Bringing Technology to Enteral Feeds: Less Art, More Science

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As survival rates for extremely preterm infants improve, attention is now being focused on improving the quality of survival through optimal nutritional management. Optimal nutrition during this critical period in early life can positively impact preterm infants' physical growth, as well as neurological development. Conversely, suboptimal nutrition early in the neonatal period contributes to the accumulation of growth deficits. For example, infants provided only glucose solutions as nutrition in the first few days of life rapidly develop large protein and essential fatty acid deficits, with the smallest, most immature infants suffering the worst postnatal malnutrition. (1)

Yet, optimizing nutrition management in the NICU, particularly through a successful progression of enteral and oral feeding of preterm infants, remains a major challenge for clinicians. Some feeding difficulties are related to immature gastrointestinal systems, but failure to start and advance enteral feedings more commonly are due to suspicion and fear of necrotizing enterocolitis (NEC), aspiration syndromes, and other life-threatening events. (2,3) Many less critical and unsubstantiated concerns about presumed causal associations between enteral feeding and adverse clinical conditions further limit successful feeding advancement. (4) As a result, preterm infants commonly are subjected to delayed onset of enteral feeds, longer duration of trophic feeds that provide inadequate nutrition, lack of progressive tolerance to increased feeding volumes, longer time to full enteral feeds, and longer transition times to oral feeding.

Feeding difficulties are the primary contributor to increased NICU resource utilization and length of stay (LOS) and result in the prolonged duration of central line days, parenteral nutrition (PN), and intra-gastric feeding (5), all leading to an increased risk of hospital-acquired infections.(6,7) In addition, clinician variability in individual practice attitudes, experience, and knowledge can influence the implementation of a feeding strategy. (5)

All of these factors contribute to significant variation in the practice of feeding in the NICU – the feeding schedule, feeding quantity, feeding advancement, feeding contents, and the

decision-making process for feeding/not feeding. While a certain amount of variation is to be expected, existing variations are significant enough to affect health outcomes for preterm infants. Standardizing the process for preterm infant feeding is one way to ensure the successful progression of enteral and oral feeding, and thus optimal nutrition management.

Evidence in Favor of Standardized Feeding Guidelines in the NICU

In a Nationwide Children's Hospital study aimed at process optimization, the implementation of a standardized feeding strategy in the NICU was shown to effectively minimize practice variability, accelerate the attainment of enteral and oral feeding milestones, and decrease LOS without increasing adverse morbidities. (5) To monitor compliance with this quality improvement initiative, multidisciplinary feeding rounds were held each week on each infant to provide education regarding the factors that were helping or impeding feeding progress.

Compared to preterm infants whose feeding strategy was prescribed by the individual attending physician and implemented by the clinical care providers, preterm infants who were placed on a standardized feeding program demonstrated a reduction in:

- Duration of trophic feeding by 7.2 days
- Time to full enteral feeds by 4.9 days
- Time from oral feeding onset to oral feeds by 16.3 days
- Duration of ventilation by 35%
- Duration of CPAP by 23%
- Duration of PN by 3.5 days
- Duration of central lines by 4.4 days
- Length of stay by 14.9 days

Mortality, NEC rates, readmissions within 30 days, and comorbidities were similar in both cohorts.

