TPN BASICS FOR THE HOSPITAL PHARMACIST

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Centre des sciences de la santé de Kingston

MALNUTRITION IN HOSPITALS

- 45 % of patients in Canada are malnourished at admission
- Independently associated with increased costs and length of stay
- Nutrition care can reduce malnutrition and the associated morbidity and mortality
- The Canadian Nutrition Screening Tool is a quick tool to identify patients at risk – 2 questions on admission
- Early intervention ideal - PN is just one type of nutrition support
- At KHSC, ~500 bed hospital approximately 5-15 patients may receive (PN) at any given time
- Major guidelines ESPEN and ASPEN
- No specific “C”SPEN, however some work in critical care nutrition

COHORT STUDY FROM THE CANADIAN MALNUTRITION TASK FORCE. *JPEN J PARENTER ENTERAL NUTR* 2016;40:487-97. ALLARD JP, KELLER H, JEEJEEBHOY KN, ET AL. MALNUTRITION AT HOSPITAL ADMISSION — CONTRIBUTORS AND EFFECT ON LENGTH OF STAY. A PROSPECTIVE

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Special Report

Safe Practices for Parenteral Nutrition

Task Force for the Revision of Safe Practices for Parenteral Nutrition: Jay Mirtallo, MS, RPh, BCNSP, Chair, Todd Canada, PharmD, BCNSP, Deborah Johnson, MS, RN, Vanessa Kumpf, PharmD, BCNSP, Craig Petersen, RD, CNSD, Gordon Sacks, PharmD, BCNSP, David Seres, MD, CNSP, and Peggi Guenter, PhD, RN, CNSN

APPROVED BY A.S.P.E.N. BOARD OF DIRECTORS JULY 21, 2004

Clinical Guidelines

A.S.P.E.N. Clinical Guidelines: Parenteral Nutrition Ordering, Order Review, Compounding, Labeling, and Dispensing

Joseph I. Boullata, PharmD, RPh, BCNSP, FASPEN[1]; Karen Gilbert, RN, MSN, CNSC, CRNP[2]; Gordon Sacks, PharmD, BCNSP, FCCP[3]; Reginald J. Labossiere, MD[4]; Cathy Crill, PharmD, BCNSP[5]; Praveen Goday, MD, MBBS, CNSC[6]; Vanessa J. Kumpf, PharmD, BCNSP[7]; Todd W. Mattox, PharmD, BCNSP[8]; Steve Plogsted, PharmD, BCNSP, CNSC[9]; Beverly Holcombe, PharmD, BCNSP, FASHP[10]; and the American Society for Parenteral and Enteral Nutrition

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jpen.sagepub.com
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online.sagepub.com

BOULLATA ET AL. 2014 FEBRUARY14 JPEN. A.S.P.E.N. CLINICAL GUIDELINES: PARENTERAL NUTRITION ORDERING, ORDER REVIEW, COMPOUNDING, LABELING, AND DISPENSING (JPEN.SAGEPUB.COM)
AYERS ET AL. 2013 A.S.P.E.N. PARENTERAL NUTRITION SAFETY CONSENSUS RECOMMENDATIONS: JPEN VOLUME 38, (3): 296-333

BACKGROUND

- 1665 Sir Christopher Wren
  - administered IV wine/ale to dogs
- 1712 trial of olive oil infusion in dogs
- 1896 high dextrose in central vein in dogs
- 1904 PN SC - abandoned as too painful
- 1937 trials of olive oil infusion, spirits
- 1964 lipid emulsions banned 2nd AE
- 1975 purified soybean formulations
- 1978 Micronutrients needs identified
- olive oil has made a comeback
- Containers from glass to PVC
- 2 in 1 to 3 in 1

SHAMSUDDIN, AF. BRIEF HISTORY AND DEVELOPMENT OF PARENTERAL NUTRITION SUPPORT. MALAYSIAN JOURNAL OF PHARMACY 2003; 1(3): 67-75

HTTPS://ONLINE.FINDGIFT.COM/GIFT-IDEAS/PERSONALIZED-PHARMACIST-CARTOON-PRINT-PID-274107/

DISCLAIMER

Presenter is ***NOT*** an expert in this subject area

Presenter is interested in sharing knowledge regarding total parenteral nutrition

