



# Enteral nutrition in neonatal and pediatric extracorporeal life support: A survey of current practice



Thomas J. Desmarais<sup>a,b</sup>, Yan Yan<sup>c</sup>, Martin S. Keller<sup>a</sup>, Adam M. Vogel<sup>a,\*</sup>

<sup>a</sup> Division of Pediatric Surgery, Washington University School of Medicine in Saint Louis, Saint Louis, MI, United States

<sup>b</sup> Geisel School of Medicine at Dartmouth, Hanover, NH, United States

<sup>c</sup> Department of Surgery, Washington University School of Medicine in Saint Louis, Saint Louis, MI, United States

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## ABSTRACT

**Purpose:** The purpose of this study was to characterize enteral (EN) nutrition practices in neonatal and pediatric patients receiving extracorporeal life support (ECLS).

**Methods:** A Web-based survey was administered to program directors and coordinators of Extracorporeal Life Support Organization centers providing neonatal and pediatric ECLS. The survey assessed patient and clinical factors relating to the administration of EN.

**Results:** A total of 122 responses (122/521, 23.4%) from 96 institutions (96/187; 51.3%) were received. One hundred fifteen provided neonatal or pediatric ECLS, and 84.2% reported utilizing EN during ECLS. 55% and 71% of respondents provide EN 'often' or 'always' for venoarterial and venovenous ECLS, respectively. EN was reported as given 'often' or 'always' by 24% with increased vasopressor support, 53% with "stable" vasopressor support, and 60% with weaning of vasopressor support. Favorable diagnosis for providing EN includes respiratory distress syndrome, pneumonia, asthma, trauma/post-operative, pulmonary hemorrhage, and infectious cardiomyopathy. Vasopressor requirement and underlying diagnosis were the primary or secondary determinant of whether to provide EN 81% and 72% of the time. 38% reported an established protocol for providing EN.

**Conclusion:** EN support is common but not uniform among neonatal and pediatric patients receiving ECLS. ECLS mode, vasopressor status, and underlying diagnosis play an important role in the decision to provide EN.

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## 1. Background

Extracorporeal Life Support (ECLS) utilizes a series of established and evolving technologies to deliver life saving treatment to critically ill patients with reversible cardiac and pulmonary failure [1]. Malnutrition in critically ill patients is extremely common and is associated with increased mortality and morbidity including impaired immune function, impaired ventilator drive, prolonged ventilator dependence, and increased infections [2]. Consequently, adequate nutrition is essential to minimize physiologic complications of critical illness and to promote patient recovery.

Enteral nutrition (EN) is the preferred method of caloric, protein, and micronutrient delivery and has been shown to reduce sepsis-associated morbidity and cost, improve intestinal immunologic function, and improve nitrogen balance in critically ill patients [3–5]. Alternatively, parenteral nutrition (PN) has been used to deliver daily caloric, protein, and micronutrient requirements [6], but is associated with several complications including intestinal villus hypoplasia, reduction of

intestinal absorptive function, increased bacterial translocation, central-line infections, hyperglycemia, and cholestasis [7].

Delivery of EN may be avoided because of concerns regarding inadequate intestinal perfusion and non-occlusive mesenteric ischemia with the development of necrotizing enterocolitis, intestinal ischemia, perforation, or gastrointestinal hemorrhage. Despite these concerns, hypoperfusion related intestinal complications while on ECLS remain an unproven risk. Several small studies have documented the feasibility and safety of EN in ECLS patients in the neonatal, pediatric, and adult populations [7–13]. Additionally, current guidelines for providing nutritional support of neonates simultaneously supported with ECLS recommend initiating enteral feeds when patients are clinically "stable" [14].

The optimum route for delivery of nutrition in neonates and children receiving ECLS is not well established and practice patterns have not been described. The goal of this study is to characterize current practice patterns of the administration and delivery of EN at centers treating neonatal and pediatric ECLS patients.