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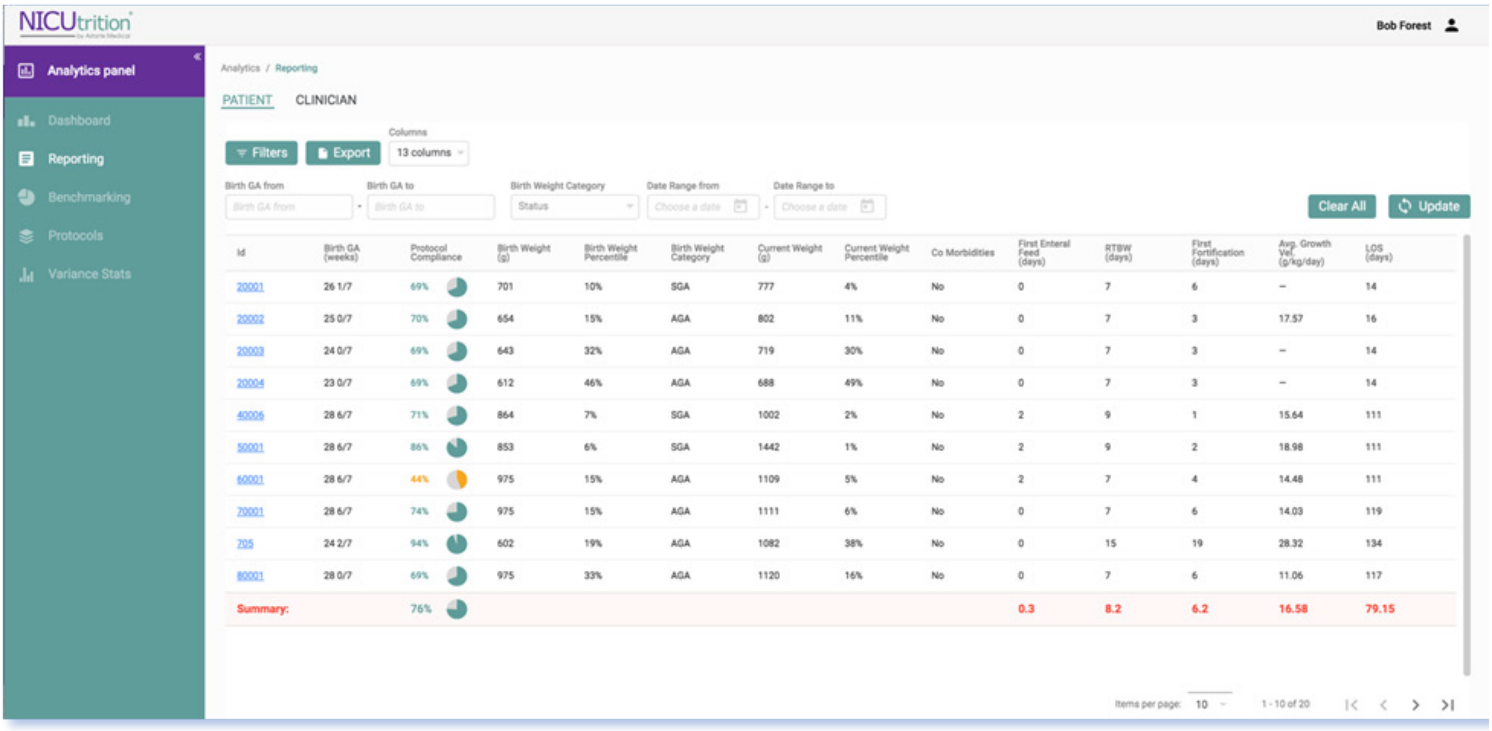

Figure 1. NICUtrition® Analytics Reporting Screenshot: A NICU departmental snapshot of protocol compliance, feeding metrics, and growth milestones.

nutritional status resulting in improved host defenses. (8) Other recent studies have demonstrated that implementing standardized feeding protocols can also improve growth outcomes in addition to reducing adverse events. (9-12)

Strides Toward Standardization

As the benefits of standardization become clearer to hospitals, many clinical practice groups have developed consensus-based enteral feeding protocols for nutrition management to provide evidence-based care with less variability. However, to be truly effective, compliance monitoring at feeding rounds is necessary to overcome the challenges of attaining feeding milestones. Educating clinicians about feeding methods will also help ensure the achievement of feeding-related goals. It is essential to help clinicians understand when, how, and why to advance feeds to attain targeted milestones.