No conflicts of interest to disclose

SCOPE OF PRESENTATION

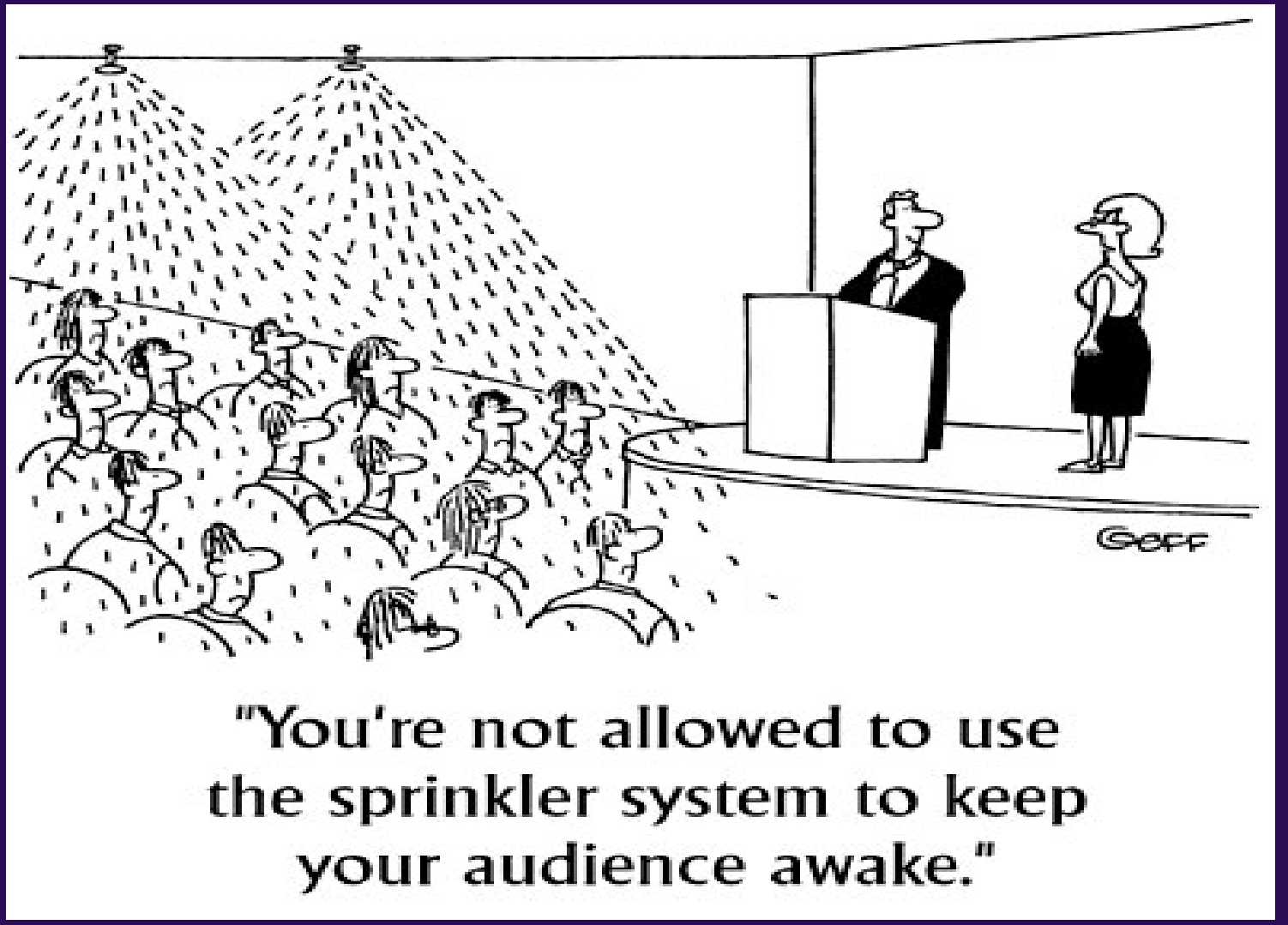
- Adult patients only
- Recognition of many different hospital practices
- Specific compounding/stability issues will not be addressed
- Complex issues will not be presented

