPE: Webinar|Platform

ABSTRACT BODY:

Background: Preterm infants with NEC have an estimated mortality rate of 15-30% and an average of 22-60 additional hospital days. Efforts to reduce the incidence of NEC are directed at reducing exposure to risk factors and promoting interventions that protect the gut. Our previous quality improvement (QI) initiative to provide exclusive mother’s own milk (MOM) to preterm infants less than 33 weeks resulted in a decreased NEC incidence from 8.9 % to 5 % between 2010 and 2015.

Objective: The objective of the NEC-Free NICU QI initiative was to further reduce the regional incidence of NEC to less than 2% in southern Alberta.

Design/Methods: This was a quality improvement (QI) initiative using the Plan-Do-Study-Act (PDSA) methodology in 2 level III and 3 level II NICUs in Calgary. We established a multidisciplinary QI team that included medical and nursing staff, clinical pharmacists, lactation consultants, and dietitians. The group reviewed evidenced-based research and clinical practices that support putative NEC prevention strategies. We established a strategic aim and key driver interventions and implemented strategies to increase the use of mother’s breast milk, maintain appropriate gut perfusion, and promote a healthy intestinal microbiome (Figure 1). We developed and used a sentinel event to review each case of NEC or spontaneous intestinal perforation in a timely manner. Donor human milk was available for the whole period of the QI initiative.

Results: A total of 456 preterm infants born less than 33 weeks gestation in sustain period (Jan 2017 to Dec 2018) compared to 741 born in the baseline period (Jan 2013 to Oct 2016). The last 3 months of 2016 was considered a washout period. maternal and clinical characteristics are summarised in table 1. The time of first expressed MOM feed decreased after the introduction of antenatal lactation consult from 20±9.1 to 13.7±8.7 hours; p<0.01. Incidence of NEC decreased in sustain period (1.3% vs. 4.6%; p= 0.002; adjusted OR= 0.30; 95%CI: 0.16-0.55). We also observed a trend towards a lower incidence of surgical NEC.

Conclusion(s): NEC-Free NICU QI initiative utilizing an early use of mother's own milk and strategies to maintain appropriate intestinal perfusion and prevent intestinal dysbiosis resulted in a significant reduction in the incidence of NEC in very preterm infants.
Key drivers

Early MOM feeding

Incidence of necrotizing enterocolitis

IMAGE CAPTION:
ABSTRACT BODY:

**Background:** Dynamic analysis of time-oriented data is widely recognized as important to quality improvement (QI) to best understand the impact of interventions on outcomes. Statistical process control (SPC) and interrupted time series (ITS) are considered the most robust approaches to time-series analysis in QI. Anecdotally, however, it appears many QI projects still use traditional statistics for data analysis, often comparing outcomes before and after an intervention.

**Objective:** To help identify opportunities to improve the quality of our QI, we sought to evaluate data methods used in neonatal intensive care unit (NICU) QI studies, focusing on the use of SPC or ITS versus traditional statistics.

**Design/Methods:** We conducted a systematic review of the literature to identify NICU QI publications from 2009 to 2018. Three databases were searched: PubMed, CINAHL, and Embase. Articles were included if they were published in English, focused on NICU patients, and met criteria to be considered QI. Articles were considered QI if they self-described as QI or if they introduced system or process changes with an explicit objective of improving healthcare delivery or outcomes with the impact of changes recorded over time. Articles were initially screened by abstract review, with full text review when abstract review was inconclusive. Full texts of all included articles were reviewed to determine approaches to data analysis.

**Results:** The initial search identified 5438 articles; 302 met final inclusion criteria (Figure 1). The number of NICU QI publications per year increased from 17 in 2009 to 54 in 2018 (Figure 2). The percentage of NICU QI publications per year using SPC or ITS methods has also increased over time, but in 2018, nearly 50% of publications continued to use statistical methods other than SPC or ITS (Figure 3).

