NUTRITION IN CRITICALLY ILL PATIENTS

CARISSA TONG, BVM&S, MRCVS

WHY DO WE NEED TO PROVIDE NUTRITION?

- Many critically ill patients have decreased caloric intake in hospital as well as altered metabolism
- Goal of providing nutrition in critical illness is to minimize further loss of lean body mass, restore nutrient deficiencies, provides substrate for healing and repair
- Loss of lean body mass impairs the animal's strength, immune function, wound healing, and likely negatively impacts overall survival

DISADVANTAGES OF FASTING

- Experimental models show
  - Intestinal mucosal atrophy
  - Increased rate of enterocyte apoptosis
  - Decreased glutamine and arginine transport
  - Changes in mucin composition of goblet and crypt cells
  - Breakdown in intestinal barrier resulting in increased intestinal permeability
  - Contribution of the gut to SIRS

OPTIMAL FEEDING ROUTE

Depends on:

- Patient-dependent factors
  - Function of the GI tract
  - Ability to tolerate tube placement
  - Risk of aspiration
- Nonpatient factors
  - Cost
  - Technical expertise

ENTERAL NUTRITION

ANY METHOD OF FEEDING THAT USES THE GASTROINTESTINAL (GI) TRACT

ENTERAL NUTRITION

Advantages

- Physiologic
- Preserves the integrity of the gastrointestinal mucosal barrier, villous function, and preserve GI immunologic function
- Helps maintain appetite
- Less expensive

ENTERAL NUTRITION

Contraindications

- Intractable vomiting,
- GI obstruction
- Ileus
- Malabsorption or maldigestion
- Inability to protect airways

ROUTE OF ENTERAL NUTRITION

- Voluntary oral intake is the best
- If voluntary intake is insufficient, then try
  - Changing diet
  - Syringe feeding
  - Appetite stimulants
- If that fails, feeding tubes have to be considered

TYPES OF FEEDING TUBES

1) Nasogastric/Nasoesophageal tube
2) Esophagostomy tube
3) Gastrotomy tube
4) Jejunostomy tube

	Indications	Contraindications	Advantages	Disadvantages	Complications
NG/NE tube					
E tube					
G tube					
J tube					

	Indications	Contraindications	Advantages	Disadvantages	Complications
NG/NE tube	-Short-term (7-14 days) -Gastric decompression -Measure GRV	-Coagulopathies -Nasopharyngeal of facial disease	-Easily placed -No adverse effect if removed by patient	-Irritating -Dislodges with vomiting -Liquid diet only -Patients remain hospitalized	-Iatrogenic placement in lungs can be fatal -NGT may create incompetence of LES
E tube					
G tube					
J tube					

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E tube	-Intermediate term (weeks to months) -Patient with function GIT distal to esophagus -Patient with facial or oral trauma	-Esophageal disease -Skin lesion/cellulitis at site -Coagulopathies	-Easily placed, well tolerated -Blenderized diets -Little adverse effect if removed by patient -Owner can use at home -Patient can eat and drink	-General anesthesia -Must wait 10-14 days prior to removal -Dislodges with vomiting	-Esophageal stricture (rare) -pneumomediastinum and pneumothorax (rare) -Cellulitis
G tube					
J tube					

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G tube	-Long terms (months to year) -Patient with esophageal disease -Patient undergoing sx for oropharynx or esophagus	-High risk for aspiration, non-ambulatory -Coagulopathies -Gastric disease -Intractable v+	-Well-tolerated -Large diameter tube reduces risk of clogging -Patients can eat and drink -Owner can use at home	-General anesthesia -Must wait 24h prior to feeding -Must wait 10-14 days prior to removal -Costly	-Peritonitis -Stoma infection -Visceral entrapment -Gastric perforation
J tube					

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J tube	-Short-term option (days to weeks) -Bypasses pancreas -In patients w/ gastroparesis, uncontrolled vomiting, proximal GI obstruction 2ry to neoplasia, massive proximal GI resection, inability to protect airways	-Peritonitis -Hypoproteinemia -Coagulopathies	-Minimal stimulation of the pancreas -Large diameter tube reduces risk of clogging -Patients can eat and drink	-Only liquid, enteral diets fed -General anesthesia and surgical placement -Must wait 24h prior to feeding -Must wait 5-7 days prior to removal -Requires CRI feeding -Expensive -Technically challenging	-Migration of tube can cause GI obstruction -Stoma infection -Cellulitis -Peritonitis

CRI VS TRICKLE FEEDING?

J Vet Intern Med 2010;24:520–526

Intermittent and Continuous Enteral Nutrition in Critically Ill Dogs: A Prospective Randomized Trial

M. Holahan, S. Abood, J. Hauptman, C. Koenigsknecht, and A. Brown

Background: Malnutrition is a common problem in critically ill dogs and is associated with increased morbidity and mortality in human medicine. Enteral nutrition (EN) delivery methods have been evaluated in humans to determine which is most effective in achieving caloric goals.

Objectives: To compare continuous infusion and intermittent bolus feeding of EN in dogs admitted to a critical care unit.

Animals: Fifty-four dogs admitted to the critical care unit and requiring nutritional support with a nasoenteric feeding tube.

Methods: Prospective randomized clinical trial. Dogs were randomized to receive either continuous infusion (Group C) or intermittent bolus feeding (Group I) of liquid EN. The percentage of prescribed nutrition delivered (PPND) was calculated every 24 hours. Frequencies of gastrointestinal (GI), mechanical, and technical complications were recorded and gastric residual volumes (GRVs) were measured.

Results: PPND was significantly lower in Group C (98.4%) than Group I (100%). There was no significant difference in GI or mechanical complications, although Group C had a significantly higher rate of technical complications. GRVs did not differ significantly between Group C (3.1 mL/kg) and Group I (6.3 mL/kg) and were not correlated with the incidence of vomiting or regurgitation.