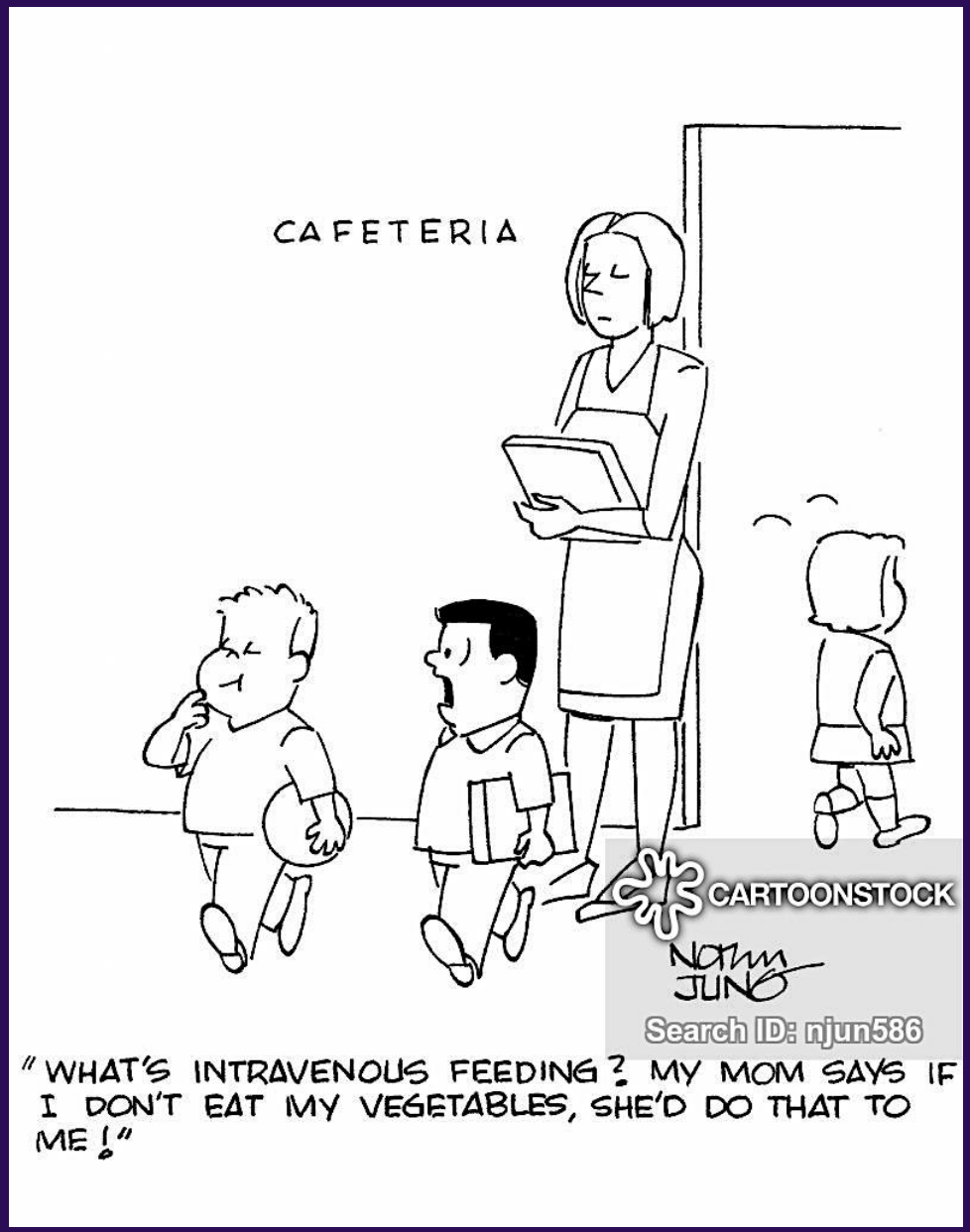
LEARNING OBJECTIVES

- Describe components and administration requirements for PN in adult patients
- Develop pharmacist clinical role in PN management

OUTLINE

- Overview of PN
  - Goals and Indications
  - Composition and Formulation
  - Delivery and monitoring
  - Complications
- Pharmacists' roles related to PN
- Case presentation and discussion