**Conclusion:** NICU QI publications have increased dramatically over the past decade, suggesting increasing use of robust QI to improve outcomes for high-risk newborns. While the use of SPC and ITS have also increased, nearly half of NICU QI publications continue to use data analysis methods that may not be the most robust. Importantly, the use of traditional statistical approaches in QI could lead to misinterpretation of results. As a field, we continue to have the opportunity to improve the quality of our QI through better data analysis methods. Next steps include analysis of results by journal, publication location, and topic area.
Figure 1: Study Selection

Figure 2: NICU QI Publications by Year, 2009-2018

Figure 3: SPC or ITS in NICU QI Publications by Year, 2009-2018

IMAGE CAPTION:
Figure 1: Study Selection
Figure 2: NICU QI Publications by Year, 2009-2018
Figure 3: SPC or ITS in NICU QI Publications by Year, 2009-2018

CONTROL ID: 3379127
TITLE: Improving Birth Certificate Accuracy in Alabama: A Quality Improvement Initiative
ABSTRACT STATUS: Sessioned
PRESENTER: Samuel Gentle
AUTHORS (LAST NAME, FIRST NAME): Gentle, Samuel1; Moore, Matthew1; blackmon, rosemary AlaHA T.2; Brugh, Brenda3; Todd, Allison1; Wingate, Martha1; Mazzoni, Sara1
AUTHORS/INSTITUTIONS: S. Gentle, M. Moore, A. Todd, M. Wingate, S. Mazzoni, University of Alabama at Birmingham, Birmingham, Alabama, UNITED STATES; R.T. blackmon, Alabama Hospital Association, Montgomery, Alabama, UNITED STATES; B. Brugh, Alabama Department of Public Health, Montgomery, Alabama, UNITED STATES;
CURRENT CATEGORY: Quality Improvement/Patient Safety
CURRENT SUBCATEGORY: Hospital-based Quality Improvement: Neonatal
KEYWORDS: birth certificate accuracy, perinatal quality collaborative.
SESSION TITLE: NICU QI and Safety I |NICU QI and Safety I
SESSION TYPE: Webinar|Platform

ABSTRACT BODY:

Background: Accurate vital statistics birth data are critical for monitoring population health and strategizing public health interventions. However, of the hospitals in Alabama participating in this initiative, only 67% of hospitals reported birth certificate accuracy rates ≥ 95%.

Objective: To increase the proportion of hospitals in Alabama reporting accurate monthly birth certificate data from 67% to 80% by October 2019.

Design/Methods: This was a statewide collaborative effort by the Alabama Perinatal Quality Collaborative including stakeholders from the Alabama Hospital Association and Alabama Department of Public Health (ADPH) Vital Statistics. Eleven variables critical to population health surveillance were monitored across ten patient charts per month per hospital for the duration of the initiative. Three months of retrospective, baseline-accuracy data were collected prior to project initiation with inclusion of actionable drivers at an individual hospital level continuously refined throughout the initiative (Figure 1). Accuracy determination was performed by health care specialists (e.g. nursing staff) at each hospital by comparing birth certificate variables from ADPH with data obtained from original hospital source materials. Interventions varied by hospital including increased staffing, automated data reports, improved variable definitions, and restructuring of systems processes for birth certificate abstraction. All data were entered into REDCap after which overall monthly accuracy rates and individual variable accuracy rates were reported at bimonthly webinars. Data were analyzed using statistical process control measures.

Results: Twenty five hospitals entered data throughout the course of the initiative, accounting for 850 chart analyses and 9,350 variable assessments. At baseline, 67% of hospitals reported birth certificate accuracy rates ≥ 95%, which increased to 90% in March 2019 and was sustained for the remainder of the initiative (Figures 2 and 3). The least accurately reported variables included birth weight (which increased from 84% to 99% accuracy) and antenatal corticosteroid exposure (which increased from 89% to 97% accuracy).

