Controversies in Parenteral Nutrition

Christopher Duggan, MD, MPH
Center for Nutrition
Center for Advanced Intestinal Rehabilitation (CAIR)
Division of Gastroenterology, Hepatology and Nutrition
Boston Children's Hospital
Harvard Medical School
Boston, MA

DISCLOSURE

In the past 12 months, I have had no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this CME activity.

Learning Objectives

- To review indications for intravenous fat emulsions in patients with intestinal failure
- To review strategies for parenteral micronutrient supplementation in the setting of manufacturing shortages

Learning Objectives

- To review indications for intravenous fat emulsions in patients with intestinal failure
- To review strategies for parenteral micronutrient supplementation in the setting of manufacturing shortages

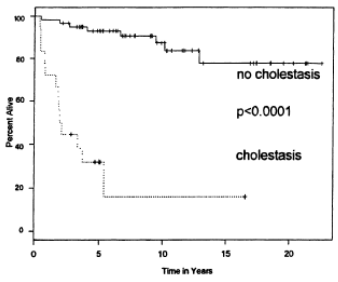
LONG-TERM PARENTERAL NUTRITIONAL SUPPORT AND INTESTINAL ADAPTATION IN CHILDREN WITH SHORT BOWEL SYNDROME: A 25-YEAR EXPERIENCE

Rubén E. Quirós-Tejeira, MD, Marvin E. Ament, MD, Laure Reyen, RN, Faye Herzog, RN, Michelle Merjanian, MD, Nancy Olivares Serrano, MD, and Jorge H. Vargas, MD

- 78 patients with
  - PN dependence for > 3 months
  - SBS defined as ≤ 75 cm residual small bowel
- 57/78 (73%) alive median age 9 years
  - Median follow-up: 9 years
  - Range of follow-up: 2.1 – 23 years

J Pediatr 2004; 145:157-63

Correlation of survival with cholestasis



J Pediatr 2004; 145:157-63

THE JOURNAL OF PEDIATRICS • www.jpeds.com ORIGINAL ARTICLES

Natural History of Pediatric Intestinal Failure: Initial Report from the Pediatric Intestinal Failure Consortium

Robert H. Squires, MD[1], Christopher Duggan, MD[2], Daniel H. Teitelbaum, MD[3], Paul W. Wales, MD[4], Jane Balint, MD[5], Robert Venick, MD[6], Susan Rhee, MD[7], Debra Sudan, MD[8], David Mercer, MD[9], J. Andres Martinez, MD[10], Beth A. Carter, MD[11], Jason Soden, MD[12], Simon Horslen, MD[13], Jeffrey A. Rudolph, MD[1], Samuel Kocoshis, MD[14], Riccardo Superina, MD[15], Sharon Lawlor, MBA[16], Tamara Haller, BS[16], Marcia Kurs-Lasky, MS[16], and Steven H. Belle, PhD, MScHyg[16], for the Pediatric Intestinal Failure Consortium*

Among the 168 infants with sufficient data to assess for the presence of cholestasis at baseline, 125 children had cholestasis, and their cumulative percentage of survival was significantly lower than in the 43 without cholestasis (79% vs 95% at 1 year, and 73% vs 88% at 3 years; P = .03).

Birthweight and PNALD

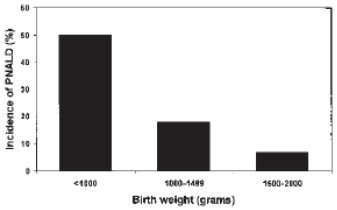


FIGURE 56-1 Relationship between the incidence of parenteral nutrition–associated liver disease (PNALD) and low birth weight. Adapted from Beale EF et al.[17]

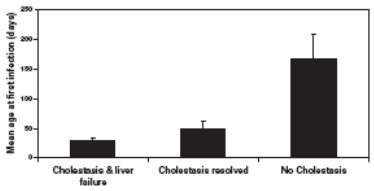


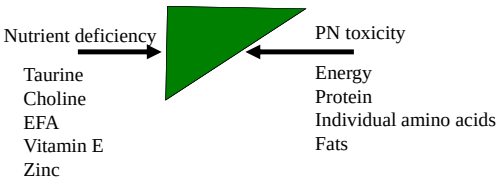
FIGURE 56-2 The effect of age at first infection on the development and severity of parenteral nutrition–associated cholestasis in neonates with intestinal resection. Adapted from Sondheimer JM, Asturias E, Cadnapaphornchai M. Infection and cholestasis in neonates with intestinal resection and long-term parenteral nutrition. J Pediatr Gastroenterol Nutr 1998;27:131–7.

