Enteral feeding algorithm for infants with hypoplastic left heart syndrome poststage I palliation

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Background: **Infants with hypoplastic left heart syndrome (HLHS) experience a high incidence of growth failure in the postoperative period following stage I palliation. Because of an increased risk of necrotizing enterocolitis in this population, clinicians may be reluctant to initiate early enteral feedings. Published guidelines for initiating and advancing enteral feedings in this population are limited.**

Objective: **To test the safety and efficacy of an enteral feeding algorithm in infants with HLHS following stage I palliation.**

Design: **Single-center, prospective case series with historical comparisons.**

Setting: **Pediatric cardiovascular intensive care unit in tertiary care children's hospital.**

Patients: **The study group consisted of consecutive patients ≥35 wks gestational age and weight ≥2 kg admitted to our cardiac intensive care unit over an 18-month period following stage I palliation of HLHS (n = 36). Excluded were nonsurvivors, patients supported on extracorporeal membrane oxygenation or those with a history of NEC or fetal intervention. These data were compared with a similar cohort of patients admitted to the cardiac intensive care unit over an 18-month period before the implementation of the feeding algorithm (n = 27).**

Intervention: **A feeding algorithm was implemented in the study group in the postoperative period for initiation and advancement of enteral nutrition.**

Measurements and Main Results: **The median duration of total parenteral nutrition was significantly higher in the control group (116 vs. 51 hrs; $p = 0.03$) compared with the study group. The median time to achieve recommended daily allowance of calories defined as 108 kcal/kg per day was significantly reduced in the study group (9 vs. 13 days; $p = 0.01$). Despite the rapid advancement of enteral feedings on the algorithm, there was no incidence of NEC in the study group compared with 11% in the control group.**

Conclusion: **The use of an enteral feeding algorithm is a safe and effective means of initiating and advancing enteral nutrition in infants with HLHS following stage I palliation. (Pediatr Crit Care Med 2009; 10:460–466)**

Key Words: hypoplastic left heart syndrome; enteral nutrition; congenital heart defects; infant malnutrition; algorithms; feeding methods

Infants with hypoplastic left heart syndrome (HLHS) experience a high incidence of growth failure in the postoperative period following stage I palliation (1–4). The growth failure in these infants may be related to insufficient nutritional intake, gastrointestinal malabsorption, or high energy expenditure (5–8). Clinicians are often reluctant to initiate and advance early enteral feedings in this population because of the increased risk of necrotizing enterocolitis (9, 10) and the high incidence of feeding intolerance and gastroesophageal reflux disease (11). Thus, providing optimal nutritional support to critically ill infants with congenital heart disease (CHD) is a significant clinical challenge and published methods for initiating and advancing enteral feedings in infants with HLHS are limited.

Multiple studies have shown that implementation of early enteral nutritional support improved nutritional outcomes, shortened duration of mechanical ventilation, lowered infection rates, improved wound healing, decreased length of stay, and reduced mortality in critically ill patients (12–16). Given the high incidence of malnutrition in infants with HLHS and the prospect of future surgeries, it is imperative to provide adequate enteral nutrition.

In 2001, a survey of nurses in the cardiac intensive care unit (CICU) at Children's Hospital, Boston, demonstrated wide variation in practice for initiating and advancing enteral feedings in the immediate postoperative period following congenital heart surgery. To decrease unnecessary variation in the delivery of enteral nutrition and to optimize caloric intake in high-risk neonates, a multidisciplinary team developed the Boston Cardiovascular Program Enteral Feeding Algorithm (Appendix). The purpose of this study was to test the safety and efficacy of this enteral feeding algorithm in infants with HLHS following stage I palliation.