Conclusions and Clinical Importance: There was a statistically significant difference in the PPND between continuously and intermittently fed dogs, but this difference is unlikely to be clinically relevant. Critically ill dogs can be successfully supported with either continuous infusion or intermittent bolus feeding of EN with few complications. Increased GRVs may not warrant termination of enteral feeding.

Key words: Clinical trials; Gastric residual volumes; Intensive care medicine; Nasoenteric feeding tubes.

Retrospective Study

Journal of Veterinary Emergency and Critical Care **20**(2) 2010, pp 232–236
doi: 10.1111/j.1476-4431.2010.00523.x

Continuous versus intermittent delivery of nutrition via nasoenteric feeding tubes in hospitalized canine and feline patients: 91 patients (2002–2007)

Jennifer A. Campbell, DVM; L. Ari Jutkowitz, VMD, DACVECC; Kari A. Santoro, BS, DVM; Joe G. Hauptman, DVM, MS, DACVS; Melissa L. Holahan, DVM and Andrew J. Brown, MA, VetMB, DACVECC, MRCVS

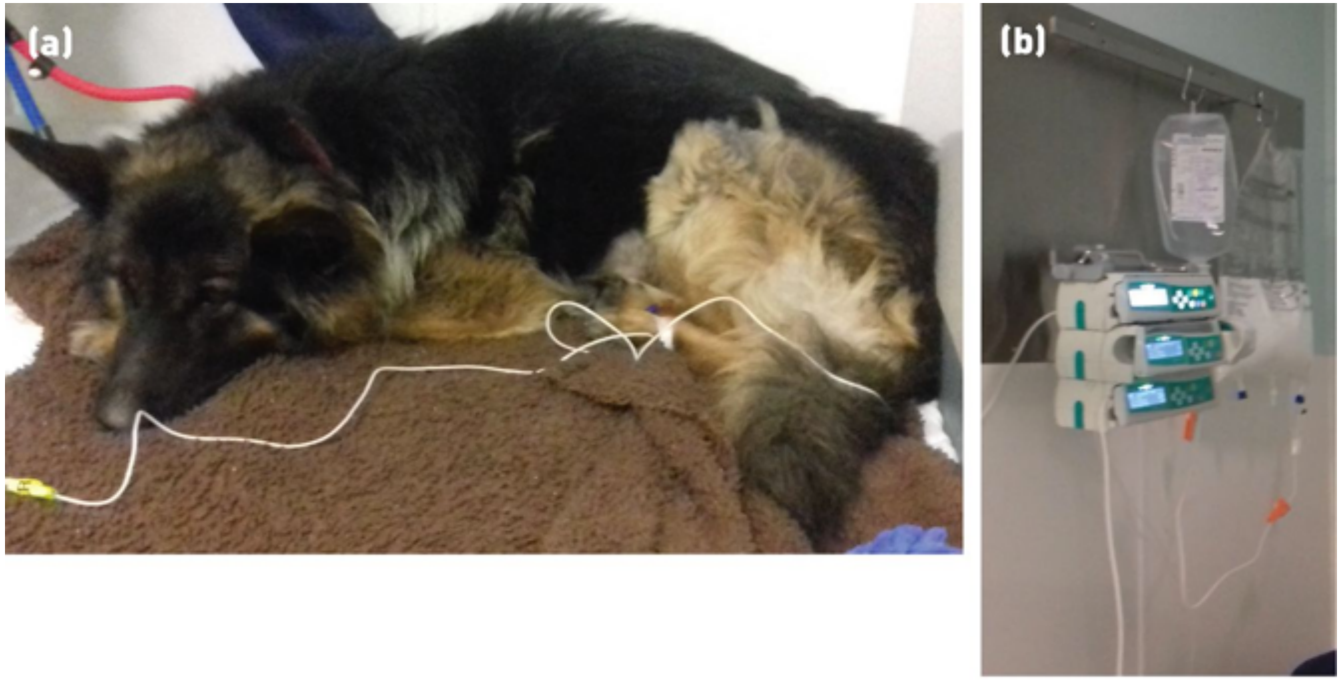
Abstract

Objective – To compare continuous to intermittent feeding at delivering prescribed nutrition in hospitalized canine and feline patients.
Design – Retrospective clinical study.
Setting – University teaching hospital.
Animals – Fifty-four cats and 37 dogs.
Measurements and Main Results – Twenty-four-hour periods of prescribed and delivered nutrition (kcal) were recorded, and the percentage of prescribed nutrition delivered (PPND) was calculated. If the patient received nasoenteric feeding for >1 day, then the average PPND per day was calculated. Frequency of gastrointestinal complications (vomiting, diarrhea, and regurgitation) was calculated per patient for each group. The PPND was not significantly different between patients fed continuously (99.0%) and patients fed intermittently (92.9%). Vomiting affected 29% of patients (26/91), diarrhea affected 26% of patients (24/91), and regurgitation affected 5% of patients (5/91). There was no significant difference in incidence of gastrointestinal complications between the patients fed continuously and the patients fed intermittently. There was a significantly higher incidence of diarrhea and regurgitation in dogs than in cats.
Conclusions – PPND was not significantly different for continuous versus intermittent feeding via nasoenteric tubes. Frequencies of gastrointestinal complications were not significantly different between patients fed continuously and patients fed intermittently. Enterally fed dogs had a significantly higher frequency of regurgitation and diarrhea than enterally fed cats. Prospective studies are warranted to investigate causes for these potential inter-species differences.

(*J Vet Emerg Crit Care 2010; 20(2): 232–236) doi: 10.1111/j.1476-4431.2010.00523.x*

CRI VS TRICKLE FEEDING?