Protein intake

Variable	2.5 g/kg/d	4.0 g/kg/d	P value
Direct bili > 2 mg/dL	27%	33%	NS
Days of PN before cholestasis	47 +/- 6	27 +/- 4	<.01
Peak direct bili	3.2 +/- 0.3	8.4 +/- 1.6	.001

Vileisis, RA et al., J Pediatr 1980; 96:893-897

PN-associated liver disease



Taurine
Choline
EFA
Vitamin E
Zinc

Energy
Protein
Individual amino acids
Fats

Risk Factors for Parenteral Nutrition–associated Liver Disease Following Surgical Therapy for Necrotizing Enterocolitis

*Debora Duro, †Paul D. Mitchell, †Leslie A. Kalish, ‡Cami Martin, †Maggie McCarthy, §Tom Jaksic, ||James Dunn, ¶Mary L. Brandt, #Kerilyn K. Nobuhara, **Karl G. Sylvester, ††R. Lawrence Moss, and *Christopher Duggan

- Cohort study of 464 infants with NEC
- Enrolled across 6 centers
- 2004 – 2007

Duro et al., JPGN 2011

FIGURE 1. Study cohort enrolled from February 2004 through February 2007.

TABLE 2. Risk factors for PNALD, unadjusted (N = 127)

	PNALD (n = 89)	No PNALD (n = 38)	P*
Demographic characteristics			
Male sex (%)	62/89 (70)	24/38 (63)	0.47
Gestational age, wk, median (Q1–Q3)	26 (25–30)	26 (25–32)	0.92
Birth weight, g, median (Q1–Q3)	916 (668–1315)	825 (697–1362)	0.95
Birth length, cm, median (Q1–Q3)	35 (31–40)	35 (32–39)	0.84
Maternal information			
Prenatal steroid use (%)	68/85 (80)	29/34 (85)	0.50
History of gestational hypertension (%)	19/82 (23)	7/36 (19)	0.65
History of gestational diabetes (%)	8/81 (10)	2/35 (6)	0.72
Birth information			
Intubation at delivery (%)	56/89 (63)	26/38 (68)	0.55
Vaginal delivery (%)	34/89 (38)	10/38 (26)	0.20
Medical history			
PDA confirmed by echocardiography before diagnosis of NEC† (%)	36/65 (55)	17/28 (61)	0.63
Abdominal wall discoloration (%)	19/89 (21)	18/38 (47)	0.003
Abdominal distension (%)	83/89 (93)	31/38 (82)	0.06
Grossly bloody stools (%)	21/88 (24)	8/38 (21)	0.73
Pneumoperitoneum (%)	5/89 (6)	7/38 (18)	0.04
Pneumatosis intestinalis (%)	40/89 (45)	10/38 (26)	0.05
Portal venous gas (%)	16/89 (18)	2/38 (5)	0.06
Feeding intolerance (%)	50/88 (57)	21/38 (55)	0.87
Acidosis on the day of diagnosis (%)	64/77 (83)	24/34 (71)	0.13
Antibiotic use on the day of diagnosis (%)	81/88 (92)	34/38 (89)	0.73
Vasopressor use on the day of diagnosis (%)	28/88 (32)	13/38 (34)	0.79
Ventilator use on the day of diagnosis (%)	71/89 (80)	24/38 (63)	0.05
Platelets <100/kg/L on the day of diagnosis (%)	16/83 (19)	4/35 (11)	0.30
WBC $>12.0 \times 10^9$ on the day of diagnosis (%)	35/82 (43)	16/35 (46)	0.76
Ever sepsis before surgery for NEC (%)	26/89 (29)	10/38 (26)	0.74
Ever Gram-negative culture before surgery for NEC (%)	15/79 (19)	2/32 (6)	0.14
Feeding history			
Days of PN before surgery for NEC, median (Q1–Q3)	12.0 (7.0–22.0)	8.0 (5.0–11.0)	0.007
Received EN on or before day of diagnosis (%)	76/89 (85)	24/38 (63)	0.01
Received breast milk on or before day of diagnosis‡ (%)	53/71 (75)	15/22 (68)	0.55
Received formula on or before the day of diagnosis‡ (%)	44/71 (62)	13/22 (59)	0.81
% of presurgery kcal/kg/day from parenteral carbohydrate	54.2 (49.5–63.0)	55.7 (46.0–61.7)	0.71
% of presurgery kcal/kg/day from parenteral fat	28.5 (18.4–32.7)	27.2 (20.3–36.5)	0.40
% of presurgery kcal/kg/day from parenteral protein	15.4 (13.6–20.2)	15.3 (12.1–19.5)	0.38
Surgical intervention§ (%)			
Exploratory laparotomy	73/89 (82)	25/38 (66)	0.05
Ileocecal valve resection	23/89 (26)	2/38 (5)	0.008
Jejunostomy	17/89 (19)	0/38 (0)	0.004
Large-bowel resection	26/89 (29)	9/38 (24)	0.52
Small-bowel resection	59/89 (66)	13/38 (34)	0.001
Small-bowel resection or jejunostomy	61/89 (69)	13/38 (34)	0.0003