MATERIALS AND METHODS

Feeding Algorithm. A multidisciplinary team of nurses, physicians, and nutritionists reviewed the literature and best practices and

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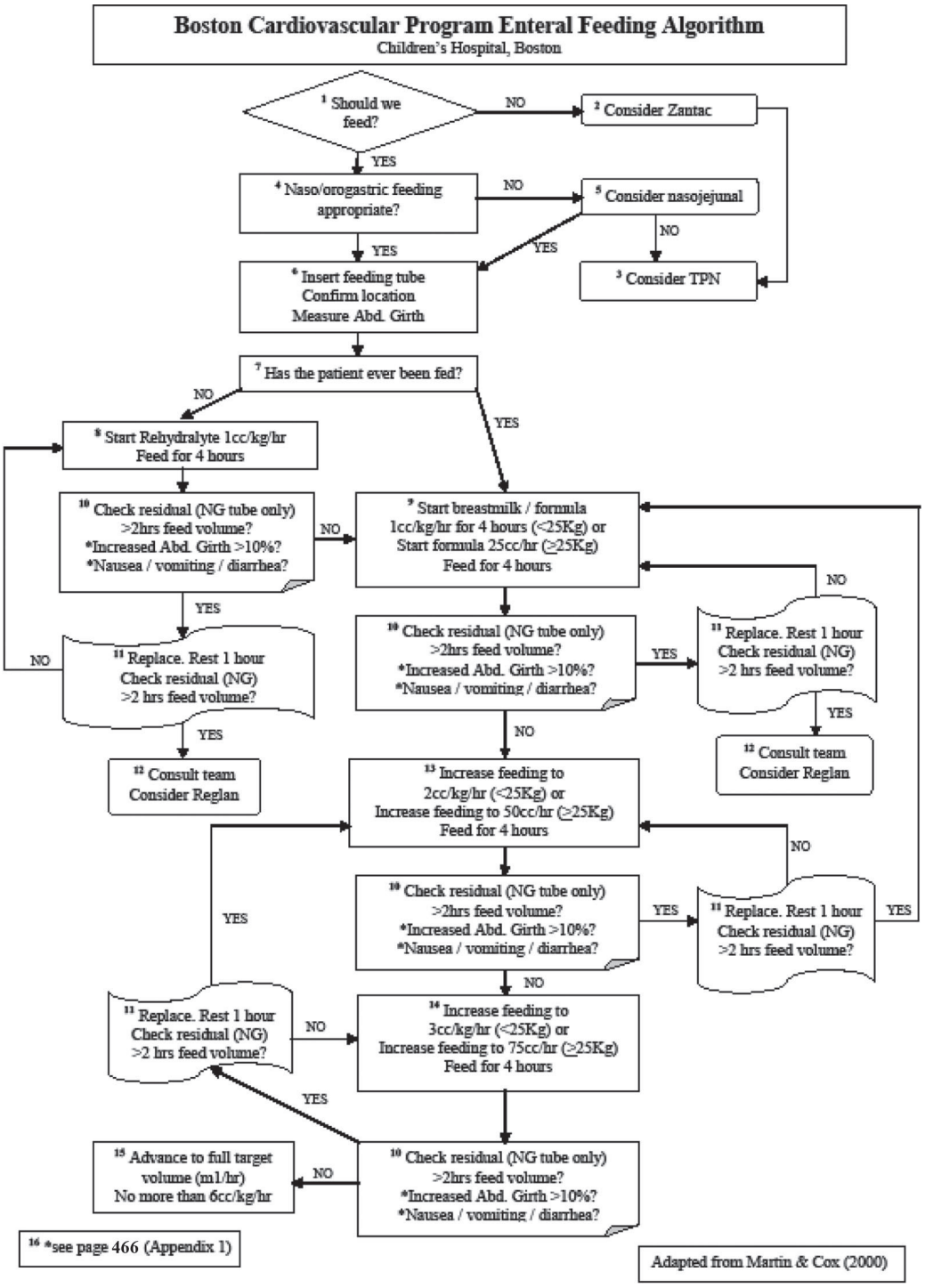

Adapted with permission from Martin and Cox (17).