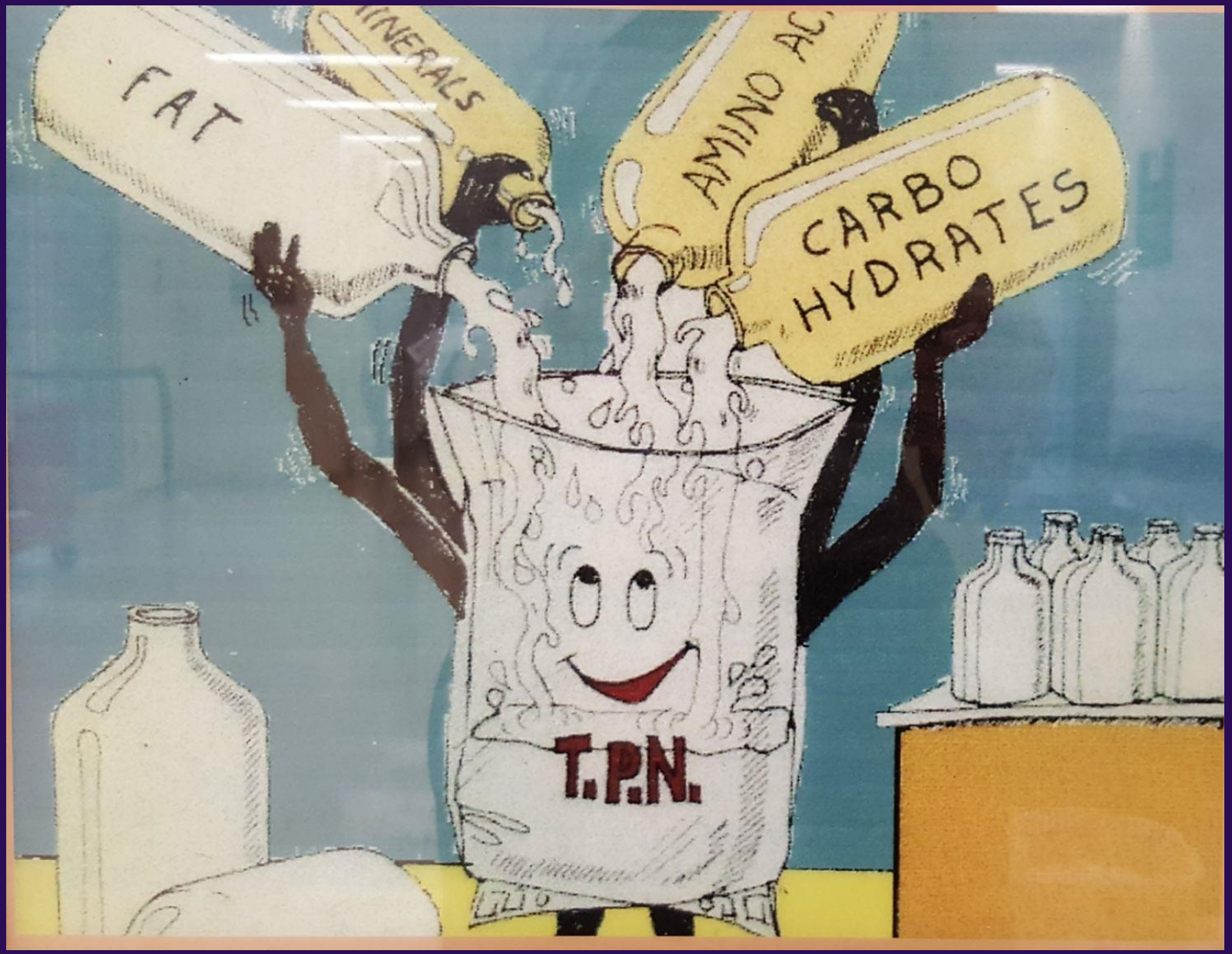




THE GOALS OF PN

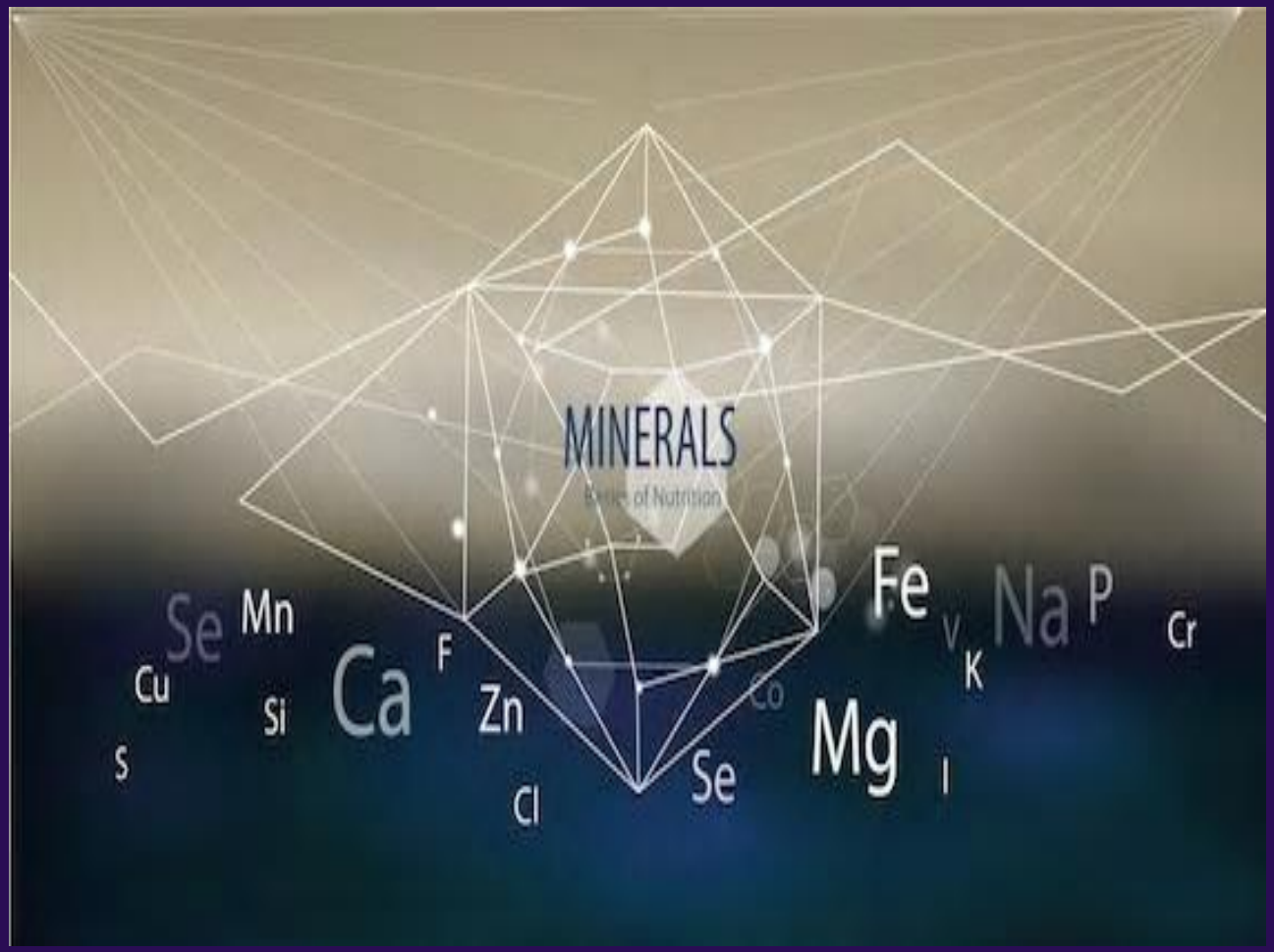
- Maintain adequate nutrition
- Support anabolism and nitrogen balance
- Prevent abnormalities or deficiencies with:
  - Fluids
  - Electrolytes
  - Vitamins and trace elements