Conclusion(s): Statewide, multidisciplinary quality improvement efforts increased the number of centers reporting ≥ 95% birth certificate accuracy. This improved accuracy is vital to accurate public health surveillance and monitoring of trends in infant outcomes.
CONTROL ID: 3371574

TITLE: Multi-disciplinary engagement improved time to first maternal milk from 45 hours to 21 hours for preterm infants in the neonatal intensive care unit

ABSTRACT STATUS: Sessioned

PRESENTER: Emily Hiriak

AUTHORS (LAST NAME, FIRST NAME): Hiriak, Emily1; Henry, Amanda1; Gresko, Annamarie1; McDonald, Lesley1; Brand, Mara1; DeSimone, Beverly1; Winstanley, Moira F.1; Gaulton, Jessica1


CURRENT CATEGORY: Neonatology

CURRENT SUBCATEGORY: Neonatal-Perinatal Health Care Delivery: Quality Improvement

KEYWORDS: Preterm, Nutrition, Breastmilk.

SESSION TITLE: NICU QI and Safety I |NICU QI and Safety I

SESSION TYPE: Webinar|Platform

ABSTRACT BODY:

Background: Early maternal milk exposure among preterm infants has many benefits including improved rates of necrotizing enterocolitis (NEC) and sepsis, as well as increased maternal milk supply. The average time that enteral feeds are initiated among preterm infants ranges widely from 48 hours to 120 hours of life in the U.S. Due to the multifactorial nature of breastfeeding success, targeted actions to improve this metric in preterm infants remain vague and overshadowed by more critical goals in the first few days of life.

Objective: Our objective was to reduce time to first maternal milk intake among preterm infants born at 23 to 36 weeks gestational age from a baseline 45 hours to 24 hours of life starting April 2017 through October 2019.

Design/Methods: A multidisciplinary quality improvement team was developed to focus on shortening the time to first maternal milk exposure among preterm infants in the neonatal intensive care unit. Three PDSA cycles were completed from April 2017 to October 2019. During the first PDSA cycle, mothers were given breastmilk cooler bags with educational materials about pumping and small-volume syringes to draw up early pumped colostrum to send to the NICU for early initiation of feeds. The second PDSA cycle focused on educating the maternity staff about the importance of early pumping, with goals of hand expressing within the first few hours of life and electric pumping within 6 hours of life. The third PDSA cycle focused on engaging mothers by using a pumping app (www.keriton.com) that tracks the frequency of pumping sessions, volume of milk collected, and includes automated reminders.

Results: Data were collected on a total of 289 preterm infants whose mothers desired to provide breastmilk. Average gestational age at birth was 31 weeks (range 23-36 weeks), and mean birthweight was 1,637 grams. Average time to first maternal milk decreased from 45 hours prior to the initiation of the QI project to 21 hours of life by November 2018 (Fig. 1). In addition, the rate of exclusive breastmilk at the time of discharge increased from 27% prior to the initiation of this QI project to 48% (VON average was 11% in 2018). Our NEC rate averaged 5% during the 5 years prior to the QI project and decreased to 3.4% during the intervention period.

Conclusion(s): A targeted, multi-disciplinary approach with the introduction of a digital app to track maternal milk production shortened the time to first maternal milk exposure by 36% over a 2-year timeframe.

Figure 1. Average time to first maternal milk decreased from 45 hours prior to the initiation of the
QI project to 21 hours of life by November 2018

IMAGE CAPTION:
Figure 1. Average time to first maternal milk decreased from 45 hours prior to the initiation of the QI project to 21 hours of life by November 2018

CONTROL ID: 3375195
TITLE: Development and Implementation of an Earlier Refeeding after Necrotizing Enterocolitis (NEC) Guideline for Non-Surgical NEC
ABSTRACT STATUS: Sessioned
PRESENTER: Ekta Patel