Figure 1. Enteral feeding algorithm. Abd, abdomen; *TPN,* total parenteral nutrition; *NG,* nosogastric.

developed the enteral feeding algorithm (Fig. 1). The algorithm was adapted from a model by Martin and Cox (17) and describes a four-step process identifying when to initiate and advance enteral feedings based upon residual gastric volume, abdominal girth, and age appropriate symptoms of gastrointestinal distress. The decision to provide enteral nutrition was discussed each morning during multidisciplinary rounds and exclusion criteria were reviewed. Before the initiation of feedings, there was evidence of adequate cardiac output (stable vital signs, low-dose inotropes, and good peripheral perfusion). Once the protocol is initiated, the goal is to facilitate the transition from full intravenous fluids to maintenance enteral feedings (total fluid intake: 100 mL/kg per day) within 16 to 20 hours. When the infant has achieved full maintenance enteral feedings or the maximum volume allowed given a fluid restriction (algorithm

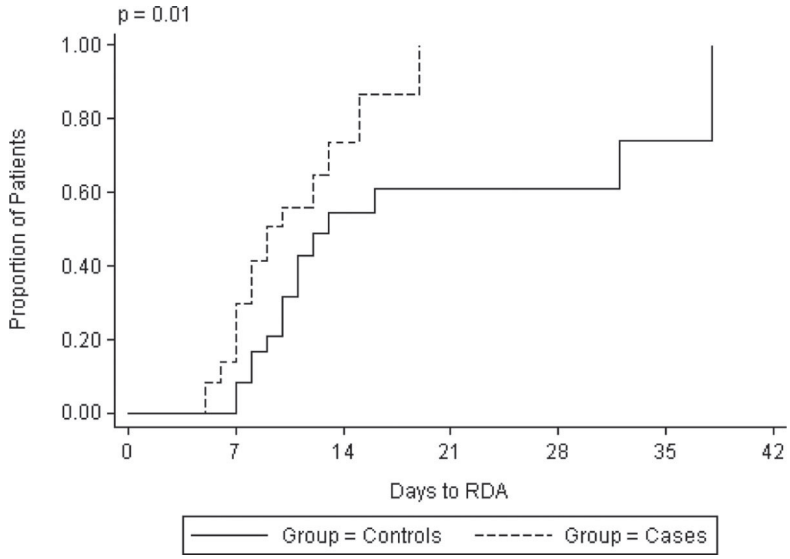

Figure 2. Comparison of time to reach recommended daily allowance (*RDA*) of calories between the two feeding groups.

completed), calories are increased by 2 kcal/ounce per day until goal calories are attained. Following extubation, infants are transitioned from continuous feeds to bolus feeds and oral intake if tolerated to normalize feeding patterns.

Study Population. The algorithm was implemented on a prospective cohort of consecutive patients ≥35 wks gestational age and weight ≥2 kg admitted over an 18-month period (October 2002–March 2004) to our CICU following stage I palliation for HLHS. We excluded nonsurvivors and patients supported on extracorporeal membrane oxygenation before the initiation of enteral feedings, those with a history of NEC before surgical intervention, and those who had a fetal intervention for management of left-sided obstructive lesions. These data were then compared with a similar cohort of patients admitted to the CICU over an 18-month period (February 2000–July 2001) before the implementation of the enteral feeding algorithm. Prospective data collection for the study group and retrospective chart review for the control group were approved by the Committee for Clinical Research at Children's Hospital, Boston, and the need for parental consent was waived.

Data Collection. Data collected for both study and control groups included demographic data, Activity, Pulse, Grimace, Appearance, and Respirations (APGAR) scores at 1 and 5 mins, presurgical severity of illness, medical diagnosis, and type of surgical procedure. Nutritional data included time to first feeding, time to achieve recommended daily allowance (RDA) of calories defined as 108 kcal/kg per day, daily calorie counts, duration of total parenteral nutrition (TPN), growth measurements, and adherence to the algorithm. Postoperative data included length of intubation, incidence of NEC following initiation of enteral feeds, and length of stay in the CICU and hospital.

Statistical Methods. Continuous data are summarized as median values with range and categorical data as number and percentage unless specified otherwise. Demographic information, anthropometric data before the implementation of the feeding protocol, outcomes, and complication data for the case and control groups were compared using the Mann-Whitney *U* test for continuous data, and Fisher's exact test for categorical data. The Kaplan-Meier method was used to estimate the time to reach RDA; a comparison between the study and the control groups was performed using the log-rank test (Fig. 2). Patients in whom enteral nutrition was started using the feeding algorithm but later converted to breastfeeding (n = 18) or discharged from our institution (n = 11) before reaching RDA of calories were included in the Kaplan-Meier analysis. Follow-up information for these patients was censored at the date of hospital discharge. A p value <0.05 was considered to be statistically significant. All analyses were conducted using SPSS (v. 15.0; SPSS, Chicago, IL) statistical software.

