Journal of Pediatric Nursing xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Journal of Pediatric Nursing

# A Post-operative Feeding Protocol to Improve Outcomes for Neonates With Critical Congenital Heart Disease

Jennifer Newcombe [a,*], Eileen Fry-Bowers [b]

[a] Loma Linda School of Nursing, United States
[b] University of San Diego, Hahn School of Nursing and Health Science, United States

ARTICLE INFO

*Article history:*
Received 18 June 2016
Revised 4 November 2016
Accepted 8 December 2016
Available online xxxx

ABSTRACT

Neonates with critical congenital heart disease (CCHD) are vulnerable to malnutrition during the post-operative period due to hypermetabolism and hypercatabolism. To improve nutritional outcomes during hospitalization, a nurse led post-operative enteral feeding protocol was implemented at a large U.S. children's hospital. During an eight-month implementation period, twenty-one neonates met protocol inclusion criteria. Days for neonates to achieve goal caloric feedings (120 kcal/kg/day) were decreased. A one-way repeated measures analysis of variance showed serum albumin levels and serial anthropometric measurements improved significantly throughout hospitalization ($p < 0.005$). Results from this quality improvement project show standardizing nutritional care for neonates with CCHD during the post-operative period is an effective way to improve nutritional outcomes and shorten length of hospital stay.



A congenital heart defect (CHD) is a structural problem of the heart present at birth. According to the American Heart Association, it is the most frequent birth defect in newborns, affecting approximately 8 out of 1000 births (American Heart Association, 2016). Neonates with critical congenital heart disease (CCHD) present with life-threatening symptoms and require cardiac surgery or catheterization within the first few days or months of life (Center for Disease Control, 2012). According to the Center for Disease Control (CDC), about 7200 newborns are born each year with CCHD.

Malnutrition is defined as the imbalance between the intake of nutrients and the body's energy demands for maintenance and growth (Mehta et al., 2013). Worldwide, anthropometric measurements are used to assess nutritional status (Joosten & Hulst, 2014). Upon admission to the hospital, a neonate's anthropometric measurements (i.e., weight, length and head circumference) are measured. These indicators are plotted onto the CDC growth chart according to the World Health Organization Standard (WHO). A Z-Score, a measurement that indicates relationship to the average score in a group, is calculated for weight to identify severity of acute or chronic malnutrition (Joosten & Hulst, 2014). According to the Michigan's Malnutrition Diagnostic Tool (M tool), malnutrition is defined in infants >30 days as a weight for age Z-Score as follows: −1 to −1.99 is mild malnutrition, −2 to −2.99 is moderate malnutrition, and −3 or less is severe malnutrition (Bouma, 2014).

Neonates with CCHD are especially vulnerable for malnutrition during the post-operative period. Neonates have an increase in resting energy expenditure (REE) and a 25% higher rate of protein breakdown (Owens & Musa, 2009). This, in addition to minimal stores of protein and body fat at birth, leave the neonate more susceptible to malnutrition compared to older children and adults (Owens & Musa, 2009).

Although the consequences of malnutrition for post-operative CCHD neonates include increased morbidity and mortality, these patients do not receive the recommended caloric and protein requirements (Wakita, Fukatsu, & Amagai, 2011). Deterrents to optimal nutrition cited in the literature include: hemodynamic instability, limitations of fluid intake, inotropic support, frequent interruptions in nutrient delivery related to feeding intolerance and heath care provider variability (Braudis et al., 2009; Del Castillo et al., 2010; Slicker et al., 2012). Malnutrition in this vulnerable population has been associated with poor clinical outcomes including delayed wound healing, bacterial infections and extended hospital stay (Wakita et al., 2011).

There are no consensus guidelines addressing post-operative feeding and growth for CCHD patients. Braudis et al. (2009) and Del Castillo et al. (2010) conducted retrospective case-controlled cohort studies comparing safety and efficacy of post-operative enteral feeding algorithms on infants with CHD. Both studies reported improved nutritional intake and decreased rates of necrotizing enterocolitis (NEC), a complication seen with CHD patients secondary to gastrointestinal hypoperfusion. These studies, however, were done only on neonates with a severe form of CCHD known as hypoplastic left heart syndrome (HLHS).

The Feeding Work Group (FWG) of the National Pediatric Cardiology Quality Improvement Collaborative (NPC-QIC) also developed

* Corresponding author at: Loma Linda University Children's Hospital, Pediatric Cardiothoracic Surgery, 11234 Anderson Street, Room 5827, Loma Linda, CA 92354, United States.
*E-mail address:* jnewcomb@llu.edu (J. Newcombe).

http://dx.doi.org/10.1016/j.pedn.2016.12.010
0882-5963/

Please cite this article as: Newcombe, J., & Fry-Bowers, E., A Post-operative Feeding Protocol to Improve Outcomes for Neonates With Critical Congenital Heart Disease, *Journal of Pediatric Nursing* (2016), http://dx.doi.org/10.1016/j.pedn.2016.12.010

recommendations for feeding in neonates with HLHS or single ventricle variants (Slicker et al., 2012). The NPC-QIC surveyed participating cardiology centers and conducted a meta-analysis of the literature to identify best nutritional practices. The NPC-QIC identified provider practice variation on timing and delivery of post-operative enteral feeding as a contributor to poor growth patterns during hospitalization. The FWG proposed usage of a pre-operative feeding, as well as a post-operative feeding algorithm.