AUTHORS (LAST NAME, FIRST NAME): Patel, Ekta1; Lesher, Aaron2; Ryan, Rita M.3
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R.M. Ryan, Case Western Reserve University UH Rainbow Babies and Children's Hospital, Cleveland, Ohio, UNITED STATES;
CURRENT CATEGORY: Neonatology
CURRENT SUBCATEGORY: Neonatal-Perinatal Health Care Delivery: Quality Improvement
KEYWORDS: necrotizing enterocolitis , refeeding, quality improvement.
SESSION TITLE: NICU QI and Safety I |NICU QI and Safety I
SESSION TYPE: Webinar|Platform

ABSTRACT BODY:
Background: For infants with NEC treated non-surgically, there is no consensus for when to re-initiate enteral feeds after NEC. In a previous meta-analysis, earlier refeeding (4-7 days after diagnosis of NEC) suggested a decreased incidence of the combined adverse outcome (NEC recurrence or stricture) and possible other benefits. Based on this analysis, we implemented a standardized guideline for non-surgical NEC through a consensus survey of key stakeholders involved in the decision to start refeeding at our institution.

Objective: Implement and monitor a multidisciplinary clinical consensus guideline to standardize the timing of initiation and rate of feeding advancement for infants with medical NEC (Bell’s stage IIA to IIIA) to decrease time to initiate trophic enteral feeds by 20% between January 2018 and December 2019.

Design/Methods: We created a survey of our neonatology and pediatric surgery divisions to develop a clinical consensus for refeeding after NEC. Subsequently, we created a guideline to re-initiate feeds earlier, based on severity of Bell’s stage, after normalization of abdominal exam and being clinically well appearing. There was no previous guideline for when to refeed. Outcome measures were days to initiation of feeds and days to full enteral feeds. Baseline data were collected from 1/2017 to 12/2017. Education was provided at neonatology division meetings and uploaded to the intranet. Infants with Bell’s stage IIA to IIIA were included in the guideline but there were no IIIA patients during the studied period. Infants with congenital heart disease and those requiring abdominal surgery were excluded a priori. Statistical analysis was done using Wilcoxon rank-sum tests.

Results: Clinical data including birth weight, gestational age, and day of life at diagnosis are shown in Table 1. For infants with Bell’s stage IIA and IIB combined, we demonstrated that the median days to initiation of feeds decreased by 61% from baseline of 9 days (range 4-14 days) to 3.5 days (range 3-12 days) (p<0.001) (Figure 1A). Median days to full feeds decreased by 35% from baseline of 20 days (range 6-93 days) to 13 days (range 8-20 days) (p=0.002) (Figure 1B).

Conclusion(s): This multidisciplinary clinical consensus for refeeding after NEC can decrease time to initiation of feeds and time to reach full enteral feeds. There was no increase in adverse outcomes including recurrence or stricture during the study period.
Table 1. Clinical Characteristics

Figure 1. A) Days to Initiation of trophic feeds before and after initiation of post-NEC Refeeding Guideline. B) Days to reach full enteral feeds (140 ml/kg/day) before and after initiation of post-NEC Refeeding Guideline.

IMAGE CAPTION:
Table 1. Clinical Characteristics

Figure 1. A) Days to Initiation of trophic feeds before and after initiation of post-NEC Refeeding Guideline. B) Days to reach full enteral feeds (140 ml/kg/day) before and after initiation of post-NEC Refeeding Guideline.

CONTROL ID: 3345426
TITLE: Reduction in Delivery Room (DR) Continuous Positive Airway Pressure (CPAP)-Associated Pneumothorax (PTX) in ≥35-Wk Gestational age (GA) Neonates
ABSTRACT STATUS: Sessioned
PRESENTER: Edward Stocks

AUTHORS (LAST NAME, FIRST NAME): Stocks, Edward; Jaleel, Mambarabath; Smithhart, William; Burchfield, Patti; Thomas, Anita; Mangona, Kate Louise M.; Kapadia, Vishal; Wyckoff, Myra; Kakkilaya, Venkatakrishna; Weaver, Jessica; Brion, Luc P.