RESULTS

Demographic Data. Forty-seven infants with HLHS were screened for the study group. Thirty-six patients who met inclusion criteria were enrolled and were managed on the algorithm for initiating and advancing enteral feedings in the postoperative period. Excluded from the study group were premature infants (n = 2), patients supported on extracorporeal membrane oxygenation (n = 3), infants who had undergone a fetal intervention (n = 1), patients who developed NEC before the initiation of feedings (n = 3), and infants who died before meeting feeding criteria (n = 2). In the control group, 39 infants were screened and 27 met inclusion criteria. Exclusions from the control group consisted of premature infants (n = 4), patients supported on extracorporeal membrane oxygenation (n = 4), infants who had undergone a fetal intervention (n = 1), patients with NEC before feeding (n = 2), and infants who died before meeting feeding criteria (n = 1). Age, gender, gestational age, APGAR scores, Pediatric Risk of Mortality scores III, and morphologic subtype of HLHS did not vary between the two groups as shown in Table 1. A change in surgical practice in our institution during the implementation of the feeding protocol resulted in the use of a right ventricle to pulmonary artery conduit for the Norwood (NW-RV to PA) operation to provide pulmonary blood flow instead of the Norwood with a Blalock-Taussig shunt (NW-BTS) for infants with HLHS. This resulted in a significant difference in the type of surgical procedure between the two groups. All patients in the control group underwent a NW-BTS whereas only 33% of the study group underwent a NW-BTS ($p < 0.001$). The remaining patients in the study group (67%) underwent a NW-RV to PA conduit.

Feeding and Outcome Data. There were no differences in the admission weight and length to the CICU and the median weight at discharge was similar for both groups. The differences in feeding and growth parameters are outlined in Table 2.

The standard for initiating and advancing TPN remained consistent throughout the study. The majority of patients received TPN although the duration of TPN was significantly shorter in the study group (51 vs. 116 hours, $p = 0.03$). Onset of enteral feedings was not significantly different and the type of enteral feeding did not vary between the two groups. The median number of days to achieve RDA of calories (108 kcal/kg per day) was significantly reduced in the study group (9 vs. 13 days; $p = 0.01$) as shown in Figure 2. Despite the rapid advancement of enteral feedings on the algorithm, there was no incidence of NEC in the study group compared with 11% in the control group (Table 3). NEC was defined using the modified Bell staging criteria as outlined by McElhinney et al (10).

Table 1. Demographic, diagnosis, and procedure-related data for the study sample

Variable	Controls (n = 27)	Cases (n = 36)	p
Age at admit (days)[a]	1 (0, 3)	2 (0, 3)	0.38
Female gender n (%)	8 (29)	18 (50)	0.13
Estimate gestational age (wks)[b]	39 (35, 41)	39 (35, 41)	0.66
One-min APGAR[b]	8 (2, 9)	8 (1, 9)	0.45
Five-min APGAR[b]	9 (6, 9)	9 (7, 10)	0.54
Diagnostic groups (%)			0.85
AA/MA	8 (30)	12 (33)	
AS/MA	1 (4)	3 (8)	
AA/MS	8 (30)	11 (31)	
AS/MS	10 (37)	10 (28)	
Type of stage 1 palliation (%)			<0.001
NW-BTS	27 (100)	12 (33)	
NW-RV to PA	0 (0)	24 (67)	
PRISM score at preoperative admission to CICU[b]	9 (0, 17)	10 (0, 29)	0.11
Age at surgery (days)[a]	4 (3, 6)	5 (4, 6)	0.39
PRISM score at postoperative admission to CICU[b]	13 (7, 31)	17 (10, 21)	0.09

APGAR, Activity, Pulse, Grimace, Appearance, and Respirations; AA, aortic atresia; MA, mitral atresia; AS, aortic stenosis; MS, mitral stenosis; NW-BTS, Norwood operation with Blalock-Taussig shunt; NW-RV to PA, Norwood operation with right ventricle to pulmonary artery conduit; PRISM, Pediatric Risk of Mortality score; CICU, cardiac intensive care unit.