- Essentially minimal difference in calories provided
- Holahan study:
  - Calories delivered: 98.4% CRI vs 100% trickle feeding
  - Higher technical complication in CRI group but overall GI complication was not different
  - Proactive implementation of feeding protocol improved average time from hospital admission to feeding (4.5 to 1.8 days)
- Campbell study:
  - Calories delivered: 99% CRI vs 92.9% trickle feeding
  - No difference in GI complication rate in between groups, but dogs had more complications than cats



PARENTERAL NUTRITION

INTRAVENOUS ADMINISTRATION OF NUTRITION

TOTAL PARENTERAL NUTRITION (TPN)

- Provision of nutritional support via a ______
- Supplies total patient energy need
- TPN solutions contain _____, _____, _____ with osmolality > ______ mOsm/L
- May be deficient in total vitamins and mineral needs, depending on the formulation

TOTAL PARENTERAL NUTRITION (TPN)

- Provision of nutritional support via a central vein to reduce risk of thrombosis
- Supplies total patient energy need
- TPN solutions contain glucose, amino acids, and lipids with osmolality > 1200 mOsm/L
  - Should not exceed 1400 mOsm/L
- May be deficient in total vitamins and mineral needs, depending on the formulation

TOTAL PARENTERAL NUTRITION (TPN)

Indications

- Patients unable to enterally absorb sufficient nutrients for more than 3–5 days with signs of malnutrition
- Severe prolonged pancreatitis when enteral feeding tubes are not an option
- Severe malnutrition with a nonfunctional GI tract
- Intolerance to enteral tube placement or force feeding

PERIPHERAL PARENTERAL NUTRITION (PPN)

- Provision of nutritional support by use of a _________
- Lower in osmolality (_____ mOsm/L), energy and protein content
- Does not supply all patient energy needs
- Typically deficient in vitamin and mineral needs

PERIPHERAL PARENTERAL NUTRITION (PPN)

- Provision of nutritional support by use of a peripherally inserted intravenous catheter
- Lower in osmolality (500-600 mOsm/L), energy and protein content
- Does not supply all patient energy needs
- Typically deficient in vitamin and mineral needs
- Also known as "partial parenteral nutrition"

PERIPHERAL PARENTERAL NUTRITION (PPN)

Indications

- Non-debilitated animals likely needing IV-administered support for >7 days
- Jugular catheter not feasible
- Need adjunct nutrients as nutritional needs can’t be completely met with enteral feeding
- Sparing protein from catabolism by providing an energy source and amino acids for protein synthesis

DIFFERENCE BETWEEN TPN VS PPN

- Route of administration
  - Central line vs PICC line
- Osmolality
  - TPN has much higher osmolality (850-1200 vs 500-600)
- Components
  - TPN uses 50% dextrose, PPN 5%
- Complication rate
  - Lower mechanical complication rate in PPN than TPN (20% vs 57%)

DISADVANTAGES OF PN

- Costly
- Necessity and difficulty of insertion and maintenance of central venous catheter
- Increased risk of infection
- Risk of thrombosis
- Metabolic disturbances

Comparison of methods of nutritional support

Factor	Type of nutritional support: Enteral feeding	TPN	PPN
Indications	Preferred whenever the gastrointestinal tract is functional	Severe malnutrition; debilitating disease	Moderate malnutrition; adjunct to enteral nutrition
Nutritional support	Complete support	Complete support	Protein-sparing; potentially complete support provided
Effect on gastrointestinal tract function	Preserves mucosal barrier of gastrointestinal tract	Associated with increased permeability of gastrointestinal tract	Associated with increased permeability of gastrointestinal tract (when used alone)
Comparative cost	Least expense	Most expense	Moderate expense

TPN = Total parenteral nutrition. PPN = Peripheral parenteral nutrition.

REQUIREMENTS FOR PN

Hospital

- Ability to obtain vascular access
- Ability to provide 24-hour nursing care
- Ability to monitor chemistry and electrolyte
- Ability to formulate or obtain PN prescription

Patient

- Able to tolerate vascular access
- No contraindications
  - Risk of increase ICP
  - High risk of thromboembolic dz,
  - Has severe coagulopathies
- Able to tolerate fluids

PN IN VETERINARY MEDICINE

J Vet Intern Med 2002;16:440–445

Retrospective Evaluation of Partial Parenteral Nutrition in Dogs and Cats

Daniel L. Chan, Lisa M. Freeman, Mary A. Labato, and John E. Rush

The purpose of this retrospective study was to evaluate the use of partial parenteral nutrition (PPN) in dogs and cats. The medical records of all dogs and cats receiving PPN between 1994 and 1999 were reviewed to determine signalment, reasons for use of PPN, duration of PPN administration, duration of hospitalization, complications, and mortality. Complications were classified as metabolic, mechanical, or septic. One hundred twenty-seven animals (80 dogs and 47 cats) were included in the study, accounting for 443 patient days of PPN. The most common underlying diseases were pancreatitis (n = 41), gastrointestinal disease (n = 33), and hepatic disease (n = 23). Median time of hospitalization before initiation of PPN was 2.8 days (range, 0.2–10.7 days). Median duration of PPN administration was 3.0 days (range, 0.3–8.8 days). Median duration of hospitalization was 7 days (range, 2–20 days). In the 127 animals receiving PPN, 72 complications occurred. These included metabolic (n = 43), mechanical (n = 25), and septic (n = 4) complications. The most common metabolic complication was hyperglycemia (n = 19), followed by lipemia (n = 17) and hyperbilirubinemia (n = 6). Most complications were mild and did not require discontinuation of PPN. Ninety-three (73.2%) of the 127 patients were discharged. All 4 animals with septic complications were discharged from the hospital. The presence, type, and number of complications did not impact the duration of hospitalization or outcome. However, animals that received supplemental enteral nutrition survived more often than those receiving PPN exclusively. Although PPN seems to be a relatively safe method of providing nutritional support, future studies are warranted to determine its efficacy.

Key words: Cat; Dog; Intravenous feeding; Nutritional support.

J Vet Intern Med 2011;25:446–452

Factors Associated with Adverse Outcomes during parenteral Nutrition Administration in Dogs and Cats

Y. Queau, J.A. Larsen, P.H. Kass, G.S. Glucksman, and A.J. Fascetti

Background: Parenteral nutrition (PN) is increasingly used to support hospitalized dogs and cats. Published assessments of outcome are limited.