AUTHORS/INSTITUTIONS: E. Stocks, M. Jaleel, W. Smithhart, P. Burchfield, A. Thomas, K.M. Mangona, V. Kapadia, M. Wyckoff, V. Kakkilaya, L.P. Brion, UT Southwestern Medical Center at Dallas, Dallas, Texas, UNITED STATES; J. Weaver, Parkland Health & Hospital System, Dallas, Texas, UNITED STATES;
CURRENT CATEGORY: Quality Improvement/Patient Safety
**CURRENT SUBCATEGORY:** Hospital-based Quality Improvement: Neonatal  
**KEYWORDS:** CPAP, Pneumothorax, Delivery Room.  
**SESSION TITLE:** NICU QI and Safety I |NICU QI and Safety I  
**SESSION TYPE:** Webinar|Platform

**ABSTRACT BODY:**

**Background:** In 2011 the Neonatal Resuscitation Program (NRP) added consideration of CPAP for spontaneously breathing infants with labored breathing or hypoxia in the DR. This was followed by increased use of DR-CPAP and frequency of PTX in >35-wk GA neonates (Smithhart et al, 2019).

**Objective:** To decrease DR-associated PTX by 50% within 1 year among ≥35-wk GA neonates with mild respiratory distress who need neither DR-positive pressure ventilation (PPV) nor DR-O\textsubscript{2} (DR-PPV/O\textsubscript{2})

**Design/Methods:** A local quality improvement (QI) project, started in April 2017, recommended avoidance of DR-CPAP for neonates ≥35-wk GA with respiratory distress who needed no DR-PPV/O\textsubscript{2} (Fig 1). Data collection started in 2012, when strict criteria for chest X-rays were established. Among those unexposed to DR-PPV/O\textsubscript{2} we collected (1) all PTX, (2) DR-CPAP-associated PTX (following DR-CPAP and visible on 1\textsuperscript{st} chest X-ray on 1\textsuperscript{st} day postnatal) and (3) spontaneous PTX (without prior positive pressure). The latter two types of PTX were confirmed with either a positive reading by a pediatric radiologist or confirmation by a single pediatric radiologist in case the 1\textsuperscript{st} reading was not definite. We used statistical process control (p chart), χ\textsuperscript{2} analysis and Mann-Whitney test.

**Results:** Among 4837 neonates without DR-PPV/O\textsubscript{2} and admitted to the NICU in 01/2012-06/2019, significant decreases were observed in DR-CPAP use (6.9% during baseline vs. 1.4% after QI implementation), total PTX (4.2% vs. 2.5% and DR-CPAP-associated PTX (1.4% vs. 0.1%), but not in spontaneous PTX (1.5% vs. 1.3%) (Fig 2&3). Among 44 neonates with CPAP-associated PTX, thoracentesis was done in 1. Among 78965 neonates delivered during that period, there was no change in number of NICU admissions for respiratory distress in those without DR-PPV/O\textsubscript{2} (0.8% vs. 0.8%, \(P=0.86\)) or duration of their hospitalization (median 6 days, interquartile range [IQR] 4-8 days in both epochs, \(P=0.46\)). Among neonates without DR-PPV/O\textsubscript{2} there was no change in postnatal age at admission for those with meconium aspiration syndrome (67 min [IQR 52,91] vs. 85 (IQR 54, 120), \(P=1.00\)). Among 730 neonates who received DR-O\textsubscript{2} but no DR-PPV and admitted to the NICU, the frequency of DR-associated PTX did not change with QI implementation (17% vs. 21%) (Fig 4).

**Conclusion(s):** CPAP-associated PTX in ≥35-wk GA neonates not needing DR-PPV or DR-O\textsubscript{2} decreased after limiting DR-CPAP. These results add evidence that could be used to clarify NRP guidelines regarding the use of DR-CPAP.