[a]Median, interquartile range (25th, 75th percentile); [b]full range.

Table 2. Anthropometric measurements at admission and feeding characteristics of the study population

Variable	Controls (n= 27)	Cases (n = 36)	p
Admission weight, kg	3.5 (2.2, 4.3)	3.2 (2.2, 4.4)	0.11
Admission length, cm	50 (45, 54)	49.3 (41, 56)	0.45
Time to first feed, days	4 (2, 10)	4 (2, 10)	0.85
Type of feeds (%)			0.45[a]
Breast milk only	14 (52)	15 (42)	
Any formula	13 (48)	21 (58)	
Parental nutrition use	20 (74)	23 (64)	0.43
Parental nutrition duration, hrs	116 (0, 440)	51 (0, 328)	0.03

[a]Compares breast milk users with formula users and those who use both.

Demographic and Outcome Data Comparison Between the NW-BTS and the NW-RV to PA Patients in the Study Group Using the Algorithm

We compared patients who underwent the NW-BTS (n = 12) and the NW-RV to PA (n = 24) operation among patients in the study group to evaluate if differences in outcomes between the study and control groups were due to the type of surgical procedure used. These data are shown in Table 4. The two surgical procedure groups did not differ by demographic and diagnostic details, time to RDA of calories, duration of TPN use, and discharge weight.

DISCUSSION

Our results indicate the feeding algorithm is a safe and an effective way to initiate and advance enteral feedings in infants with HLHS following stage I palliation. This study demonstrated that implementing a feeding protocol enabled patients to achieve RDA of calories earlier in their postoperative course and also decreased the duration of TPN use.

Infants with complex CHD have a high prevalence of both acute and chronic malnutrition (18). Previous studies have shown that patients with HLHS following stage I palliation have suboptimal nutrition (1, 2). Kelleher et al (3) identified an association between poor nutrition in infants with HLHS and an extended length of stay for both the intensive care unit and hospital. Briassoulis et al (16) evaluated nutritional indices in critically ill children and concluded there was a high rate of fat and protein depletion leading to malnutrition, which is associated with increased morbidity and mortality. The authors recommended that early and aggressive nutritional support may decrease the incidence of growth failure in this population. In our study, we found that implementing a feeding protocol improved nutrition by achieving RDA of calories sooner in comparison to those infants whose feeding was advanced in a nonstructured fashion. However, we did not demonstrate weight gain at discharge. This may be related to the short duration of the study and long-term follow-up is necessary to evaluate adequate weight gain.

Many obstacles exist to providing adequate nutritional support to critically ill patients including underprescription of enteral nutrition, individual practice variations, and multiple disruptions in the actual delivery of feedings (19, 20). Various studies indicate that critically ill patients received between 50% and 70% of caloric requirements (21, 22). Barriers to the delivery of enteral nutrition included fluid restriction, mechanical problems with feeding tubes, residual volumes, procedures, hemodynamic instability, daily care, and gastrointestinal distress (2, 23–25). Our results indicate that implementing a feeding protocol reduced practice variation and limited barriers to advancing enteral feedings.

Optimizing delivery of nutritional support to critically ill patients includes development of a standardized nutritional protocol, a multidisciplinary approach, improved education for all staff members, and routine review of practice within the intensive care unit (21). The implementation of a feeding protocol can reduce barriers to providing optimal nutritional support to critically ill pediatric patients (15). Evidence-based feeding protocols reduced the time to achieve desired caloric intake (18, 20, 26–28) and standardized protocols for early enteral nutrition reduced feeding intolerance and improved clinical outcomes (15, 26). Critically ill adult patients managed with an evidence-based nutritional protocol were more likely to receive adequate nutrition, required less ventilatory support, and had a lower risk of mortality (14). A protocol used by Briassoulis et al (29) to evaluate the effectiveness of early enteral feeding in critically ill pediatric patients demonstrated that 86% of patients were able to tolerate early intragastric feedings and costs were significantly reduced. Jeffries et al (9) used a feeding protocol following surgical palliation for infants with HLHS and initiated feedings within 5.9 days (±3.1 days), achieved full feedings (100 mL/kg per day) within 11.1 days