## 2. Methods

The Washington University in St. Louis School of Medicine Institutional Review Board (#201302094) approved this study. The Extracorporeal Life Support Organization (ELSO) is an international consortium of health care professions and scientists who are dedicated to the

\* Corresponding author at: Division of Pediatric Surgery, Washington University School of Medicine in St. Louis, One Children's Place, Suite 5540, Saint Louis, MO 63110, United States. Tel.: +1 314 454 6022; fax: +1 314 454 2442.

E-mail address: [vogelam@wudosis.wustl.edu](mailto:vogelam@wudosis.wustl.edu) (A.M. Vogel).

development and evaluation of novel therapies for support of failing organ systems [15]. Contact information for ECLS program directors and coordinators was obtained from participating centers identified on the ELSO Web site. The survey was administered through the REDCap electronic data capture tool hosted at Washington University in St Louis [16]. A link to the survey was sent electronically on June 4, 2013, with reminders sent on June 17, 2013, and again on July 8, 2013. The thirteen question Web-based survey was designed to assess nutritional implementation and delivery practices in neonatal and pediatric patients on ECLS. The survey (see Appendix A) sought to determine factors that might influence EN implementation such as ECLS mode, patient diagnosis, vasopressor support, and pharmacologic paralysis as well as administration preferences (gastric vs. post-pyloric and institutional unit-based “feeding” protocols).

The data were compiled anonymously and analyzed as a composite. Responses are reported as ranges for continuous data and percentages for categorical data. Write-in answers are reported as direct quotes or grouped by theme.

### 3. Results

Surveys were sent to 521 individuals from 187 institutions. One hundred twenty-two responses (23.4%) were received representing 96 institutions (51.3%). Of the 122 responses, 115 individuals reported providing neonatal or pediatric ECLS at the 90 centers they represented. Of these centers, 68.8% are located in the United States, 5.6% in the United Kingdom, and the remaining centers come from fifteen other countries.

One hundred fourteen individuals continued the survey, and 96 (84.2%) reported providing enteral nutrition (EN), while 18 (15.8%) reported not providing enteral nutrition to their patients on ECLS. As summarized in Table 1, respondents were asked to rate how often their center provides EN to children on ECLS based on ECLS mode, patient diagnosis, level of vasopressor support, and pharmacologic paralysis. Respondents were also asked to rank which of these four categories would be considered the most important when deciding whether or not to provide EN (Table 2).

Twenty-five respondents reported that there was at least one factor considered more important at their institution than the four factors discussed above. In the free response space provided, the most commonly listed factors included bowel functionality [14], severity of illness [2], lactic acidosis [2], presence of central cannulation [2], and cardiac arrest [2]. Other reasons included: “presence of feeding tube prior to heparinization” and “unit preference.”

Forty-four of the respondents declared that there is a preferred anatomic site for the delivery of enteral feeds during ECLS. Of those reporting a preferred site for delivery of enteral feeds, 18 (41%) reported ‘gastric’ as the preferred site, while 26 (59%) reported ‘post pyloric’ as the preferred site.

Thirty-six respondents, 38% of those answering the question, reported that their institution had an established protocol for managing enteral nutrition on ECLS. Fourteen respondents reported a pediatric only protocol, three a neonatal only protocol, and nineteen reported having both pediatric and neonatal protocols.

### 4. Discussion

The results of our survey indicate that the vast majority of ECLS program directors and coordinators at ELSO centers provide EN to neonatal and pediatric patients receiving ECLS. Significant variability appears to exist with regard to the patient and clinical parameters that dictate the decision to initiate EN. ECLS patients are often the most critically ill and may gain significant benefit from EN [14]. However, there have been no rigorous, prospective studies investigating the role of EN on outcome in ECLS patients.