HTTPS://WWW.CARTOONSTOCK.COM/DIRECTORY/I/INTRAVENOUS_FEEDING.ASP



HTTPS://WWW.RN101.NET/SINGLE-POST/2018/03/03/NURSING-CARE-FOR-PATIENTS-RECEIVING-TOTAL-PARENTERAL-NUTRITION-TPN

Micronutrients:
Vitamins, Minerals, and Electrolytes



STANDARD ELECTROLYTES

Table 5. Suggested Intravenous Electrolyte Doses for Adults.[5,25]

Electrolyte	Maintenance Range[a]	Intake Maximums[b,c]
Sodium	1–2 mEq/kg/d	150 mEq/L
Potassium	1–2 mEq/kg/d	240 mEq/d
Calcium	10–15 mEq/d	25 mEq/d
Magnesium	8–20 mEq/d	48 mEq/d
Phosphate	20–40 mmol/d	60 mmol/d
Chloride/acetate	Change to maintain acid base balance	

[a]These requirements are based on healthy people with normal losses.
[b]Suggested maximums may vary depending a facility policies. Compounding limitations may not allow for additions at maximum threshold.
[c]Intake maximums are to be used as a guide to help the practitioner with safe electrolyte dosing and avoid potential error but should not supersede clinical judgment.

STANDARD MULTIVITAMINS

- Adult: (based on RDA)
- Multi – 12
  - Multi-12 with vitamin K in the USA only
  - Vitamin K 150 mcg per day required
    - can be given daily or weekly
  - Pediatric Multivitamins contain vitamin K
  - Not contained or inadequate amounts in PN (vitamin D, iron)

Fat soluble vitamins :

- Vitamin A (retinol) 3300 units
- Vitamin D (ergocalciferol) 200 units
- Vitamin E 10 units

Water Soluble Vitamins

- Vitamin C (ascorbic acid) 100 mg
- Niacinamide 40 mg
- Vitamin B2 3.6 mg
- Vitamin B1 (thiamine) 3 mg
- Vitamin B6 (pyridoxine HCl) 4 mg
- Dexpanthenol 15 mg
- Biotin 60 mcg
- Folic acid 400 mcg
- Vitamin B12 (cyanocobalamin) 5 mcg

TRACE ELEMENTS

	Micro+4 conc® per mL	Micro+6 conc® per mL	RDA 2009 (ASPEN)	RDA 2019 (ASPEN)
Zinc	5 mg	5 mg	2-5 mg	3-5 mg
Selenium	-	60 mcg	20-60 mcg	60-100 mcg
Copper	1 mg	1 mg	0.3-0.5 mg	0.3-0.5 mg
Chromium	10 mcg	10 mcg	10-15 mcg	< 1000 mcg
Manganese	0.5 mg (500 mcg)	0.5 mg (500 mcg)	60-100 mcg	55 mcg
Iodine	-	75 mcg	n/a	n/a

Available products do not match the recommended daily allowances (RDA) for adults
One dose daily is recommended; one dose is usually 1 mL