Table 3. Weight gain and other selected outcomes comparison for the two feeding groups

Variable	Controls (n = 27)	Cases (n =36)	*p*
Weight at discharge, kg	3.3 (2.2–4)	3.2 (2.1–4)	0.38
Weight loss during hospitalization	−0.18 (−0.5–0.1)	−0.1 (−0.6–0.5)	0.23
Incidence of NEC (%)	3 (11)	0 (0)	0.07
Duration of ventilation, days	7 (1–21)	6 (2–20)	0.19
Length of stay in CICU, days	12 (6–29)	10 (7–55)	0.07
Length of stay in the hospital, days	19 (10–77)	16 (10–67)	0.07

NEC, necrotizing enterocolitis; CICU, cardiac intensive care unit.
All values mean (range) unless otherwise noted.

Table 4. Comparison of patients using the feeding protocol based on type of surgery: Norwood operation with Blalock-Taussig shunt or right ventricle to pulmonary artery conduit

Variable	NW-BTS (n = 12)	NW-RVPA (n = 24)	*p*
Gestational age	39 (37–41)	39 (35–41)	0.56
APGAR scores			
One minute	8 (4–8)	8 (1–9)	0.96
Five minutes	9 (7–9)	9 (7–10)	0.83
Admission weight	3.3 (2.6–4.4)	3.2 (2.2–4.2)	0.38
Age at surgery, days	4 (2–5)	5 (2–36)	0.001
PRISM score at 24 hr postop	16.5 (11–19)	16.5 (10–21)	0.48
Days to first feed	5 (3–10)	4 (2–7)	0.25
Days to RDA[a]	9 (5–19)	7 (5–12)	0.35
TPN use (%)	9 (75)	14 (58)	0.46
Duration of TPN use, hr	67.5 (0–289)	38 (0–328)	0.28
Weight loss in hospital, kg	−0.2 (−0.5–0.23)	−0.1 (−0.5–+0.52)	0.52
Duration of ventilation, days	6 (4–14)	5.5 (2–20)	0.47
Length of CICU stay, days	9.5 (8–22)	10 (7–55)	0.88
Length of hospital stay, days	21 (12–63)	15 (10–67)	0.14

NW-BTS, Norwood operation with Blalock-Taussig shunt; NW-RVPA, Norwood operation with right ventricle to pulmonary artery conduit; APGAR, Activity, Pulse, Grimace, Appearance, and Respirations; TPN, total parenteral nutrition; PRISM, Pediatric Risk of Mortality score; RDA, recommended daily allowance; CICU, cardiac intensive care unit.
[a]Excludes breast fed infants and NW-BTS (n = 7); NW-RVPA (n = 13).

(±4.9 days), and had an 18% incidence of NEC. In our study using the algorithm, enteral feedings were initiated on postoperative day 4 (range, 2–10), RDA of calories (108 kcal/kg per day) was achieved 9 days (range, 5–19) after the onset of enteral feedings, and there were no cases of NEC in the study group.

The risk of developing NEC in infants with HLHS is significantly higher than in neonates with other forms of CHD (10). Carlo et al (30) evaluated Doppler flow patterns of the descending aorta in term infants with CHD and concluded that compromised diastolic flow in the mesenteric circulation may contribute to the development of NEC. Cheung et al (31) reported profound changes in the splanchnic blood flow in infants palliated with a BTS. Del Castillo et al (32) compared gut perfusion in infants with single ventricle physiology and found that regardless of the type of palliation (BTS vs. RV-PA conduit), there was abnormal intestinal blood flow. Malagon et al (33) also found an increase in gut permeability in children with CHD following cardiopulmonary bypass. In a study to identify gastrointestinal morbidity after the NW procedure in infants with HLHS, the authors encouraged early identification of NEC and suggested that implementation of a nutritional protocol may reduce the incidence of NEC in this high-risk population (9).