Currently, though, there is no practical way to evaluate the adherence to nutrition guidelines or assess desired feeding and nutrition-related outcomes to improve the practice of care. Protocol implementation and management is still a manual, self-reported process. There was an early promise of using the electronic medical record (EMR) to support research and provide clinical decision support, but the reality is that EMRs have created workflow disruption and do not provide insights related to feeding and nutritional goals in real-time. Furthermore, many clinical practice groups end up with a wealth of collected data and no tool or process to mine the data for useful insights to benefit their patients.

NICUtrition®: Digital Tools to Standardize Feeding and Optimize Nutrition for Preterm Infants

To overcome the challenges of manual standardization, understand protocol adherence or lack thereof, and to gather useful insights from feeding data, clinical practice groups could benefit from an operational tool to more effectively implement a hospital's feeding

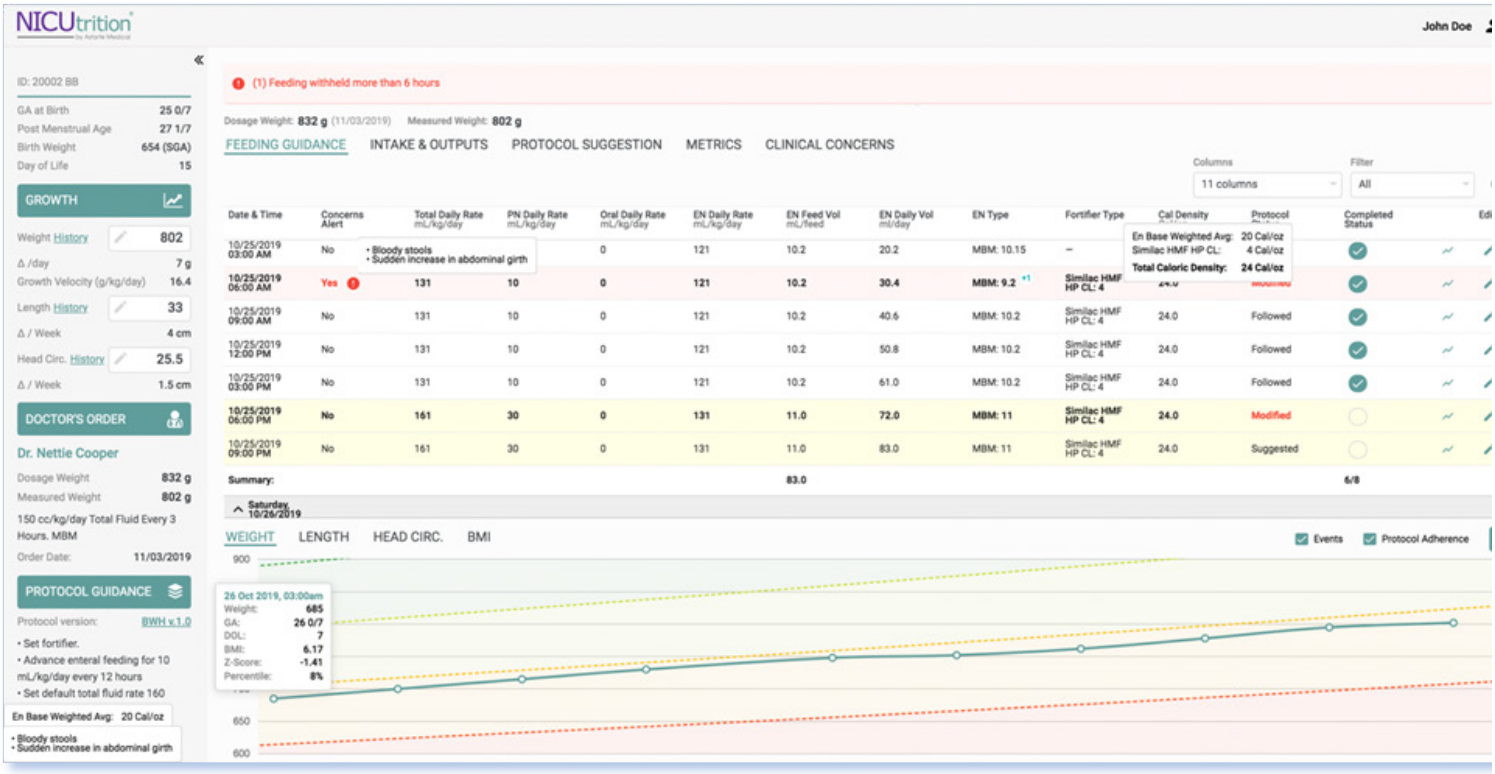

Figure 2 NICUtrition® Guidance Screenshot: prospective feeding plan based on the hospital's own enteral feeding protocol shown in an interactive dashboard to chart feedings and view historical data.

protocol and promote compliance.

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NICUtrition® by Astarte Medical supports feeding protocols, feeding practice, and decision-making in the NICU with a suite of digital tools designed to standardize feeding and optimize nutrition for preterm infants. NICUtrition® uses a hospital's feeding protocol and creates a rules engine based on those guidelines. It provides for structured documentation of the reason(s) why protocols are not being followed, which today is either not captured or is buried in flowsheet notes. NICUtrition® has bi-directional integration with a hospital's EMR so that duplicate documentation is not required. With the ability to integrate through FHIR standards or Epic's App Orchard, implementation of this digital tool is much simpler than custom integration projects or EMR reports with manual review.

The NICUtrition® suite currently consists of NICUtrition® Analytics – an audit and monitoring tool for protocol compliance – and NICUtrition® Guidance – a real-time feeding decision support tool to standardize the practice of feeding and reduce documentation time.

By extracting a hospital's historical feeding data, NICUtrition® Analytics (Figure 1) measures adherence and correlates it to outcomes. As a one-time audit, Analytics can identify a hospital's historical levels of adherence to protocols and provide a baseline to measure compliance and outcomes, bringing to light areas for improvement.