The relationship of ECLS and the initiation of EN on gastrointestinal physiology has been explored in patients receiving ECLS. An analysis of a cohort of 16 neonatal VA ECLS patients showed an overall increase in intestinal permeability [10]. The initiation of enteral nutrition to seven patients did not result in any additional changes in intestinal permeability. Therefore, although intestinal integrity in ECLS patients may be compromised, it does not appear to deteriorate with EN. The results of intestinal hormone response (gastrin, cholecystokinin, and peptide-YY) to enteral nutrition in neonates supported on VA ECLS have also been evaluated in twelve patients and compared to twelve

**Table 1**  
Utilization of enteral nutrition based on ECLS mode, diagnosis, vasopressor status, and paralysis.

Variable	N (%)	Never (%)	Occasionally (%)	Some (%)	Often (%)	Always (%)
VA ECLS	96 (100)	4 (4.1)	24 (25)	15 (15.6)	37 (38.5)	16 (16.7)
VV ECLS	91 (94.8)	2 (2.2)	13 (14.3)	11 (12)	37 (40.7)	28 (30.8)
Neonatal diagnoses						
Meconium aspiration	75 (78.1)	17 (22.7)	14 (18.7)	10 (13.3)	18 (24)	16 (21.3)
PPHN	75 (78.1)	13 (17.3)	13 (17.3)	10 (13.3)	18 (24)	16 (21.3)
Respiratory distress syndrome	80 (83.3)	12 (24)	16 (20)	11 (13.8)	23 (28.8)	18 (22.5)
Sepsis	83 (86.5)	17 (20.5)	16 (19.3)	16 (19.3)	24 (29)	10 (12)
Congenital diaphragmatic hernia	77 (80.2)	36 (46.8)	14 (18.2)	12 (15.6)	10 (13)	5 (6.5)
Congenital cardiac disease	85 (88.5)	13 (15.3)	24 (28.2)	19 (22.3)	16 (18.8)	13 (15.3)
Pediatric diagnosis						
Pneumonia	87 (90.6)	2 (2.3)	15 (17.2)	10 (11.5)	31 (35.6)	29 (33.3)
Asthma	73 (76.0)	2 (2.7)	12 (16.4)	8 (11)	26 (35.6)	25 (34.2)
ARDS	86 (89.6)	2 (2.3)	15 (17.4)	13 (15.1)	28 (32.6)	28 (32.6)
Trauma/postoperative	75 (78.1)	4 (5.3)	11 (14.7)	19 (25.3)	24 (32)	17 (22.7)
Pulmonary hemorrhage	81 (84.4)	6 (7.4)	14 (17.3)	15 (18.5)	21 (26)	25 (30.9)
Infectious cardiomyopathy	83 (86.5)	5 (6)	16 (19.3)	12 (14.5)	32 (38.6)	18 (21.7)
Congenital cardiac disease	86 (89.6)	9 (10.5)	20 (23.3)	19 (22.1)	23 (26.7)	15 (17.4)
Cardiac arrest	84 (87.5)	17 (20.2)	17 (20.2)	17 (20.2)	21 (25)	12 (14.3)
Rhabdomyolysis	65 (67.7)	13 (20)	13 (20)	11 (17)	13 (20)	15 (23)
Bone marrow transplant	60 (62.5)	20 (33.3)	5 (8.3)	13 (21.7)	12 (20)	10 (16.7)
Hematologic transplant	53 (55.2)	17 (32)	5 (9.4)	11 (20.8)	10 (18.9)	10 (18.9)
Vasopressor agent status						
Increasing support	93 (96.9)	39 (42)	17 (18.3)	15 (16.1)	18 (19.4)	4 (4.3)
“Stable” support	92 (95.8)	8 (8.7)	25 (27.2)	10 (10.9)	32 (34.8)	17 (18.5)
Weaning support	87 (90.6)	5 (5.7)	18 (20.7)	12 (14)	32 (36.8)	20 (23)
Pharmacologic Paralysis	92 (95.8)	18 (19.6)	19 (20.7)	13 (14.1)	28 (30.4)	14 (15.2)

Reports the responses of survey participants who were asked to rate how often their institution provided enteral nutrition for patients on extracorporeal life support. ECLS: extracorporeal life support; VA: venoarterial, VV: venovenous, ECLS: extracorporeal life support, PPHN: persistent pulmonary hypertension of the newborn.

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