As evidenced by our findings, early enteral feedings were well tolerated. In a study of critically ill children, the majority of patients were able to tolerate feedings within 24 hrs of admission (34). Chellis et al (35) found that early enteral nutrition was well tolerated and cost effective. Although our study did not evaluate individual methods of feeding, Horn and Chaboyer (36) reported that critically ill pediatric patients experienced similar outcomes in term of gastrointestinal distress when given either continuous or intermittent gastric feedings.

The primary outcome in our study was time to achieve RDA but it is clear that long-term growth is the desired goal. In a study evaluating the energy expenditure and nutritional requirements following the NW procedure, the results indicated that these infants experience a hypermetabolic response to cardiopulmonary bypass and increased energy expenditure in the immediate postoperative period (5). Infants with single ventricle physiology had a slower rate of growth postoperatively in comparison to infants who underwent a complete cardiac repair (4). Schwarz et al (37) reported that malnourished infants with CHD required approximately 150 kcal/kg per day to achieve significant growth. Although we show that RDA of calories can be achieved sooner using our feeding protocol, future studies should be directed at long-term growth and improved clinical outcomes related to early feeding.

The limitations of this study include the retrospective nature of the review for the control group and the change in surgical practice that occurred during the study. Although we broke down the study group to assess for differences and found none that significantly affected outcomes, we cannot be certain they are not related to surgical procedure. We were unable to calculate the time to RDA of calories in 29 patients as they were either breastfeeding (n = 18), discharged (n = 6), or transferred to an outside hospital (n = 5) before achieving RDA. However, all of the patients from the study group used the algorithm and were followed throughout the study to assess the safety of the algorithm and to evaluate all other clinical outcomes. This study occurred over a 3-yr period and the nature of the pre- and postdesign may not reflect practice changes that occurred over time. The algorithm was not tested on premature infants, patients supported on extracorporeal membrane oxygenation, infants with a history of NEC before the initiation of feedings, or patients who had undergone a fetal intervention for left-sided obstructive lesions. Further study is needed to establish the safety and efficacy of the enteral feeding algorithm in these high-risk infants.

CONCLUSIONS

We demonstrated that our enteral feeding algorithm is a safe and an effective way to initiate and advance enteral feedings in infants with HLHS following stage I palliation. We found that implementing a feeding protocol enabled patients to achieve RDA earlier in their

postoperative course and also decrease the duration of TPN use. Since January 2002, the algorithm has been a standard of care for all postoperative patients admitted to the pediatric cardiovascular intensive care unit at Children's Hospital, Boston.

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APPENDIX. PROTOCOL: BOSTON CARDIOVASCULAR PROGRAM ENTERAL FEEDING ALGORITHM

The enteral feeding algorithm is used to standardize the management of enteral nutrition in postoperative cardiac patients admitted to the cardiovascular ICU.

The algorithm provides an outline for clinicians to initiate and advance enteral nutrition based upon residual gastric volume, abdominal girth, and gastrointestinal distress. The algorithm should be used as a practice guideline and should not supersede clinical judgment.

Exclusion Criteria

The algorithm was not designed to be used on infants <35 wks gestational age, infants weighing <2 kg, patients with a history of NEC, or in those supported on extracorporeal membrane oxygenation.