TABLE 3. Independent predictors of PNALD (N = 127)

	Odds ratio (95% CI)	P
Weeks of PN*	2.37 (1.56–3.60)	<0.0001
Small-bowel resection or jejunostomy	4.96 (1.97–12.51)	0.0007

CI = confidence interval; PN = parenteral nutrition; PNALD = parenteral nutrition–associated liver disease.
* Cumulative exposure from birth through 4 weeks after surgery.

Use of a fish oil-based lipid emulsion to treat essential fatty acid deficiency in a soy allergic patient receiving parenteral nutrition

Table 3 Comparison of lipid emulsions (10 g fat/100 ml).

Product	Intralipid® (Baxter Healthcare/ Fresenius Kabi)	Liposyn II® (Abbott)	Omegaven™ (Fresenius AG)
Oil source			
Soybean (g)	10	5	0
Safflower (g)	0	5	0
Fish (g)	0	0	10
% Fats			
Linoleic (g)	50	65	0.1–0.7
α-linolenic (g)	9	4	<0.2
EPA (g)	0	0	1.28–2.82
DHA (g)	0	0	1.44–3.09
Oleic (g)	26	17.7	0.6–1.3
Palmitic (g)	10	8.8	0.25–1
Stearic (g)	3.5	3.4	0.05–0.2

EPA:eicosapentaenoic acid; DHA: docosahexaenoic acid.

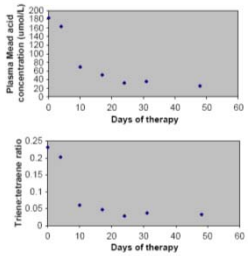
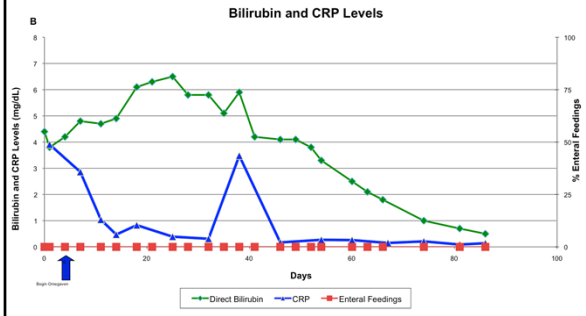


Figure 1 Plasma Mead acid levels and triene:tetraene ratios improve and return to normal after initiation of therapy with Omegaven™

Gura et al.

