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Strategies to Optimize Nutrition in Extracorporeal Membrane Oxygenation (ECMO) Therapy Patients

Disclosures:

I have no commercial relationships to disclose

Presentation Overview:

Nutrition Support for patients on ECMO (Extra Corporeal Membrane Oxygenation) is difficult due to the presence of vasoactive medication, hemodynamic instability and the potential risk for ischemic bowel. The critical care guidelines, in general, don't address this specific subset of patients. A review of the literature suggests that enteral feeding, starting early, is safe. However, it may be difficult to achieve optimal feeds. The VIS Score (Vasoactive Inotropic Support Score) is a helpful tool to assess the maximum vasoactive dosages that are safe for enteral feeding. There are new techniques to estimate REE, for patients on ECMO, which may help guide clinicians in knowing when optimal nutrition support is achieved. The use of PN in patients on ECMO has not been thoroughly studied, though it is utilized, and may be helpful in achieving nutritional goals.

Objectives:

At the conclusion of the presentation, the learner will be able to:

- Acknowledge the safety of enteral feeding for patients on ECMO
- Assess which pressor dosages are safe for enteral feeding
- Understand the Vasoactive Inotropic score and its use to help guide enteral feeding
- Perceive barriers to reaching goal calories/protein and strategies for improvement
- Know how to assess caloric needs for the ECMO patient
- Discuss the use of PN in ECMO patients

Fast Facts:

It is safe to start enteral feeds early.

It is safe to feed, enterally, at a VIS score of < 14

Minimizing npo for procedures should help achieve optimal nutrition

Indirect Calorimetry and blood gases pre and post the oxygenator can be utilized to assess REE

PN May be utilized to reach nutrition goals

Learning Assessment Questions:

- 1. Gastric feeding while on ECMO is safe to start early.

  A) True B) False

- 2. Using the VIS Score: when would you hold feeds?
  - A)epi .04 and vaso .04, B) epi at .15 C) Levo .02 and dopa 5 and milrinone 0.125
- 3. Barriers to adequate feeding on ECMO:
  - A)Holding feeds for procedures B)high GRV C) A and B
- 4. To estimate energy needs while on ECMO do the following:
  - A)Predictive equations B) Indirect Calorimetry C)Indirect Calorimetry added to V02 and VC02 from Blood draws pre/post oxygenator or per the "De Waele protocol"
- 5. When feeding patients on ECMO use:
  - A) Semi-elemental B) Polymeric formula C) Either formula
- 6. Using PN while on ECMO is contraindicated:
  - A) True B) False

Learning Assessment Answers:

1. A. True : Recent literature supports safety
2. B. Epi at 0.15 : This equals a VIS score of 15
3. A. and B: Holding feeds for npo and GRV decreases enteral infusion
4. C. Indirect Calorimetry added to V02 and VC02 from Blood draws pre/post oxygenator or per "De Waele protocol" : New literature shows how to estimate REE from blood draws and IC
5. C. Either formula: Recent literature shows both are safe
6. B. False: More studies need to be done, but currently it appears appropriate

References:

Scott, L, Early enteral feedings in adults receiving venovenous extracorporeal membrane oxygenation. JPEN 2004

Lukas, G, Nutritional support in adult patients receiving extracorporeal membrane oxygenation. Crit Care Resusc. 2010

Ferrie, S, Nutrition support during extracorporeal membrane oxygenation (ECMO) in adults: a retrospective audit of 86 patients. Intensive Care Med. 2013

Umezawa, M, Early enteral nutrition in adults receiving venoarterial extracorporeal membrane oxygenation: an observational case series JPEN 2013

Ridley, E, Nutrition therapy in adult patients receiving extracorporeal membrane oxygenation: a prospective, multicenter, observational study Crit Care Resusc. 2015

McGowan, L, Adequacy of nutrition support during extracorporeal membrane oxygenation Clin Nutr. 2018