NICUtrition® Analytics also can provide continuous insights into reasons why feeding protocols are not adhered to or why minimal outcomes are achieved despite adherence through real-time, ongoing monitoring of protocol adherence correlated with patient outcomes. This information enables clinical teams to continuously educate and train their staff on established protocols and make the appropriate adjustments as needed to meet expected outcomes more effectively.

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Can Standardized Care Also Be Personalized Care?

Standardized protocols alone are insufficient if they do not also allow for some degree of personalization to the specific preterm infant. Standardization and personalization do not have to be mutually exclusive and can complement each other. Standardization can enhance personalization by supplementing physician experience and reducing guesswork for clinicians. In fact, standardizing care and measuring outcomes enables providers to create personalized treatment plans for patients by taking a variety of factors into account, such as outcomes for similar patients.

NICUtrition® Guidance (Figure 2) is a real-time feeding decision support tool to standardize practice and reduce documentation time of feedings, while also allowing for patient personalization. It is an interactive, bedside dashboard that, for each feed, pre-populates how the infant should be fed based on that institution's clinical practice guidelines. It provides one-click approval if the protocol is being followed, but also allows for alterations and notations by the NICU team, in a structured format, based on observations or other indicators. The Guidance tool ensures consistent delivery of care by presenting protocols in an intuitive format, reducing the possibility of individual interpretation of the protocols – providing the when, how, and why to the clinical team in a structured format that can be analyzed without the need for a costly data study.

The NICUtrition® suite of digital products provides a more effective way to implement an institution's established feeding guidelines and serves as a useful tool in providing insights into individual infant feeding metrics and nutrition-related goals, as well as NICU-wide results.

Standardized and Personalized Feeding: Helping Preterm Infants Survive and Thrive

By optimizing nutrition through both standardized and personalized feeding strategies, a real impact can be made in the most critical time of growth for preterm infants. Moving away from manual processes to digital tools can move the neonatal nutrition field forward and provide a measurable benefit to all stakeholders - administrators, physicians, nurses, and, most importantly, our tiniest, most vulnerable patients.