Experience with Omega 3 fatty acids



Gura K et al., Pediatrics 2006; 118:197-201

Safety and Efficacy of a Fish-Oil–Based Fat Emulsion in the Treatment of Parenteral Nutrition–Associated Liver Disease

Kathleen M. Gura, PharmD[a,b], Sang Lee, MD[c], Clarissa Valim, MD, ScD[b,c,d], Jing Zhou, MS[d], Sendia Kim, MD[c], Biren P. Modi, MD[c], Danielle A. Arsenault, BS[c], Robbert A. M. Strijbosch, BS[c], Suzanne Lopes, RN[e], Christopher Duggan, MD, MPH[b], Mark Puder, MD, PhD[c]

- 18 infants with SBS who developed cholestasis were
  - Taken off IL
  - Placed on Omegaven (1 g/kg/d)
- Historical cohort of 21 infants followed at same institution

Pediatrics 2008; 121:e678

Direct bilirubin trends

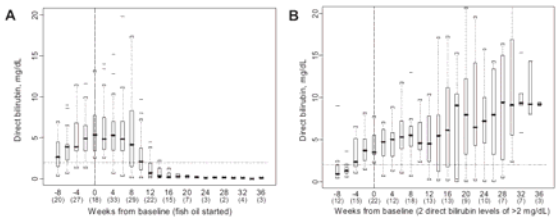


FIGURE 1
Direct bilirubin trajectories over time (weeks from baseline) for the fish-oil (A) and soybean (B) cohorts. Box plots represent the distribution of direct bilirubin levels in each 2-week interval plotted at the end of the interval, except for the bar at week 0, which represents only direct bilirubin measures at baseline. The number of observations contained in each 2-week interval is in parentheses. The solid bar within the box represents the median value; upper boundary of the box, the 75th percentile; lower boundary of the box, 25th percentile. Whiskers extend to the most extreme observation within 1.5 IQR units of the 25th and 75th percentiles.

Pediatrics 2008; 121:e678

TABLE 4 **Comparison of Safety Markers for the Period Before Fish Oil, From 30 Days After Starting Fish Oil Until the End of Follow-up (Primary Comparison) and From the Date in Which Fish Oil Was Started Until Day 30 of Treatment**

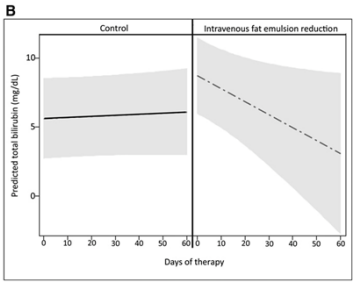
Variable	Before Fish Oil ($N = 17$)[a]	After Fish Oil	
		30 d to End ($N = 17$)[a]	0–30 d ($N = 18$)
Essential fatty acid deficiency			
Triene/tetraene ratio >0.2, *n* (%)	—	1 (5.9)	1 (5.6)
Maximum triene/tetraene, median (minimum, maximum)	—	0.05 (0.016, 0.28)	0.04 (0.02, 0.33)
Hypertriglyceridemia (triglycerides > 400 mg/dL), *n* (%)	1 (5.9)	0 (0.0)	0 (0.0)
Maximum triglycerides, median (minimum, maximum)	196 (89, 441)	162 (51, 336)	182 (107, 383)
Bleeding and coagulopathies			
INR >2, *n* (%)	1 (5.9)	0 (0.0)	0 (0.0)
Mean INR, median (minimum, maximum)	1.1 (0.99, 1.71)	1.1 (0.96, 1.33)	1.1 (0.92, 1.39)
Mean level of platelets, median (minimum, maximum)	175 (78, 390)	292 (103, 462)	220 (88, 380)
Minimum level of platelets, median (minimum, maximum)	104 (30, 298)	179 (26, 331)	145 (41, 268)
Infections			
No. of new infections per week, median (minimum, maximum)	0.24 (0, 1.29)	0.25 (0.06, 1.56)	0.25 (0, 1.0)
No. of central line infections per week, median (minimum, maximum)	0.13 (0, 0.57)	0.18 (0, 1.0)	0 (0, 0.67)
No. of Gram-positive infections per week, median (minimum, maximum)	0 (0, 0.29)	0 (0, 0.35)	0 (0, 0.25)
No. of Gram-negative infections per week, median (minimum, maximum)	0 (0, 0.26)	0.01 (0, 1.0)	0 (0, 0.33)
Growth			
Weight-for-age *z* score, mean ± SD	−4.2 ± 1.6	−4.5 ± 2.0	−4.4 ± 1.7

Unanswered questions

- Are these “Omegaven” or “absence of Intralipid” effects?
- What is the natural history of infants treated with omegaven?
- Does improvement of cholestasis herald prevention of cirrhosis?
- Can PNALD be prevented with omega-3 fats?
- Mechanisms?