FORMULATION

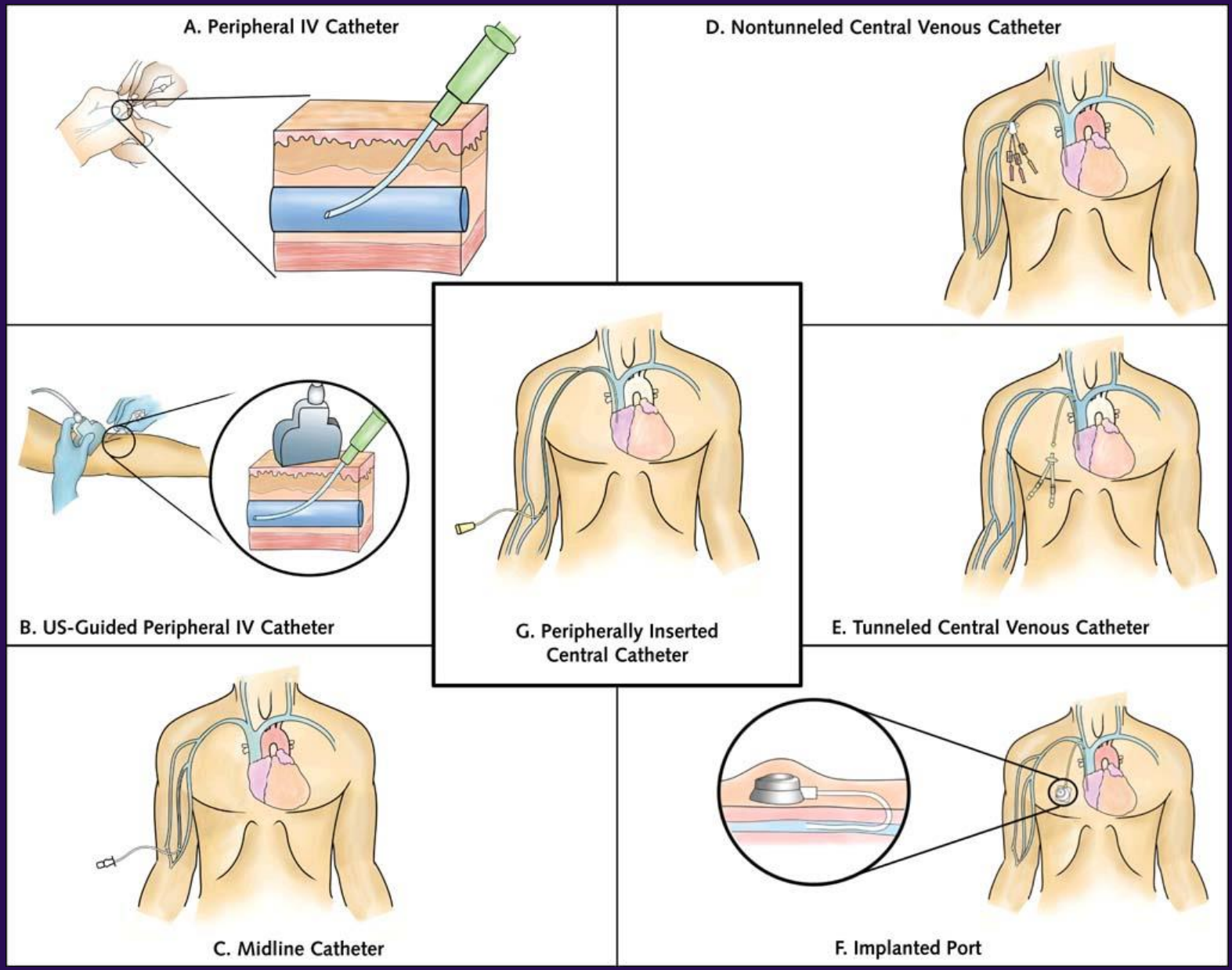
- Multi-chamber bags versus compounded
- 2-in-one and 3-in-one
- Fat emulsion differences

HTTPS://DIAMEDICALUSA.COM/MEDICAL-EQUIPMENT/SPECIAL/MONTHLY-SPECIALS/PRACTI-TPN-BAG-VITAMINS/

HTTP://GWEBBYVERSE.BLOGSPOT.COM/2016/02/

TRUE or FALSE?

ALL CENTRAL LINE TIPS END UP IN THE SAME ANATOMICAL LOCATION ?


A. Peripheral IV Catheter
D. Nontunneled Central Venous Catheter
B. US-Guided Peripheral IV Catheter
G. Peripherally Inserted Central Catheter
E. Tunneled Central Venous Catheter
C. Midline Catheter
F. Implanted Port

DELIVERY

Central lines (most common)

- PICC, Hickman, central line(IJ), port-a-cath

Peripheral (rare)

- Can only infuse up to 10% dextrose or 900mOsm/L

Filters

- 0.22 micron for amino acid and dextrose solution (2 in 1)
- 1.2 micron required when infusing lipids or 3 in 1

Timing of lipid infusion administration

Protect from light?

TABLE 7-3. Monitoring for Adult Patients on Parenteral Nutrition

Parameter	Initial	Daily	Weekly
Anthropometric			
Weight	x	x	x
Height	x		
Physical examination	x	x	
Intake and output	x	x	
Metabolic assessment			
Na, K, Cl, CO_2	x	x[a]	x
Ca, Phos, Mg	x	x[a]	x
Glucose	x	x[a]	x
BUN/SCr	x	x[a]	x
Liver function tests	x		x
Prothrombin time	x		x
Prealbumin	x		x
Triglycerides	x[b]		x
Complete blood count	x	x[a]	x
Nitrogen balance	As needed	As needed	As needed
Indirect calorimetry	As needed	As needed	As needed

BUN, blood urea nitrogen; Phos, phosphate; SCr, serum creatinine.

[a]Daily until stable, then once or twice weekly.

[b]Initially and before each advancement of intravenous fat emulsions, then once weekly. If septic, more frequent monitoring is prudent.