Objective: Evaluate type and prevalence of complications and risk factors for death and complications in dogs and cats receiving PN.

Animals: Three hundred and nineteen dogs and 112 cats that received PN at a teaching hospital between 2000 and 2008.

Methods: Retrospective case review. Diagnosis, duration of PN administration, concurrent enteral feeding, death, and mechanical, septic, and metabolic complications were abstracted from medical records. Association of each parameter with complications and death was analyzed by binary logistic regression.

Results: Pancreatitis was the most common diagnosis (109/319 dogs, 34/112 cats), and 137/319 dogs and 51/112 cats died. Dogs and cats received 113 ± 40% and 103 ± 32% of resting energy requirement, respectively. Mechanical (81/319 dogs, 16/112 cats) and septic (20/319 dogs, 6/112 cats) complications were not associated with death ($P > .05$). Hyperglycemia was the most common metabolic complication (96/158 dogs, 31/37 cats). Hypercreatininemia in dogs (8/79) was the only complication associated with death ($P < .01$). Chronic kidney disease in dogs, hepatic lipidosis in cats, and longer duration of inadequate caloric intake before PN in both species were negatively associated with survival ($P < .05$). Factors positively associated with survival included longer duration of PN administration in both species, enteral feeding in cats with any disease, and enteral feeding in dogs with respiratory disease ($P < .05$).

Conclusions and Clinical Importance: PN can be effectively used to provide the energy requirements of most critically ill dogs and cats. Most complications accompanying PN administration do not affect survival.

Key words: Critical care; Hyperglycemia; Intravenous feeding; Retrospective.

- Most common underlying disease is pancreatitis
- Most common complication if metabolic > mechanical > septic
- Most common metabolic complication is hyperglycemia

PN IN VETERINARY MEDICINE

J Am Vet Med Assoc. 2004 Jul 15;225(2):242-50.

Evaluation of complications and prognostic factors associated with administration of total parenteral nutrition in cats: 75 cases (1994-2001).

Pyle SC[1], Marks SL, Kass PH.

Author information

Abstract

OBJECTIVE: To determine frequency and types of complications, prognostic factors, and primary diseases affecting clinical outcome associated with administration of total parenteral nutrition (TPN) in cats.

DESIGN: Retrospective study.

ANIMALS: 75 cats that received TPN for > or = 12 hours.

PROCEDURE: Medical records were reviewed, and information was obtained on signalment, history, problems at initial evaluation, physical examination findings, weight and changes in weight while receiving TPN, duration in the hospital before initiation of TPN, the type of TPN catheter used, duration of TPN administration, and final diagnosis. Laboratory results obtained immediately prior to TPN and at 24 and 96 hours following initiation of TPN administration were compared.

RESULTS: Reports of weight loss at initial evaluation, hyperglycemia at 24 hours, or diagnosis of chronic renal failure were significantly associated with increased mortality rate. Greater serum albumin concentrations prior to and at 96 hours following TPN administration were significantly associated with decreased mortality rate. Mechanical and septic complications were infrequent and not associated with increased mortality rate. Most cats had multiple diseases. The overall mortality rate was 52%; among 75 cats, 36 recovered, 23 were euthanatized, and 16 died as a result of their primary illness or complications associated with their illness.

CONCLUSIONS AND CLINICAL RELEVANCE: Results indicated high mortality rate in cats maintained onTPN that had multiple concurrent diseases associated with a poor prognosis. Indicators of poor prognosis included a history of weight loss, hyperglycemia at 24 hours following TPN administration, hypoalbuminemia, and chronic renal failure.

- Most cats have multiple concurrent disease associated with poor prognosis and high mortality rate (52%)
- Poor prognostic indicators:
  - History of weight loss
  - Hyperglycemia at 24h after TPN
  - Hypoalbuminemia
  - Chronic renal failure

PN IN VETERINARY MEDICINE

Retrospective Study

Journal of Veterinary Emergency and Critical Care 25(3) 2015, pp 405–412
doi: 10.1111/vec.12306

Retrospective evaluation of ProcalAmine administration in a population of hospitalized ICU dogs: 36 cases (2010–2013)

Natasha V. Olan, DVM and Jennifer Prittie, DVM, DACVIM, DACVECC

Abstract

Objective – To describe the use of ProcalAmine as a source of parenteral nutrition in hospitalized dogs and to report complications possibly referable to its use.
Design – Retrospective study.
Settings – Private veterinary teaching hospital.
Animals – Thirty-six dogs hospitalized in ICU receiving ProcalAmine between October 2010 and March 2013.
Interventions – None.
Measurements and Main Results – The most common underlying disease process in this population of dogs was trauma ($n = 8$). Median duration of administration was 4 days and median resting energy requirement provided via ProcalAmine was 33%. ProcalAmine was administered via central catheters in 86% of cases and via peripheral catheters in 14% of cases. The overall mechanical complication rate was 19%. Metabolic complications possibly associated with ProcalAmine administration were documented in 12/36 dogs. Hyponatremia was most commonly identified ($n = 6$) followed by hyperglycemia ($n = 4$), hypochloremia ($n = 2$), azotemia ($n = 2$), metabolic alkalosis ($n = 2$), hyperchloremia ($n = 1$), and metabolic acidosis ($n = 1$).
Conclusion – ProcalAmine appears to be relatively safe and a viable option for parenteral nutrition in ill and injured dogs. Due to the potential for electrolyte derangements and other metabolic complications, daily monitoring of these parameters is advisable.