Intravenous Fat Emulsions Reduction for Patients with Parenteral Nutrition–Associated Liver Disease

Mary Petrea Cober, PharmD, BCNSP, Ghassan Killu, PharmD, Allison Brattain, PharmD, Kathleen B. Welch, MS, MPH, Shaun M. Kunisaki, MD, and Daniel H. Teitelbaum, MD



J Pediatrics 2011

Controversies

- Is it <u>safe</u> to provide so many calories using parenteral dextrose?
  - Dalton et al., NASPGHAN 2013
- Is it <u>effective</u> to limit fat to 1 g/kg/d re: cholestasis prevention?
  - Nehra et al., JPEN 2013
  - Levit et al., PAS 2013

Original Communication

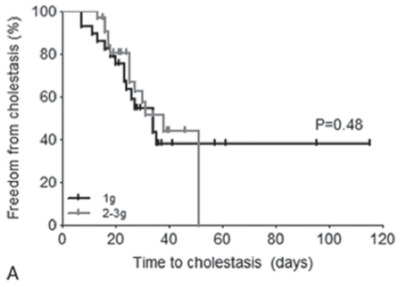
Provision of a Soy-Based Intravenous Lipid Emulsion at 1 g/kg/d Does Not Prevent Cholestasis in Neonates

Deepika Nehra, MD[1]; Erica M. Fallon, MD[1]; Sarah J. Carlson, MD, MSc[1]; Alexis K. Potemkin, RN[1]; Nathanael D. Hevelone, MPH[2]; Paul D. Mitchell, MSc[3]; Kathleen M. Gura, PharmD[4]; and Mark Puder, MD, PhD[1]

Journal of Parenteral and Enteral Nutrition
Volume 37 Number 4
July 2013 498-505

DOI: 10.1177/0148607112453072
jpen.sagepub.com
hosted at
online.sagepub.com

- 61 infants with surgical GI disease who received PN for at least 3 weeks at BCH
- 29 received 1 g/kg/d of IL
- 32 received 2-3 g/kg/d



A

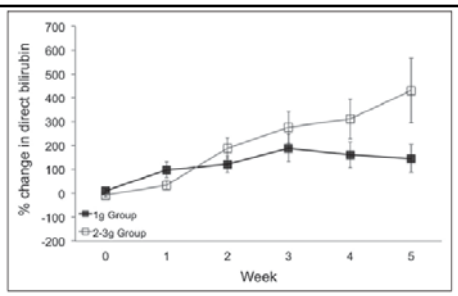


Figure 3. Percent change in direct bilirubin from baseline (week 0) to week 5 for the 1-g and 2- to 3-g groups. The percent change in direct bilirubin compared with baseline increased over time in both groups ($P < .001$), with the 2- to 3-g group marginally higher than the 1-g group at week 5 only ($P = .05$). Data represent mean ± SEM (adjusted for baseline direct bilirubin using the generalized estimating equation model).

[4170.4] Intravenous Fat Emulsion (IFE) for the Prevention of Parenteral Nutrition Associated Liver Disease (PNALD) in Preterm Neonates

Orly L. Levit, Kara L. Calkins, Lorraine I. Kelley-Quon, Leena C. Gibson, Daniel T. Robinson, David A. Elashoff, Tristan R. Grogan, Matthew J. Bizzarro, Richard A. Ehrenkranz. Pediatrics, Yale University School of Medicine, New Haven, CT; Pediatrics, David Gefen School of Medicine-UCLA, Los Angeles, CA; Statistics, David Gefen School of Medicine-UCLA, Los Angeles, CA; Pediatrics, Feinberg School of Medicine, Northwestern University, Chicago, IL.