Lu, M, Effects of Nutritional Intervention on the survival of patients with cardiopulmonary failure undergoing extracorporeal membrane oxygenation therapy In Vivo 2018

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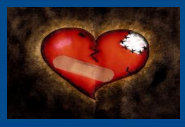
Gaies, M, Vasoactive-Inotropic Score (VIS) is Associated with Outcome After Infant Cardiac Surgery: An Analysis from the Pediatric Cardiac Critical Care Consortium (PC) and Virtual PICU System Registries, Pediatr Crt Care Med. 2014

De Waele, E, Energy expenditure of patients on ECMO: A prospective pilot study Acta Anaesthesiol Scand. 2018



JOHNS HOPKINS MEDICINE

Strategies to Optimize Nutrition in Extracorporeal Membrane Oxygenation (ECMO) Therapy Patients

Presented by: Patricia Brown RD-AP, CNSC

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Learning Objectives

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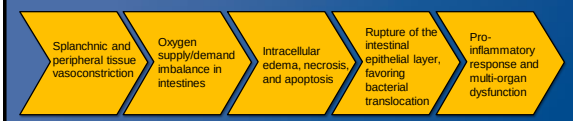
Pathophysiology

- At rest, 20-25% of cardiac output is distributed to the splanchnic circulation
  - Accounts for 30% overall oxygen consumption
- When eating, blood flow to the splanchnic circulation can double
  - Postprandial hyperemic response

Flordelis Lasierra JL et al. *Med Intensiva.* 2015;39:40-48.

What is the issue?

Shock Pathophysiology



EN administration would increase intestinal oxygen demand and splanchnic blood flow due to vasodilation

Flordelis Lasierra JL et al. *Med Intensiva.* 2015;39:40-48.

ECMO Literature to Date

	Scott	Lukas	Umezawa	Ferrie	Ridley	Hunt	MacGowan	Lui	Ohbe
Year	2004	2010	2013	2013	2015	2018	2018	2018	2018
# pts	27	48	7	86	107	58	203	102	1769
type	Retro	Retro	Prospect	Retro	Prospect	Prospect	Retro	Retro	Retro
Goal	Safety	Adequacy Survivor Nonsurvivor	Tolerance Safety Early EN	Safety Barriers	Practices Barriers	Practices Outcome	Practices Outcome	Pratices Outcome Early EN	Outcome Early EN
ECMO	VV	VA/VV	VA/VV	VA/VV	VA/VV	VA/VV	VV	VA/VV	VA

	Scott	Lukas	Umezawa	Ferrie	Ridley	Hunt	MacGowan	Lui	Ohbe
Days to EN	1-1.5	1-2	1-2	0.5	0.5	4	0.5	0.8-1.6	<2 12% VS > 3
Equation	25/kg	Schofield +1.2-1.5	25/kg	Schofield +1.1-1.2	Schofield or 25/kg or Other	25/kg	25/kg	Harris Bene SF+AF	NR
Pro	1.2-1.5	1.2-2	NR	1.2 minimum	NR	1.2-2	1.2 minimum	1.2 minimum	NR
Type	EN:67% PN:1 EN/PN: 30%	EN: 69% PN:4% EN/PN 25%	EN All	EN All PN: 18	EN:84% PN 7% No 5% ON10%	EN 96.6% EN/PN 3.4%	EN:95% PN5%	EN All	NR
Route	Gastric	Gastric NJ 3	Gastric	Gastric	Gastric 90% NDT 10%	90% Gastric NDT 7%	Gastric 60% NDT35%	Gastric (bolus 73%)	NR
Formula	semi-elemental	Polymeric	Polymeric Some fiber	Polymeric	1.25 kcal 34% 2 kcal 28%, 1.5 kcal 22%, 1.0	Poly and Semi	NR	Poly and Semi	