Currently, no evidence exists to show whether standardizing care during the post-operative period for all neonates with CCHD may be an effective way to improve nutritional outcomes and decrease length of stay. The purpose of this article is to address this gap by describing the implementation of a nurse-led post-operative feeding protocol at a regional children's hospital.

## Local Problem

In 2014, a retrospective review of chart data revealed 53 neonates underwent surgery at the hospital. Twenty-four patients underwent single ventricle repair and 29 patients had biventricular repair. Time to initiation of enteral feedings post extubation was 33 h ($SD = 1.95$). Patients from both groups demonstrated weight loss during their hospitalization. The median WHO Z-Score for weight at time of discharge for biventricular repair patients was −1.0, while single ventricle repair was −1.64. Using the M tool, both groups of infants discharged after 30 days of life, likewise met the criteria for mild malnutrition (Bouma, 2014). Both groups also demonstrated poor growth in length and head circumference.

## Project Aims

The purpose of this quality improvement project was to improve anthropometric measurements by standardizing nutritional care during the post-operative period. The following primary question was addressed: Does implementation of a post-operative feeding protocol improve nutritional outcomes and decrease hospital length of stay for neonates with CCHD who have undergone heart surgery?

## Methods

### *Setting and Ethics*

This institution performs complex surgeries for children with CCHD such as single ventricle repair (i.e., the Norwood procedure, which consists of creating a shunt from the subclavian artery to the pulmonary artery or from the right ventricle to pulmonary artery and enlarging the hypoplastic aorta); it also specializes in biventricular repair surgeries such as repair of Tetralogy of Fallot and ventricular septal defect. This quality improvement project was submitted to the institutional review board and was deemed not human subjects research. Confidentiality of patient information, however, was maintained by keeping electronic files of the data on a password-protected computer.

### *Planning and Implementation*

The Plan-Do-Study-Act (PDSA) model guided the study design for this project. This four stage cyclic approach to process improvement includes stages of change that involve planning an intervention to an identified problem, doing or implement the intervention, studying the outcomes of the intervention, and acting to sustain or improve the intervention (Taylor et al., 2014). The PDSA model can be used alone or part of a broader quality improvement approaches like Six Sigma, Lean or quality improvement collaborative. This model has been tested and evaluated in healthcare settings and is considered reliable and valid (Taylor et al., 2014).

Given the assessment described above, the advance practice registered nurse (APRN) in the CTICU organized a multidisciplinary taskforce to analyze nutrition practices from time of patient extubation to discharge. Taskforce members included a cardiac surgeon, pediatric intensivists, a neonatologist, a pediatric gastroenterologist, dieticians from the CTICU and neonatal intensive care unit (NICU), representatives from occupational therapy (OT), and speech therapy (ST), the CTICU nurse practitioner, bedside nurses, and the medical and nursing directors of the CTICU. Barriers to proper nutrition noted by the taskforce during group discussions included: patients not receiving the recommended caloric or protein intake, delays in placing feeding orders into electronic health record, and disruptions in feedings related to feeding intolerance.

Because there are no feeding guidelines for CCHD neonates, the taskforce reviewed published algorithms by Braudis et al. (2009), Del Castillo et al. (2010) and Slicker et al. (2012). The taskforce determined that it could not recommend usage of a specific feeding algorithm because protein supplementation and criteria for feeding intolerance were not addressed in these algorithms. Therefore, the taskforce adapted algorithms from each of the studies and included criteria for protein supplementation. Del Castillo et al. (2010) findings were utilized to develop contraindications, as well as considerations for initiating enteral feedings. Braudis et al. (2009) results were used to determine criteria for continuous versus bolus feedings and timing of assessment for feeding tolerance. Finally, Slicker et al. (2012) recommendations were utilized to determine how to consolidate continuous nasogastric feedings and criteria to evaluate aspiration.

The revised feeding protocol consisted of four algorithms (Supplementary material) and included criteria for donor breast milk. The algorithms were built into an order-set in the electronic health record (EHR). This protocol was then presented to six hospital committees (e.g. nutrition sub-committee of pharmacy and therapeutics), which granted approval for its implementation.

### *Intervention*

The protocol was implemented in the CTICU from August 2015 to March 2016. Twelve hours following extubation, nurses screened patients based on predetermined inclusion/exclusion criteria (Table 1). If patients met inclusion criteria, the feeding protocol was started. Education, policy change, documentation and rounding strategies, as described below, ensured proper implementation of protocol.

### *Education*

The project champion trained members of the unit based nursing council (UBC) and other nursing support personnel (i.e., "super users") about the protocol. Over a two-week period, UBC members

**Table 1**
Feeding protocol inclusion/exclusion criteria.

| Inclusion criteria | Relative inclusion criteria (per physician discretion) use the continuous feeding pathway | Exclusion criteria |
|---|---|---|
| Neonate who has undergone open heart surgery for CCHD within 30 days of life<br>>38 weeks gestation<br>>2.5 kg<br>Extubated a minimum of 12 h<br>Respiratory rate < 60<br>Admitted to Pediatric Cardiothoracic Intensive Care Unit | High flow/NIPPV<br>**Do not transition to bolus feeds until off highflow/NIPV.<br>Previous GI surgery<br>Respiratory rate > 60 | Heterotaxy patients<br><38 weeks gestation<br><2.5 kg<br>Hemodynamic instability (Dopamine > 5 mcg/kg/min, Milrinone > 0.5 mcg/kg/min)<br>NEC symptoms (frank blood in the stools and or NG, abdominal distension)<br>Previous history of NEC |

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