Retrospective Study

Journal of Veterinary Emergency and Critical Care 23(3) 2013, pp 305–313
doi: 10.1111/vec.12029

Clinical experience with a lipid-free, ready-made parenteral nutrition solution in dogs: 70 cases (2006–2012)

Isuru Gajanayake, BVSc, DACVIM, MRCVS; Claire E. Wylie, BVM&S, MSc, PhD, MRCVS and Daniel L. Chan, DVM, DACVECC, DACVN, MRCVS

Abstract

Objective – To review the clinical use of a lipid-free, ready-made amino acid and glucose parenteral nutrition (PN) solution in dogs.
Design – Retrospective study of dogs from 2006 to 2012 that received this form of PN.
Setting – University veterinary teaching hospital.
Animals – Seventy dogs presented to the hospital for treatment of various diseases in which PN was used as part of patient management. Dogs were administered PN at the discretion of the primary clinician.
Intervention – A lipid-free, ready-made solution containing amino acid (59 g/L) and dextrose (100 g/L) was administered intravenously as a constant rate infusion to provide nutritional support.
Measurements and Main Results – PN was provided for a median of 2.2 days (range 0.5–9.5 days) in the 70 dogs, totaling 168 days of PN. The PN provided a median of 5.5 g/100 kcal of protein (range 1–9.5 g/100 kcal) and a median of 2.2 mg/kg of bodyweight per minute (range 0.8–5.2 mg/kg/min) of glucose, which reflected a median of 57% of the resting energy requirement (range 9–100%). Metabolic complications developed in 43 of 67 dogs where these data were recorded, but the development of hyperkalemia was the only complication associated with a poor outcome (eg, death or euthanasia). Mechanical complications were seen in 28 dogs, and all but one of these occurred when PN was delivered through peripheral catheters. Septic complications were confirmed in 5 dogs.
Conclusions – This form of PN is suitable for clinical use and can provide both protein and calories to ill dogs. It was, however, associated with a high rate of complications and requires careful patient monitoring.

COMPONENTS OF PN

- Carbohydrates
- Lipid
- Protein
- Others

CARBOHYDRATES

- Typically from 50% Dextrose (500 mg/mL), contains 1.7 kcal/mL
  - PPN uses 5% dextrose
- Proportion of dextrose is limited to prevent excessive osmolarity (2523 mOsm/L)
- 40-60% energy requirement from dextrose
  - Lower if risk of glucose intolerance (e.g. Diabetic)

LIPIDS

- Soy bean or sunflower oil based
- Usually 20% lipid emulsions (200 mg/mL), contains 2 kcal/mL
- Numerous benefits:
  - Isotonic
  - Energy dense source
- Some controversy
  - Concurrent administration of dextrose & lipid may result in insufficient lipid use
  - n-6 fatty acid may be pro-inflammatory (contributes arachidonic acid precursors, prevents inactivation of PAF)
- Patients receive 40-60% energy requirement from lipid
  - Lower in pancreatitis

PROTEIN

- Amino acids
- Slows muscle breakdown, aids immune and organ function, plays a role in wound healing
- Most commonly 8.5% Amino Acid solution (8.5mg/ml)
- 4 to 6 g of protein per 100 kcal for dogs and 6 or more g of protein per 100 kcal for cats
  - Contains 4 kcal/g in proteins
- Patients with protein intolerance (e.g. HE, severe kidney failure) should receive reduced levels (3g/100kcal)

OTHERS

- If receiving PN > 10 days or severely malnourished, addition of zinc, copper, manganese and chromium may be considered
- Vit B complex, vitamin A and D are commonly added
- Some clinicians add Zinc as there is some evidence of Zn depletion in critically ill patients

Table 130-2 **Guidelines for Micronutrient Dosages in PN Admixtures**

Micronutrient	Dosage
Vitamin B complex*	0.2 to 0.5 ml/100 kcal
Potassium phosphate	8 to 10 mmol/1000 kcal
Magnesium sulfate	0.8 to 1.0 mEq/100 kcal
Zinc	1 mcg/kcal

FORMULATING PN PRESCRIPTION

1) Calculate resting energy requirement (RER): (BW kg x 30) + 70 = kcal/day
2) Calculate total energy requirement (TER): RER x illness factor
    1) Not commonly used anymore as literature demonstrating critically ill patients are in catabolic state but may not have increased energy demands and the risk of over supplementation causing harm
3) Determine protein requirement: 4-6g/100kcal for dogs and 6g/100kcal for cats
4) Determine volume of nutrient solutions required: dextrose, lipid, amino acid
5) Determine total volume of PN per day
6) Determine the daily vitamin requirements
7) Determine the hourly rate of PN

COMPOUNDING PN SOLUTION

- Practice aseptic technique
- Add amino acids and dextrose solution separately → minimize Maillard reaction
- Protect from light
- Reducing risk of lipid embolization
  - Embolization occurs when lipid particles > 5 um make up > 0.4% of PN solution, usually occurs when placed >24 hours in room temperature
- Compound PN in specialized bags composed of ethylene vinyl acetate (impermeable to air)

ADMINISTRATION OF PN

- Start at 50% of targeted goal
- Administer through 1.2 micrometer filter
- Administer in 10-12 hours (rather than 24 hours) can reduce complication rate
- Maintain sterility of catheter, intravenous tubing, and PN bag
- Do not disconnect the patient from the PN bag unless attaching a new bag
- Wean PN off over several hours once patients are taking in 50% of nutrients enterally

MONITORING THERAPY

- Daily inspection of catheter site
- Daily monitoring of body weight
- Labwork: BG, TP, serum appearance, serum electrolytes
- GI signs and appetite
- Daily assessment and adjustment of nutritional plan

TIMING OF NUTRITIONAL PROVISION?

TIMING OF NUTRITIONAL PROVISION?

- Early provision has been shown to be beneficial in many studies both in people and in veterinary medicine

N Engl J Med. 2011 Aug 11;365(6):506-17. doi: 10.1056/NEJMoa1102662. Epub 2011 Jun 29.

Early versus late parenteral nutrition in critically ill adults.