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Cals	25/kg	Schofield +1.2-1.5	25/kg	Schofield +1.1-1.2	Schofield or 25/kg or Other	25/kg	25/kg	Harris Bene SF+AF	NR
Type	EN:67% PN:1 EN/PN: 30%	EN: 69% PN:4% EN/PN 25%	EN All	EN All PN: 18	EN:84% PN 7% No 5% ON10%	EN 96.6% EN/PN 3.4%	EN:95% PN5%	EN	NR
% cal goal	slow progress over 1 week to 80%	slow progression (6 days to reach 50% 9 days to reach 60%) VV:67% VA:50%	slow progression over 4 days up to 70% in 1 week	79% w/prop quickly to goal 38% intolerant in first 5 days	avg 20 kcal/kg included propofol (13%)	31% included prop and D IVF (34%)	89.8% included prop and D IVF. Used catch up feeds. Used NJ feeds and PN for intolerance of EN	92.5% survivor group, 1 week to get to goal	NR

	GVR x 2 > 150 then start prokinetic	GVR > 200	Ischemic G.Ulcer Diarrhea	GVR>200 x 2 w/ distention 38%, 40% diarrhea	100 ml 22%	G. ulcer ischemic diarrhea 57%	GVR x 2 > 300	NR	NR
Prokinetic	95% by 48hr	71%	none	23%	66%	NR	52.2%	NR	NR
Ischemic	zero	zero	zero	zero	5 (4.5%) listed as reason for PN	1 not sig	zero	NR	0 % early 1% Late EN
Pressors	Dopa Levo(no dosage)	NR	3/7 pressors VIS > 37 ? rate on EN	NR	NR	VIS 6.18	NR	NR	Late group
Take Away	safe to feed	ECM0 patients underfed at 55%	EN is safe	EN well tolerated. Start Early underfed	EN frequently held for procedures. Cal/Pro deficits exist.	Underfed Frequently held for procedure >50%EN associated with better	Adequate possible. Underfed Frequently held for procedures. Underfed no	higher cal= > survival Tolerate bolus feeds	< Mortality early EN group (12%) Delayed: Levo, dopa sicker

EN while on Vasoactives

	Berger 2004 Surgical ICU	Khalid 2010 Mixed ICU	Mancl 2013 Mixed ICU	Merchan 2017 MICU	Chin 2018 CVSICU
Aim	Practice and quantify NS (no dosages given)	Early EN on pressors > 2drugs or > 2 days	Tolerability and safety on pressors	Tolerability and factors associated	Relationship of VIS on EN to ischemic gut
Time to start	2-3 days	< 2 days vs > 2 days	NR (any overlap)	1-2 days	4 days
Goal %	70% by 2 weeks included IVF and Prop	NR	50-60% (13 kcal/kg/day)	40%	60% including IVF and prop
Formula	Intact some with fiber	NR	Average: 1.5 kcal/ml (1.2-2 kcal/ml)	Average 1.5 kcal/ml (1.8 kcal/ml 40%) Intact	Semi 74% Intact 26% On high VIS
Tip position	Gastric 49% Jejunal 13%	NR	Gastric: 95% Post pyl: 5%	Gastric 97%	Gastric 50% Post pyl 50%
Complication	None	None	3 ischemic bowel complications	Gastric residuals, rising lactate, Emesis	1 ischemic (diffuse)
Results	Safe, slow progress Dopa and norepi less tolerance	Early EN=lower mortality. More evident with more	More tolerance with lower dosage or with	Tolerated VIS score of < 14	Safe to feed up to VIS of 10 > 11 trophic or

High Pressor/ Vasoactive Inotropic Score (VIS)≥10[1]

VIS = sum of

- 1 x dopamine dose (µg/kg/min)
- 1 x dobutamine dose (µg/kg/min)
- 100 epinephrine dose (µg/kg/min)
- 100 norepinephrine dose (µg/kg/min)
- 10 x milrinone dose (µg/kg/min)
- 10,000 x vasopressin dose (U/kg/min)
  (0.04 U/min for a 75 kg patient is ~ 5 points)
- 10 x phenylephrine dose (µg/kg/min)
- Consider hold TF if ≥10