Variable	Arm Mean(SD,%)		p-value
	1gm/kg/d(N=63)	3gm/kg/d(N=66)	
BW(gm)	884 (278)	930 (288)	0.34
GA(weeks)	26.4 (1.7)	26.4 (1.7)	0.79
Male gender	40(64)	40(61)	0.73
SGA	17(27%)	11 (17%)	0.16
NEC	11(18%)	9 (14%)	0.52
Weight at 28 days	1120 (356)	1210 (362)	0.17
Weight velocity at discharge	20.0(4.3)	20.1(4.4)	0.86
Duration of TPN	25.5(20.4)	24.7(19.7)	0.83
TB at full feeds	2.7(2.4)	3 (2.7)	0.55
DB at full feeds	0.9(1.4)	0.7(1)	0.56
PNALD	41 (71%)	37 (62%)	0.30
Length of stay	96.5 (53.0)	86.7(34.0)	0.22

"Our" Current Approach

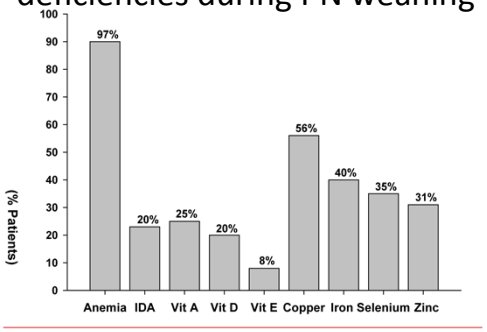
- Limit IL dose to 1 g/kg/day among all patients likely to be on PN for > 3 weeks
  - NAC
  - Including NICU
  - Make up calories with dextrose
- If a patient meets criteria for Omegaven protocol, switch them to 1 g/kg/day of this experimental therapy

Learning Objectives

- To review indications for intravenous fat emulsions in patients with intestinal failure
- To review strategies for parenteral micronutrient supplementation in the setting of manufacturing shortages

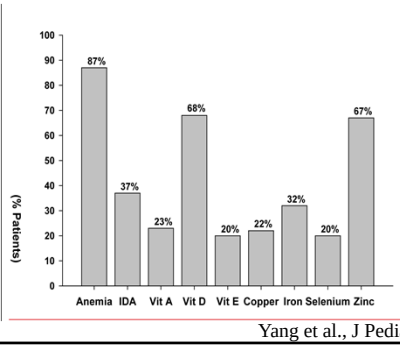
"Total" parenteral nutrition

Prevalence of micronutrient deficiencies during PN weaning



Yang et al., J Pediatr 2011

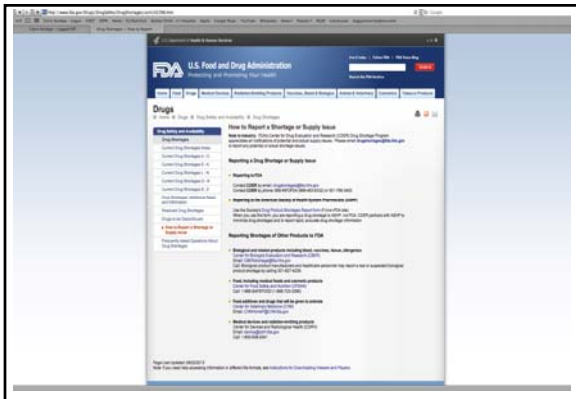
Prevalence of micronutrient deficiencies during full EN



Yang et al., J Pediatr 2011

Parenteral component shortages

- Phosphate
- Multivitamins
- Trace elements
- Ethanol



http://www.fda.gov/Drugs/DrugSafety/DrugShortages/ucm142398.htm

Centers for Disease Control and Prevention

MMWR

Morbidity and Mortality Weekly Report

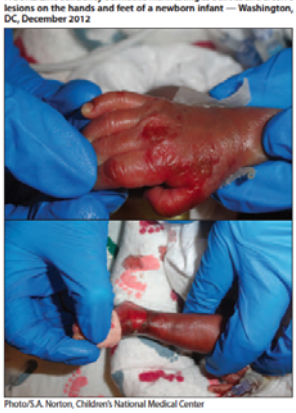
Weekly / Vol. 62 / No. 7 February 22, 2013

Notes from the Field

Zinc Deficiency Dermatitis in Cholestatic Extremely Premature Infants After a Nationwide Shortage of Injectable Zinc — Washington, DC, December 2012

- 3 premature infants in NICU with cholestasis and PN dependency developed skin lesions
- Blood, urine, CSF and wound cultures were negative

FIGURE. Zinc deficiency dermatitis manifesting as bullous and erosive lesions on the hands and feet of a newborn infant — Washington, DC, December 2012