Casaer MP[1], Mesotten D, Hermans G, Wouters PJ, Schetz M, Meyfroidt G, Van Cromphaut S, Ingels C, Meersseman P, Muller J, Vlasselaers D, Debaveye Y, Desmet L, Dubois J, Van Assche A, Vanderheyden S, Wilmer A, Van den Berghe G.

Author information

Abstract

BACKGROUND: Controversy exists about the timing of the initiation of parenteral nutrition in critically ill adults in whom caloric targets cannot be met by enteral nutrition alone.

METHODS: In this randomized, multicenter trial, we compared early initiation of parenteral nutrition (European guidelines) with late initiation (American and Canadian guidelines) in adults in the intensive care unit (ICU) to supplement insufficient enteral nutrition. In 2312 patients, parenteral nutrition was initiated within 48 hours after ICU admission (early-initiation group), whereas in 2328 patients, parenteral nutrition was not initiated before day 8 (late-initiation group). A protocol for the early initiation of enteral nutrition was applied to both groups, and insulin was infused to achieve normoglycemia.

RESULTS: Patients in the late-initiation group had a relative increase of 6.3% in the likelihood of being discharged alive earlier from the ICU (hazard ratio, 1.06; 95% confidence interval [CI], 1.00 to 1.13; P=0.04) and from the hospital (hazard ratio, 1.06; 95% CI, 1.00 to 1.13; P=0.04), without evidence of decreased functional status at hospital discharge. Rates of death in the ICU and in the hospital and rates of survival at 90 days were similar in the two groups. Patients in the late-initiation group, as compared with the early-initiation group, had fewer ICU infections (22.8% vs. 26.2%, P=0.008) and a lower incidence of cholestasis (P<0.001). The late-initiation group had a relative reduction of 9.7% in the proportion of patients requiring more than 2 days of mechanical ventilation (P=0.006), a median reduction of 3 days in the duration of renal-replacement therapy (P=0.008), and a mean reduction in health care costs of €1,110 (about $1,600) (P=0.04).

CONCLUSIONS: Late initiation of parenteral nutrition was associated with faster recovery and fewer complications, as compared with early initiation. (Funded by the Methusalem program of the Flemish government and others; EPaNIC ClinicalTrials.gov number, NCT00512122.).

EPaNIC trial

- Critically ill patients receiving late supplemental parenteral nutrition were more likely to be discharged alive and earlier from the ICU compared to standard care.
- There was no difference in the mortality rates in hospital or at 90 days.

J Vet Intern Med 2003;17:791–798

Effect of Early Enteral Nutrition on Intestinal Permeability, Intestinal Protein Loss, and Outcome in Dogs with Severe Parvoviral Enteritis

Albert J. Mohr, Andrew L. Leisewitz, Linda S. Jacobson, Jörg M. Steiner, Craig G. Ruaux, and David A. Williams

A randomized, controlled clinical trial investigated the effect of early enteral nutrition (EN) on intestinal permeability, intestinal protein loss, and outcome in parvoviral enteritis. Dogs were randomized into 2 groups: 15 dogs received no food until vomiting had ceased for 12 hours (mean 50 hours after admission; NPO group), and 15 dogs received early EN by nasoesophageal tube from 12 hours after admission (EEN group). All other treatments were identical. Intestinal permeability was assessed by 6-hour urinary lactulose (L) and rhamnose (R) recoveries (%L, %R) and L/R recovery ratios. Intestinal protein loss was quantified by fecal α_1-proteinase inhibitor concentrations (α_1-PI). Median time to normalization of demeanor, appetite, vomiting, and diarrhea was 1 day shorter for the EEN group for each variable. Body weight increased insignificantly from admission in the NPO group (day 3: 2.5 ± 2.8%; day 6: 4.3 ± 2.3%; mean ± SE), whereas the EEN group exhibited significant weight gain (day 3: 8.1 ± 2.7%; day 6: 9.7 ± 2.1%). Mean urinary %L was increased, %R reduced, and L/R recovery ratios increased compared to reference values throughout the study for both groups. Percent lactulose recovery decreased in the EEN group (admission: 22.6 ± 8.0%; day 6: 17.9 ± 2.3%) and increased in the NPO group (admission: 11.0 ± 2.6%; day 6: 22.5 ± 4.6%, P = .035). Fecal α_1-PI was above reference values in both groups and declined progressively. No significant differences occurred for %R, L/R ratios, or α_1-PI between groups. Thirteen NPO dogs and all EEN dogs survived (P = .48). The EEN group showed earlier clinical improvement and significant weight gain. The significantly decreased %L in the EEN versus NPO group might reflect improved gut barrier function, which could limit bacterial or endotoxin translocation.

Key words: Alpha$_1$-proteinase inhibitor; Canine; Gut barrier function; Lactulose; Rhamnose.

- Compared early RN (w/in 12 hours) vs NPO group (fed >12 hours)
- Assessed intestinal permeability by differential urinary sugar recovery of lactulose and L-rhamnose
- Early EN of dogs with severe CPV enteritis was associated with more rapid clinical improvement
- Increased in body weight in early EN = reduced catabolism quicker
- Decreased in urine lactulose in early EN group = improved gut tight junctions

Retrospective Study

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Early nutritional support is associated with decreased length of hospitalization in dogs with septic peritonitis: A retrospective study of 45 cases (2000–2009)

Debra T. Liu, DVM; Dorothy C. Brown, DVM, MSCE, DACVS and Deborah C. Silverstein, DVM, DACVECC