Mancl/ Chin Ischemic bowel complications

age	EN goal	Formula	Tube tip	Start rate	Mean rate	Avg VIS	Max VIS	Residual > 300	Rising lactate
89 yrs	55	Intact 1 kcal/ml	Gastric	55	48	9.5	16.4	Yes	No
76 yrs	65	Intact 2 kcal/ml	Gastric	65	29	36	97	Yes	Yes
54 yrs	45	Semi 1.5 kcal/ml	Gastric	10	25	14	14	No	Yes

Signs of Intestinal Ischemia

Clinical	Laboratory	Radiological
• Gastric residue > 500mL • Abdominal bloating • Intense abdominal pain • Intraabdominal pressure > 15mmHg • Ileus • Oliguria • Shock	• Hyperlactacidemia • Metabolic acidosis • Leukocytosis	• Without significant alterations (20-25%) • Intestinal pneumatosis • Free fluid • Dilated and thickened bowel loops • Air in portal vein or pneumoperitoneum

Umezawa Makikado LD et al. *Diet and Nutrition in Critical Care*. 2014.

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So far:

- Appears safe to start early
- Nonnutritive benefits to starting early
- Slow advance may be advantageous
- Include IVF and Propofol calories
- Appears safe with VIS score < /= 10
- Feed with Caution with VIS score > 14
- Monitor gastric residuals, abdominal exam, lactate trends, hemodynamic changes
- Gastric or Postlyloric
- Favor semi-elemental , lower osmolality
- The BIG QUESTION IS: HOW MUCH?

3/5/2019

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	Scott	Lukas	Umezawa	Ferrie	Ridley	Hunt	MacGowan	Lui	Ohbe
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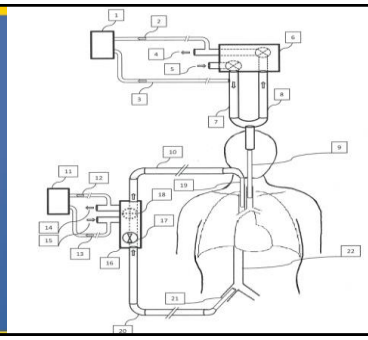
ECMO : Estimating REE 2015

- Measuring resting energy expenditure during extracorporeal membrane oxygenation: preliminary clinical experience with a proposed theoretical model

E. De Waele, K. van Zwam, S. Mattens, K. Staessens , M. Diltoer , P. M. Honore, J. Czapla, J. Nijs, M. La Meir, L. Huyghens and H. Spapen

Intensive Care Department, Universitair Ziekenhuis Brussel (UZ Brussel), Vrije Universiteit Brussel (VUB), Brussels, Belgium Department of Cardiac Surgery, Universitair Ziekenhuis Brussel (UZ Brussel), Brussels, Belgium

19 kcal/kg



Resting Energy Expenditure: Indirect Calorimetry Principle

Weir Equation:

$$REE\ (kCal/day) = [3.9\ (VO_2) + 1.1\ (VCO_2)] \times 1.44$$

VO_2: consumed oxygen rate (mL/min)
VCO_2: produced carbon dioxide rate (mL/min)

Weir, J. B. D. (**1949**). "New Methods For Calculating Metabolic Rate With Special Reference To Protein Metabolism." Journal Of Physiology-London **109**(1-2): 1-9.

Weir, J. B. D. (**1990**). "Nutrition Metabolism Classic - New Methods For Calculating Metabolic-Rate With Special Reference To Protein-Metabolism." Nutrition **6**(3): 213-221.