Photo/S.A. Norton, Children's National Medical Center

CASE REPORT

Drug Shortage–Associated Increase in Catheter-Related Blood Stream Infection in Children

AUTHORS: Matthew W. Ralls, MD,[a] R. Alexander Blackwood, MD, PhD,[b] Meghan A. Arnold, MD,[a] M. Luisa Partipilo, PharmD, BCNSP,[c] James Dimond,[a] and Daniel H. Teitelbaum, MD[a]

abstract

BACKGROUND: Ethanol lock therapy (ELT) has been shown to reduce

TABLE 1 Mean Rate of CRBSI per 1000 Catheter Days ± SD

	Pre-ELT (historical)	Daily ELT (historical)	Daily ELT	Less than daily ELT[a]	*P* value
	8.0 ± 5.4	1.3 ± 3.0	0.68 ± 1.27	6.16 ± 2.5	
Daily $ELT_{Historical}$ vs daily $ELT_{Current}$		1.3 ± 3.0	0.68 ± 1.27		.55
Daily $ELT_{Historical}$ vs less than daily ELT		1.3 ± 3.0		6.16 ± 2.5	<.001[b]
Daily $ELT_{Current}$ vs less than daily ELT			0.68 ± 1.27	6.16 ± 2.5	<.001[b]
Pre-$ELT_{Historical}$ vs less than daily ELT	8.0 ± 5.4			6.16 ± 2.5	.27

[a] Less than daily is defined as either twice weekly or weekly administration.
[b] Statistically significant.

Parenteral Component Shortages

- Raw material shortages
- Discontinuations
- Fewer manufacturing firms
- Limited capacity of remaining companies to increase supplies

« People & Politics »

"Children Are Dying"

Comments (0) | Published May 22, 2013

In October 2011, President Obama signed an executive order telling the FDA to work harder to address drug shortages. Health advocates say the crisis he forecast at that time is now here. Photograph by Kristoffer Tripplaar-Pool/Getty Images.

http://www.washingtonian.com/articles/people/children-are-dying/indexp6.php

« People & Politics »

Celebrity Trend Uses Nutrients Hospitals Desperately Need

Experts say: "We've got babies' lives hanging in the balance while we're worried about getting through a hangover."

By Alexandra Robbins

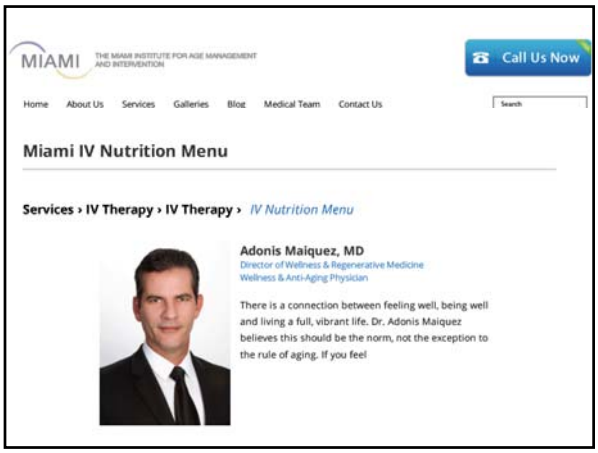
Comments (0) | Published July 29, 2013

It's been called the new "it" bag. The "vitamin drip"—a trendy, expensive treatment of vitamins and nutrients delivered intravenously—is billed as a way to [illegible] and reenergize those who are tired, stressed out, dehydrated, or [illegible] night's sleep.

X Factor judge **Simon Cowell** swears by it. **Madonna**, **Cindy Crawford**, and the Miami Heat's **Rashard Lewis** have been rumored to be fans.

Meanwhile, unbeknownst to them, patients across the country—especially premature babies—have been malnourished because of a lack of some of the same nutrients found in the vitamin drip.

In late May, *Washingtonian* reported that nationwide shortages are threatening the lives of patients who need IV nutrition to survive. Hospitals have resorted to hoarding, rationing, and bartering. At least 15 people—almost certainly more—have died. The shortages particularly endanger infants in neonatal intensive-care units (NICUs), whose



SBAR: 4/24/2013 Medication Backorders

S **Sodium Phosphate and Potassium Phosphate** are **on national backorder** at this time.