Abstract

Objective – To determine whether the timing and route of nutritional support strategy affect length of hospitalization in dogs with naturally occurring septic peritonitis.
Design – Retrospective study encompassing cases from 2000 to 2009.
Setting – University teaching hospital.
Animals – Forty-five dogs that survived septic peritonitis.
Interventions – None.
Measurements and Main Results – Nutritional strategy for each dog was categorized as either enteral nutrition (EN: free choice voluntary eating or assisted tube feeding) or central parenteral nutrition (CPN). Early nutritional support was defined as consistent caloric intake initiated within 24 hours postoperatively. Consistent caloric intake occurring after 24 hours was defined as delayed nutritional support. Data reflective of nutritional status included body condition score, serum albumin concentration, and duration of inappetence before and during hospitalization. Body weight change from the beginning to the end of hospitalization was calculated. A modified Survival Prediction Index 2 score was calculated for each dog at admission. Additional clinical data recorded for comparison of illness severity included indicators of severe inflammation (eg, presence of toxic changes in neutrophils and immature neutrophils), coagulopathy (eg, prolonged prothrombin time and activated partial thromboplastin time), the use of vasopressors and blood transfusions, and presence of concurrent illnesses. Nutrition-related complications were classified as mechanical, metabolic, or septic complications. Multivariate linear regression analyses were used to determine the relationship of nutritional strategy with hospitalization length, while considering the presence of nutrition-related complications, the nutritional status- and illness severity-related variables. While controlling for other variables, dogs that received early nutrition had significantly shorter hospitalization length (by 1.6 days). No statistically significant association was found between route of nutrition and hospitalization length. The presence of concurrent illnesses and nutrition-related metabolic complications were also associated with longer hospitalization length (by 2.1 and 2.4 days, respectively).
Conclusions – Early nutritional support in dogs with septic peritonitis is associated with a shorter hospitalization length.

- Dogs receiving early nutrition (within 24 hours post-op) had significantly shorter hospital stays (1.6 days)
- No association found in route of nutrition and hospitalization length
- Mechanisms by which nutrition decreases LOH:
    - Hormonal modulation attenuating the hypermetabolic response
    - Preservation of hepatic antioxidant defense
    - Prevention of protein-caloric malnutrition and its complications
    - Maintain GI barrier and is associated w/ improve blood flow to GIT, liver and kidneys

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RETROSPECTIVE STUDY

Veterinary Emergency and Critical Care
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Retrospective evaluation of the route and timing of nutrition in dogs with septic peritonitis: 68 cases (2007–2016)

Kristin M. Smith DVM, DACVECC | Aaron Rendahl PhD | Yiwen Sun | Jeffrey M. Todd DVM, DACVECC

Veterinary Medical Center, University of Minnesota, St Paul, MN

Correspondence
Dr. Kristin Smith, Central Hospital for Veterinary Medicine, 4 Devine Street, North Haven, CT 06473.
Email: kristinsmithdvm@gmail.com

Abstract

Objective: To determine the impact of route of nutrition on length of hospitalization and survival to discharge in dogs with septic peritonitis.

Design: Retrospective study from 2007 to 2016.

Setting: University teaching hospital.

Animals: Sixty-eight dogs with septic peritonitis that survived ≥48 hours.

Interventions: None.

Measurements and Main Results: Nutritional strategy was categorized into 1 of 4 groups: voluntary, feeding tube, parenteral (PN), and combined feeding tube and PN. Body weight, body condition score, time without caloric intake before and during hospitalization, length of hospitalization, and percentage of resting energy requirements provided during the first 3 days of nutritional support were recorded. Overall, 54/68 dogs survived (79%). Survival Prediction Index 2 scores were not significantly different between groups. Dogs receiving PN only were less likely to survive than those receiving any enteral nutrition (OR 9.7; 95CI 1.84–58.75). Compared to dogs not receiving PN, dogs receiving any PN were significantly less likely to survive (OR 9.66; 95% CI 1.7–105.8), and were in hospital significantly longer ($P = 0.025$). Metabolic complications associated with PN were frequent but not associated with increased length of hospitalization or survival to discharge.

Conclusions: Dogs with septic peritonitis that received any PN were in hospital longer and less likely to survive but may have been sicker than those receiving other forms of nutritional support. Further studies are warranted to evaluate reasons for worse outcomes in dogs with septic peritonitis receiving PN.

- Dogs that received PN were sicker (needed vasopressor and blood products, lower albumin, longer LOH) and were less likely to survive
- Dogs receiving voluntary feedings significantly more likely to survive than dogs receiving assisted nutrition
- For each day w/o caloric intake in hospital, LOH increased by 0.6 $\pm$ 0.3 days

Retrospective Study

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Retrospective evaluation of the impact of early enteral nutrition on clinical outcomes in dogs with pancreatitis: 34 cases (2010–2013)

Jessica P. Harris, DVM; Nolie K. Parnell, DVM, DACVIM; Emily H. Griffith, PhD and Korinn E. Saker, MS, DVM, PhD, DACVN

Abstract

Objective – To evaluate the effect of early enteral nutritional therapy on time to return to voluntary intake, maximum food consumption, incidence of gastrointestinal intolerance (GI), and total hospitalization time for dogs with acute pancreatitis.
Design and Setting – Retrospective analysis of dogs with pancreatitis at a veterinary teaching hospital between 2010 and 2013.
Animals – Thirty-four client-owned dogs diagnosed with acute or acute-on-chronic pancreatitis.
Procedures and Interventions – Medical records of dogs evaluated for inappetence, anorexia, and GI for which a diagnosis of pancreatitis was recorded were reviewed. The time to initiation of food offerings since hospitalization were recorded in addition to signalment, historical medical conditions, chief complaint, physical examination findings, diagnostic results, treatments provided, timing of food offering (within 48 h of hospitalization, early feeding group (EFG) versus delayed feeding group (DFG), diet therapy (low fat versus high fat), caloric intake (% resting energy requirement), incidence of GI (%), and length of hospitalization (LOH) (days). A Clinical Severity Index Score (CSIS) was determined for each patient.
Measurements and Main Results – Dogs in the EFG demonstrated a decreased time to return of voluntary intake (2.1 days, EFG versus 2.7 days, DFG; $P = 0.05$) and time (days) to maximum intake (3, EFG versus 3.4 DFG) as compared to the DFG dogs. The DFG exhibited more GI versus EFG irrespective of CSIS grouping (60% versus 26%, $P = 0.04$). A CSIS ≥ 7 was associated with prolonged LOH ($P = 0.004$); however, time to initiation of feeding and diet selection did not impact LOH ($P = 0.8$).
Conclusions and Clinical Relevance – Results of the study suggested that feeding within 48 hours of hospitalization for canine pancreatitis has a positive impact on return to voluntary intake and decreases the frequency of GI in these patients, independent of CSIS. The traditional protocol of withholding food during hospitalization may not be necessary nor yield the most benefit for patient recovery; subsequently early enteral refeeding should be considered.