References:

1. *Thureen PJ. Early aggressive nutrition in the neonate. Pediatr Rev. 1999;20(9):e45-55.*
2. *Jadcherla SR, Peng J, Moore R, et al. Impact of personalized feeding program in 100 NICU infants: pathophysiology-based approach for better outcomes. J Pediatr Gastroenterol Nutr. 2012;54(1):62-70.*
3. *Jadcherla SR, Stoner E, Gupta A, et al. Evaluation and management of neonatal dysphagia: impact of pharyngoesophageal motility studies and multidisciplinary feeding strategy. J Pediatr Gastroenterol Nutr. 2009;48(2):186-192.*
4. *Hay WW. Optimizing nutrition of the preterm infant. Zhongguo Dang Dai Er Ke Za Zhi.2017;19(1):1-21.*
5. *Jadcherla SR, Dail J, Malkar MB, McClead R, Kelleher K, Nelin L. Impact of Process Optimization and Quality Improvement Measures on Neonatal Feeding Outcomes at an All-Referral Neonatal Intensive Care Unit. JPEN J Parenter Enteral Nutr. 2016;40(5):646-655.*
6. *Ramasethu J. Prevention and treatment of neonatal nosocomial infections. Matern Health Neonatol Perinatol. 2017;3:5.*
7. *Sengupta A, Lehmann C, Diener-West M, Perl TM, Milstone AM. Catheter duration and risk of CLA-BSI in neonates with PICCs. Pediatrics. 2010;125(4):648-653.*
8. *Stefanescu BM, Gillam-Krakauer M, Stefanescu AR, Markham M, Kosinski JL. Very low birth weight infant care: adherence to a new nutrition protocol improves growth outcomes and reduces infectious risk. Early Hum Dev. 2016;94:25-30.*
9. *Chu S, Procaskey A, Tripp S, Naples M, White H, Rhein L. Quality improvement initiative to decrease time to full feeds and central line utilization among infants born less than or equal to 32 0/7 weeks through compliance with standardized feeding guidelines. J Perinatol. 2019;39(8):1140-1148.*
10. *Graziano PD, Tauber KA, Cummings J, Graffunder E, Horgan MJ. Prevention of postnatal growth restriction by the implementation of an evidence-based premature infant feeding bundle. J Perinatol. 2015;35(8):642-649.*
11. *Morgan C, Tan M. Attainment Targets for Protein Intake Using Standardised, Concentrated and Individualised Neonatal Parenteral Nutrition Regimens. Nutrients. 2019;11(9).*
12. *Viswanathan S, McNelis K, Super D, Einstadter D, Groh-Wargo S, Collin M. Standardized Slow Enteral Feeding Protocol and the Incidence of Necrotizing Enterocolitis in Extremely Low Birth Weight Infants. JPEN J Parenter Enteral Nutr. 2015;39(6):644-654.*

Disclosure: Tammi Jantzen is Co-founder and CFO, Astarte Medical.

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About the Founders

After working together for 15 years in venture capital, Tracy Warren and Tammi Jantzen set out to blaze a path investing in companies they were most passionate about – those with technologies focused on women's and children's health and wellbeing. As a largely underserved area of innovation and investment, they wanted to make an impact. To gain insights into clinical needs and pain points, they visited women's and

children's hospitals across the country, talking to innovation groups and researchers. It was during a visit to Brigham and Women's Hospital in Boston that they met Katherine Gregory, RN, Ph.D. Kate has a unique background having hands-on clinical experience alongside academic and research credentials. She started her career as a NICU nurse and has a Ph.D. in mucosal immunology. She had been doing research on preterm infant microbiome and gut health for several years. In that initial meeting, Kate opened their eyes to the challenges of feeding preterm infants and early life nutrition, and they were immediately hooked. Founded in 2016, Astarte Medical is a precision medicine company using software and predictive analytics designed to standardize feeding, optimize nutrition and quantify gut health to improve health outcomes for preterm infants.