B These products are used in parenteral nutrition, hypophosphatemia, and in diabetic ketoacidosis IV fluids. These electrolytes have been on backorder with small allocations for a period of time and supply is now almost depleted.

A
1. Sodium Phosphate 3 mmol/mL injection – 3 vials remaining
2. Potassium Phosphate 3 mmol/mL injection – 5 vials remaining

R **Effective immediately – 4/24/2013**

· **Sodium Phosphate** injection – Supply is depleted except for a very small number of vials (3). These vials will be sequestered for ICU emergent use and/or in the DKA patient population. Pharmacy is expecting a shipment by the end of this week.

· **Potassium Phosphate** injection– Supply is almost depleted except for a very small number of vials (5). This product will be sequestered for ICU emergent use and/or in the DKA patient population.

· DKA floorstock fluids as they currently exist will no longer be manufactured by Pharmacy due to this backorder.

· Phosphate will NOT be included in parenteral nutrition mixtures at this time.

Recommendations for Trace Element Shortages

For patients receiving 7 nights of parenteral nutrition (PN) and/or <50% enteral feeds

Biochemical monitoring: complete blood count (CBC) with differential, copper, ceruloplasmin c-reactive protein (CRP), vitamin A*

*Vitamin A to be checked if not monitored in the past 6 months. Rationale: evaluate for risk of hypervitaminosis A

Patients 2 years and older:
Start Flintstones® Complete multivitamin for supplementation

Patients under 2 years of age:
Provider discussion

For patients receiving less than 7 nights of PN and >50% enteral feeds:

Biochemical monitoring: CBC with differential, copper, ceruloplasmin, CRP at time patient is impacted.

If impacted by zinc or selenium shortage, monitor these levels

No additional supplementation needed. Encourage copper (zinc if applicable) rich foods (see appendix)

Repeat CBC with differential, copper, ceruloplasmin (zinc and selenium as applies) in 2 months' time

Courtesy Home PN Program Boston Children's Hospital

Peditrace™

Concentrate for solution for infusion

Trace element additive solution for pediatric patients on total parenteral nutrition.

COMPOSITION

1 ml contains:

Zinc chloride	521 µg
Copper chloride $2H_20$	53.7 µg
Manganese chloride $4H_20$	3.60 µg
Sodium selenite anhydrous	4.38 µg
Sodium fluoride	126 µg
Potassium iodide	1.31 µg
Hydrochloric acid to pH 2	
Water for injections to 1 ml	

PROPERTIES

Sterile solution containing trace elements for addition to amino acid solution or glucose solution (see compatibility) in the parenteral nutrition of premature and fullterm infants and children.

0·

IV Multivitamin Reference Tool:

Vitamin	Pediatric Hospira (5ml)	Petiatric Infuvite Baxter (5ml)	Adult Hospira (10ml)	MVI-12 Hospira (10ml)	Adult Infuvite Baxter (10ml)
A	0.7mg (retinol)	2300 units (palmitate)	1 mg (retinol)	1mg (retinol)	3300 units (retinol)
D	10mcg (ergo)	400 units (chole)	5mcg (ergo)	5mcg (ergo)	200 units (chole)
E	7mg	7 units	10 mg	10mg	10 units
K (phytonadione)	200mcg	200mcg	150mcg	None	150mcg
C (ascorbic acid)	80mg	80mg	200mg	200mg	200mg
B-1 Thiamine	1.2 mg	1.2mg	6mg	6mg	6mg
B-2 Riboflavin	1.4mg	1.4mg	3.6mg	3.6mg	3.6mg
Niacinamide	17mg	17mg	40 mg	40mg	40mg
Dexpanthenol	5mg	5mg	15mg	15mg	15mg
Biotin	20mcg	20mcg	60 mcg	60mcg	60mcg
B-12	1 mcg	1 mcg	5 mcg	5mcg	5mcg
B-6 Pyridoxine	1mg	1mg	6mg	6mg	6mg
Folic Acid	140mcg	140mcg	600mcg	600mcg	600mcg

Table courtesy Home PN Program Boston Children's Hospital

Conclusions

- Current approach to prevent/treat PNALD is not 100% clear at this time.
- Shortages of components of PN have significant implications for our patients.
- Biochemical monitoring is critical to document nutrient deficiency states.
- Advocacy efforts must continue.