- Early feeding group (within 48 hours) had quicker return to voluntary intake and reached maximum intake faster than late group
    - Presence of intraluminal nutrients may stimulate central hunger impulses via neurologic signaling pathways
- No difference in LOH

ENTERAL OR PARENTERAL NUTRITION?

EN VS. PN?

- EN is preferred
- Enteral feeding and gut stimulation can:
  - Stimulate mucosal regeneration via growth factors and stimulated mucosal blood flow
  - Decreased splanchnic cytokine production
  - Modulate acute phase response
  - Decreased catabolism
  - Preserve protein
  - Decreased bacterial translocation
- **CALORIES trial:** no difference in mortality between EN vs PN

ASPEN + SCCM GUIDELINES

Clinical Guidelines

aspen | LEADING THE SCIENCE AND PRACTICE OF CLINICAL NUTRITION
American Society for Parenteral and Enteral Nutrition

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Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.)

Stephen A. McClave, MD[1*]; Beth E. Taylor, RD, DCN[2*]; Robert G. Martindale, MD, PhD[3]; Malissa M. Warren, RD[4]; Debbie R. Johnson, RN, MS[5]; Carol Braunschweig, RD, PhD[6]; Mary S. McCarthy, RN, PhD[7]; Evangelia Davanos, PharmD[8]; Todd W. Rice, MD, MSc[9]; Gail A. Cresci, RD, PhD[10]; Jane M. Gervasio, PharmD[11]; Gordon S. Sacks, PharmD[12]; Pamela R. Roberts, MD[13]; Charlene Compher, RD, PhD[14]; and the Society of Critical Care Medicine[†] and the American Society for Parenteral and Enteral Nutrition[†]

ASPEN + SCCM GUIDELINES

- Initiate EN within 24-48hr if patients who are able to maintain voluntary intake
- Withhold EN until patient is hemodynamically stable and be used in caution in patients weaning off vasopressors (concern for gut ischemia)
- Utilizing EN exclusively until day 7, at which PN should be considered if unable to meet >60% of energy requirement by EN

COMPLICATIONS OF PN

COMPLICATIONS OF PN

- Mechanical complications
  - Peripheral venous thrombophlebitis
- Metabolic complications
  - Refeeding syndrome
- Septic complications

MECHANICAL COMPLICATIONS

- Occurs ~25-46% of veterinary studies
- Catheter dislodgement, catheter disconnection, catheter occlusion, chewed lines, occluded lines and thrombophlebitis

PERIPHERAL VENOUS THROMBOPHLEBITIS (PVT)

- Inflammation of limb, venous thrombosis, extravasation of solution, and failure of IV injection tubing
- In human medicine, PVT is the reason why PPN isn't used more often
- Pathogenesis:
  - Damage to venous wall and endothelium
  - Fibrin, WBC, RBC and platelets adhere to the catheter within few hours
  - Endothelial damage → venoconstriction → decreased venous dilution of infusion solution
  - Local release of inflammatory vasoactive mediators → escalate inflammatory response, incr platelet aggregation → thrombosis

PERIPHERAL VENOUS THROMBOPHLEBITIS (PVT)

- Ways to reduce PVT development
  - Use small-bore, silicone catheters
  - Ensure catheter tips residing away from a joint
  - Shorten duration of catheter being in situ
  - Administer PN for 12 hours
  - Use solution with < 600-750 mOsm/L
  - Use solution with lipids, as they may have protective effect on venous endothelial wall

METABOLIC COMPLICATIONS

- Transient hyperglycemia most common
- Others include hypertriglyceridemia, increased BUN, hypoglycemia, hyperbilirubinemia, increased ALP
- Refeeding syndrome

Table 130-1 **Conditions that Can Predispose Patients Receiving PN to Metabolic Complications.**

Complication	Predisposing Conditions
Hyperglycemia	Diabetes mellitus, hyperadrenocorticism
Lipemia	Pancreatitis, idiopathic hyperlipidemia, diabetes mellitus, hyperadrenocorticism
Azotemia	Renal failure
Hyperammonemia	Hepatic failure, portosystemic shunt
Refeeding syndrome (hypokalemia, hypophosphatemia and/or hypomagnesemia)	Prolonged starvation or catabolic disease, diabetes mellitus

REFEEDING SYNDROME

- Syndrome of severe hypophosphatemia, hypokalemia, hypomagnesemia and other electrolytes derangements that can be induced in an anorexic, malnourished patients
- Usually occurs 3 days after feeding
- Hypophosphatemia
  - Pre-existing whole body phosphorus depletion
  - Presence of CHO induces release of insulin → intracellular shift of phosphorus
  - Feeding induces conversion from catabolism to anabolism and insulin release → body utilizes phosphorus → magnifies hypophosphatemia

REFEEDING SYNDROME

- Hypophosphatemia leads to
  - Decreased cardiac contractility (unknown mechanism)
  - Decreased leukocyte function
  - Hypoxic cellular injury 2ry to decr 2,3 DPG in cells and abnormal erythrocytes → neuromuscular dysfunction
  - In severe cases, hemolytic anemia can occur
- Hypokalemia & hypomagnesemia also lead to similar signs seen with hypophosphatemia
  - Occurs mainly d/t increase in insulin and intracellular shift

SEPTIC COMPLICATIONS

- Occurs rarely (<7%)
- Catheter-related infections are the main concern
- Occurrence largely prevented by practicing aseptic technique when handling PN solution and catheter

ANY QUESTIONS?