**Figure 1.** Flow Diagram showing the time frame of changes in management of 35-42wk GA neonates with respiratory distress  

**Figure 2.** DR-CPAP among 4837 35-42wk GA neonates with resuscitation team call without DR-O\textsubscript{2} or DR-PPV and admitted to the NICU
UCL, upper confidence limit; CL, central line

Fig 3. Pneumothorax among 4837 >35wk GA neonates with resuscitation call who received neither DR-O₂ nor DR-IPPV and were admitted to the NICU

Left panel: all pneumothoraces; Middle panel: confirmed CPAP-associated pneumothorax (following DR-CPAP, pneumothorax visible on 1st chest X-ray and 1st day postnatal); Right panel: confirmed spontaneous pneumothorax (no prior PPV or CPAP)

UCL, upper confidence limit; CL, central line

Figure 4. CPAP-associated pneumothorax (visible on 1st chest X-ray and 1st day postnatal) among 730 35-42wk GA neonates with resuscitation call who received DR-O₂ but no DR-IPPV and were admitted to the NICU

UCL, upper confidence limit; CL, central line

**IMAGE CAPTION:**
Figure 1. Flow Diagram showing the time frame of changes in management of 35-42wk GA neonates with respiratory distress

Figure 2. DR-CPAP among 4837 35-42wk GA neonates with resuscitation team call without DR-O₂ or DR-PPV and admitted to the NICU

UCL, upper confidence limit; CL, central line

Fig 3. Pneumothorax among 4837 >35wk GA neonates with resuscitation call who received neither DR-O₂ nor DR-IPPV and were admitted to the NICU

Left panel: all pneumothoraces; Middle panel: confirmed CPAP-associated pneumothorax (following DR-CPAP, pneumothorax visible on 1st chest X-ray and 1st day postnatal); Right panel: confirmed spontaneous pneumothorax (no prior PPV or CPAP)
Figure 4. CPAP-associated pneumothorax (visible on 1st chest X-ray and 1st day postnatal) among 730 35-42wk GA neonates with resuscitation call who received DR-O2 but no DR-IPPV and were admitted to the NICU.
Background: Following the 2010 American Academy of Pediatrics (AAP) clinical report on Premedication for Nonemergency Endotracheal Intubation, the University of Utah Newborn Intensive Care Unit (NICU) created guidelines to reflect those recommendations. Initial adherence to unit guidelines was believed to be high; however, a 2018 manual chart review of 6 months of admissions showed that 54% of appropriate intubation opportunities were premedicated. Only 39% included analgesia. A team was formed to further understand the problem and with a goal to improve usage of the AAP recommended medications.

Objective: The aim of our initiative was to increase intubation premedication from 69% to greater than 80% within a three-month period in the University of Utah NICU.

Design/Methods: A team was created with key stakeholders. Using literature review and informal conversations with
thought leaders, a key driver diagram was built (Figure 1). We created an “intubation huddle script” tool and an educational reminder card for visual triggers. An educational experience served as the formal renaming and reframing of the process, with neurodevelopmental care as the focus. The process was renamed “Neurodevelopmentally Sensitive Intubation (NSI).” The education explicitly empowered all care givers to discuss the goals of care by shifting process ownership from ordering provider to all caregivers. Electronic medical record (EMR) queries reported usage as a percent of appropriate opportunities premedicated with analgesia per month.

Results: In the first month that the education was presented and the reminder tools were visible on the unit, the appropriate usage per opportunity improved from a pre-intervention baseline of 69% to 100%. A p-chart spanning 12 months showed sustained improvement at a mean of 93% appropriate premedication (Figure 2).

Conclusion(s): Over the last decade since the AAP clinical report on the topic, intubation premedication has been a challenging norm to establish. By renaming the process, reframing the context, and shifting ownership from the ordering provider alone to the care team as a whole, including bedside nurses, sustained improvement occurred without creating a new guideline or changing the EMR order set. This is a novel report addressing contextual and adaptive factors that have allowed for highly reliable implementation.

Key Driver Diagram

IMAGE CAPTION:
Key Driver Diagram