Initiating and Advancing Enteral Nutrition

Box 1	**Should we feed?** The decision to provide enteral nutrition is discussed each morning during multidisciplinary rounds. Exclusion criteria are reviewed. Prior to the initiation of feedings, there should be evidence of adequate cardiac output (stable vital signs, low dose inotropes, and good peripheral perfusion). Discussion includes the patient's volume goal of enteral feeds for the next 24 hrs.
Box 2	**If no, consider Zantac** Patient will remain by mouth only (NPO) and Zantac is continued or initiated to reduce the patient's risk of gastrointestinal ulceration.
Box 3	**Consider total parenteral nutrition** If patient will remain NPO for ≥ 3 days, TPN is initiated with goal calories of 80–90 kcal/kg/day. Return to box #1 and evaluate readiness for enteral feeding daily.
Box 4	**If yes, naso/orogastric feeding appropriate?** Feedings are initiated via naso/orogastric route, unless there is a history of feeding intolerance (residuals >2 hrs of feed volume, increased abdominal girth >10% or vomiting).
Box 5	**If no, consider nasojejunal** Nasojejunal route is used if the patient has a history of feeding intolerance (residuals >2 hrs of feed volume, increased abdominal girth >10% or vomiting).
Box 6	**If yes, insert feeding tube, confirm location and measure abdominal girth** Feeding tube is inserted per unit policy and procedure. Abdominal girth is measured for baseline comparison.
Box 7	**Has the patient ever been fed?** If the patient has been fed prior to surgery advance to box #9. If not, move to box #8.
Box 8	**If no, start Rehydralyte 1 cc/kg/hr. Feed for 4 hrs** Use a clear liquid as a first feed to assess patient tolerance. Feed volume for 4 hrs.
Box 9	**If yes, start breastmilk/formula at 1 cc/kg/hr for 4 hrs (<25 kg). Start formula 25 cc/hr (≥25 kg). Feed for 4 hrs** Use breast milk or full strength formula at prescribed rate for 4 hrs.
Box 10	**Check residual (NG tube only) >2 hrs feed volume? Increased abdominal girth >10%? Nausea/vomiting/diarrhea?** Check gastric residual volume (NG tubes only) and if there is greater than 2 hrs of feed volume, an increased in abdominal girth greater than 10%, or the patient experiences nausea/vomiting or diarrhea, move to box #11.
Box 11	**If yes, replace. Rest 1 hour. Check residual (NG only) <2 hours feed volume?** Replace residual volume and hold feeds × 1 hr. Recheck residual gastric volume on NG tubes only. If there is greater than 2 hours of gastric aspirate volume, move to box #12.
Box 12	**If yes, consult medical team and consider Reglan** The medical team should be consulted for further evaluation of feeding intolerance. Consider using Reglan, a prokinetic agent, to improve gastric emptying. Return to box #1 and evaluate readiness for enteral feeding daily.
Box 13	**If no, increase feeding to 2 cc/kg/hr for 4 hrs (<25 kg). Start formula 50 cc/hr (≥25 kg). Feed for 4 hrs** Advance volume to prescribed rate for 4 hrs.
Box 14	**If no, increase feeding to 3 cc/kg/hr for 4 hrs (<25 kg). Start formula 75cc/hr (≥25 kg). Feed for 4 hrs** Advance volume to prescribed rate for 4 hrs.
Box 15	**Advance to full target volume (mL/hr). No more than 6 cc/kg/hr. Advance to full target volume as discussed on daily rounds and do not exceed maximum volume of 6 cc/kg/hr.**
Box 16	**Page 2 of the Enteral Feeding Algorithm** Page two of the algorithm allows the bedside nurse to troubleshoot common barriers to advancing enteral feeds. It provides a guideline and encourages medical team consultation when patient is unable to advance on the algorithm. **Nausea/vomiting** • If the patient is complaining of nausea, stop feeding ×1 hr then restart per algorithm. • Exclude constipation as contributing factor (see below). • If vomiting recurs, stop feeding ×1 hr and restart at half volume, then follow algorithm. • If vomiting persists, consult medical team. • Consider Reglan–prokinetic agent to improve gastric emptying. • Consider nasojejunal tube feeding. **Diarrhea** • Review the patient's medications as contributing factor. • Check stool sample for reducing substances. • Send stool sample for culture and sensitivity; *C. difficile*. • If diarrhea persists, consult with nutritionist for alternate formula. • Persistent diarrhea–stop feeding ×24 hrs to exclude feed as contributing factor (only if no other cause has been identified). **Constipation** • Consult medical team for bowel regimen. • Consider alternate formula (added fiber–patients >1 yr). • Consider use of free water. **Increased abdominal girth >10%** • Consult medical team. • Exclude constipation as contributing factor. **Guiac + stools** • Consult medical team.