ECMO : Estimating REE 2018

- Energy expenditure of patients on ECMO: A prospective pilot study
- Elisabeth De Waele, Joop Jonckheer, Joeri J. Pen, Joy Demol, Kurt Staessens, Luc Puis, Mark La Meir, Patrick M. Honoré, Manu L. N. G. Malbrain, Herbert D. Spapen
- Quite interesting

Insert Elisabeth chart

IC and Blood Draws Pre and Post Oxygenator

- Measuring Energy Expenditure in Extracorporeal lung support patients (MEEP) Protocol, Feasibility and Pilot Trial T. Wollersheim Clinical Nutrition Jan 2017
- Lung IC Measurement+ BGA from pre and post ECMO membrane
- Use the model published by Dash and Basingthwaighte to determine O2 and C02 content in blood pre and post membrane
- VV ECMO
- None of the equations matched the Energy Expenditure
- Presence of VV ECMO did not effect REE

Nutrirea – 2 Study Design

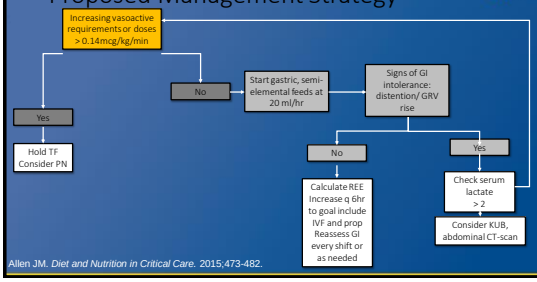
- Randomized Controlled Enteral vs Parenteral ICU, Vent, Vasoactives Started nutrition within 24 hrs of intubation
- PN for at least 72 hrs, then either EN if stable or PN up to 7 days
- Day 8 switched to EN, regardless of hemodynamic stability
- Primarily on Norepi , 12% were on 2 drugs
- EN : started at goal rate, polymeric , isosmotic formula
- 20-25 kcal/kg 1st week, 25-30 kcal/kg 2nd week
- Primary: 28 day mortality

Nutreria- 2 Outcomes

- Enteral Nutrition did not reduce mortality or secondary infections and is associated with greater risk of digestive complications than PN.

- Started at goal rate
- Fed on norepi of :
- Did not say if included other cals
- Avg of 20 kcal/kg

Proposed Management Strategy



Allen JM. *Diet and Nutrition in Critical Care.* 2015;473-482.

Questions

- Gastric feeding on ECMO is safe to start early.
- A) True B) False
- Using the VIS Score: when would you hold feeds?
  - A)epi .04 and vaso .04, B) epi at .15 C) Levo .02 and dopa 5 and milrinone 0.125
- Barriers to achieving adequate feeding on ECMO are:
  - A)Holding feeds for procedures B)high GRV C) A and B
- To estimate energy needs while on ECMO do the following:
  - A)Predictive equations B) Indirect Calorimetry C)Indirect Calorimetry added to V02 and VC02 from Blood draws pre/post oxygenator or per "De Waele protocol"
- When feeding patients on ECMO use:
  - A) Semi-elemental B) Polymeric formula C) Either formula
- Using PN while on ECMO is contraindicated
  - A) True B) False

Answers

- Gastric feeding on ECMO is safe to start early.
- **A) True**
- Using the VIS Score: when would you hold feeds?
  - **B) Epi at 0.15**
- Barriers to adequate feeding on ECMO
  - **A)Holding feeds for procedures B)high GRV C) A and B**
- To estimate energy needs while on ECMO do the following:
  - **C)Indirect Calorimetry added to V02 and VC02 from Blood draws pre/post oxygenator or per "De Waele protocol"**
- Feed patients on ECMO with
  - **A) Semi-elemental B) Polymeric formula C) Either formula**
- Using PN while on ECMO is contraindicated
  - **B) False**

References

- Scott, L, Early enteral feedings in adults receiving venovenous extracorporeal membrane oxygenation. JPEN 2004
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- 12. Measuring Energy Expenditure in extracorporeal lung support Patients (MEEP) – Protocol, feasibility and pilot trial, T. Wollersheim, Clinical Nutrition 2017
- 13. Measuring resting energy expenditure during extracorporeal membrane oxygenation: preliminary clinical experience with a proposed theoretical model E. De Waele, Acta Anaesthesiologica Scandinavica (2015)