KHSC ORDER SET PARENTERAL NUTRITION MONITORING

Vitals

☒ Baseline height and weight before starting PN
☒ Weigh weekly every Monday. Discontinue when PN discontinued

Lines

☒ PICC line (double lumen) or central line insertion
☒ Change amino acid/dextrose and fat emulsion infusion set every 24 hours

Lab Investigations

Before starting PN (if not already done):
☒ CBC, PTT, PT/INR, Na, K, Cl, creatinine, glucose, calcium, magnesium, phosphate, ALT, ALP, total bilirubin, albumin, triglycerides

THEN daily for 5 days. Discontinue when PN discontinued:
☒ Na, K, Cl, creatinine, glucose, calcium, magnesium, phosphate

THEN every Monday. Discontinue when PN discontinued:
☒ CBC for 1 month, then reassess
☒ Na, K, Cl, creatinine, glucose, calcium, magnesium, phosphate
☒ ALP, total bilirubin, albumin, triglycerides, ALT

Additional Lab Investigations

☒ Capillary blood glucose q6 h until target rate achieved, then physician to reassess frequency

PN solution

☒ Change amino acid/dextrose solution every 24 hours (maximum hang time 24 hours)

MRS. T.

- 89 female
- 45 kg (recent wt loss)
- DM2 (no meds)
- HTN
- AFIB, CHADS 5-6
- *CrCl* 0.63 mL/sec (37 mL/min)
- Home medications:
  - Apixaban 5 mg po bid
  - Metoprolol 25 mg po bid
  - Valsartan 40 mg po daily
  - Furosemide 40 mg po daily
  - Potassium 16 mmol po daily
  - Magnesium oxide 420 mg po bid
  - Vitamin D, calcium, iron

Course in hospital:

- Day 0 admission with Bowel obstruction – NPO - NG tube
- Day 10 - TPN to start

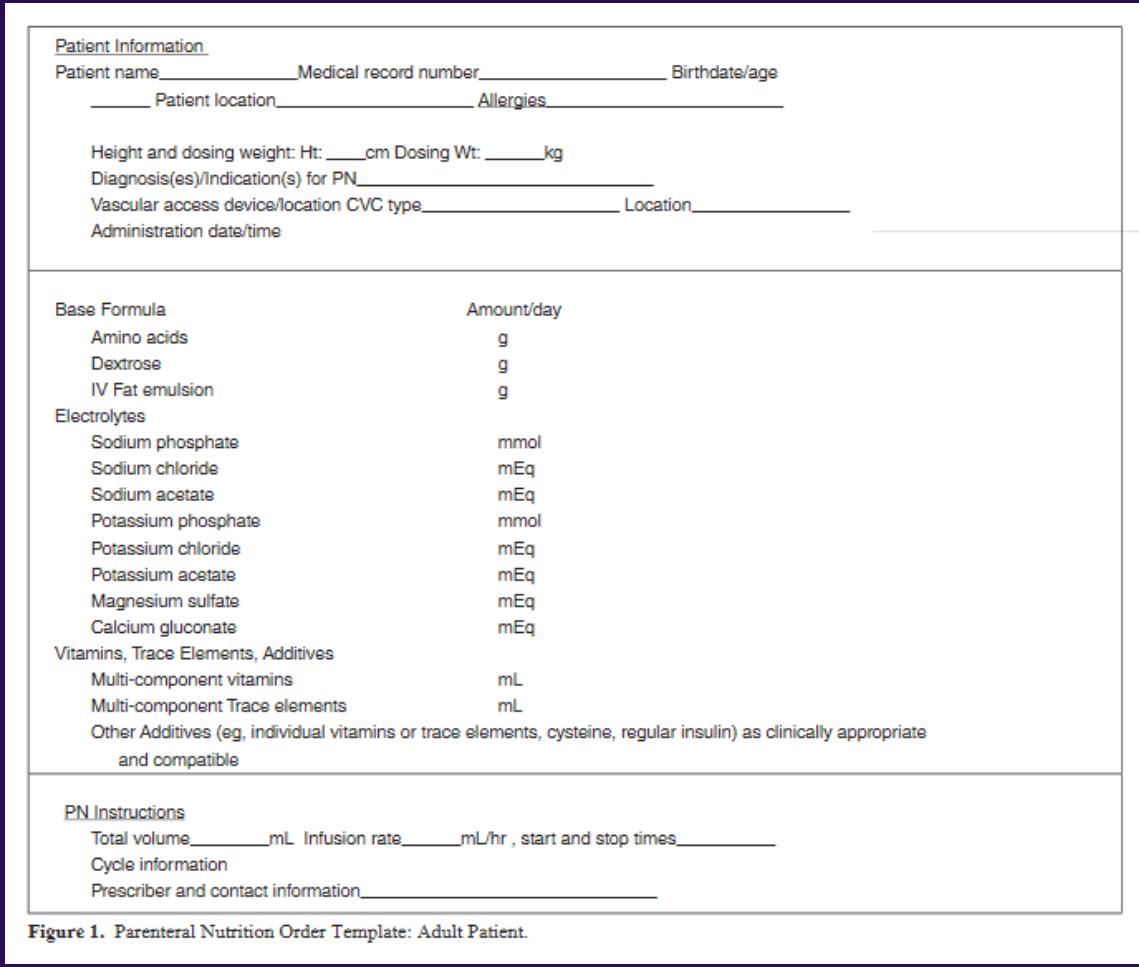
TPN INITIATION

- Amino acid and dextrose via PICC @ 25 mL/h x 24 hours, then increase by 10 mL/h every 24 hours until goal rate 70 mL/h
- Lipid infusion 20% at 15mL/h x 12 hours daily
- Standard electrolytes

SAFE PRESCRIBING

- High alert medication
- Standardized orders (solution and monitoring)
- Hospital policies
- Pharmacy procedures
- RN/MD education

SAMPLE ASPEN ORDER TEMPLATE



Patient Information

Patient name_____Medical record number_____ Birthdate/age

_____ Patient location_____ Allergies_____

Height and dosing weight: Ht: ____cm Dosing Wt: _____kg

Diagnosis(es)/Indication(s) for PN_____

Vascular access device/location CVC type_____ Location_____

Administration date/time

Base Formula	Amount/day
Amino acids	g
Dextrose	g
IV Fat emulsion	g
Electrolytes	
Sodium phosphate	mmol
Sodium chloride	mEq
Sodium acetate	mEq
Potassium phosphate	mmol
Potassium chloride	mEq
Potassium acetate	mEq
Magnesium sulfate	mEq
Calcium gluconate	mEq
Vitamins, Trace Elements, Additives	
Multi-component vitamins	mL
Multi-component Trace elements	mL

Other Additives (eg, individual vitamins or trace elements, cysteine, regular insulin) as clinically appropriate and compatible

PN Instructions

Total volume_____mL Infusion rate_____mL/hr , start and stop times_____

Cycle information

Prescriber and contact information_____

Figure 1. Parenteral Nutrition Order Template: Adult Patient.

KHSC PPO

Amino Acid and Dextrose Solution (Choose one)

- ☐ Amino acid 5% and dextrose 16.6%
- ☐ Amino acid 5% and dextrose 10%
- ☐ Other: _____

Micronutrient Additives

Potassium and sodium usually ordered as chloride, except in circumstances of hyperchloremia

Electrolyte	☐ Standard	☐ Non-Standard
Calcium	2.25 mmol/L	_____ mmol/L
Magnesium	2.5 mmol/L	_____ mmol/L
Sodium	35 mmol/L	_____ mmol/L ☐ Chloride ☐ Acetate
Potassium	40 mmol/L	_____ mmol/L ☐ Chloride ☐ Acetate
Phosphate	15 mmol/L	_____ mmol/L
Multivitamins (Multi-12®)	10 mL daily	10 mL daily

Trace element	☐ Standard (Micro Plus 6 Concentrate® 1 mL)	☐ Non-Standard
Chromium	10 mcg/day	_____ mcg/day
Copper	1 mg/day	_____ mg/day
Manganese	0.5 mg/day	_____ mg/day
Selenium	60 mcg/day	_____ mcg/day
Zinc	5 mg/day	_____ mg/day
Iodide	75 mcg/day	

Micronutrient Additives Continued...

Infusion Rate

- ☐ Initiate amino acid and dextrose infusion IV at 25 mL/h for 6 hours, then increase by 25 mL/h every 6 hours if capillary blood glucose is less than 10 mmol/L, until target rate of _____ mL/h is reached
- ☐ Initiate amino acid and dextrose infusion IV at _____ mL/h for _____ hours, then increase by _____ mL/h every _____ hours if capillary blood glucose is less than 10 mmol/L, until target rate of _____ mL/h is reached
- ☐ cyclic PN regimen: _____
- ☒ If rate is not increased on schedule due to increased blood glucose **THEN** contact physician to obtain insulin orders

Fat Emulsion

- ☐ No fat emulsion
- ☐ 20% fat emulsion *(choose one)*
  - ☐ ClinOleic® *(Contraindicated with egg, soy or olive oil allergy)* (infuse with 1.2 micron in-line filter)
  - ☐ SMOF® *(Contraindicated with egg, soy, olive oil and fish oil allergy)*
  - ☐ Intralipid® *(Contraindicated with egg or soy Allergy)*

Infusion Rate

- ☐ _____ mL/h for 12 hours daily. Discard remaining solution when complete
- ☐ _____ mL/h for ___ hours _____ (indicate specific days). Discard remaining solution when complete

Additional Supplementation

- ☐ Phytonadione (Vitamin K1) 10 mg IV/subcutaneous weekly on Friday while receiving PN (if patient is not on Warfarin)

PN Interruptions

- ☒ If PN solution is unavailable, run 10% dextrose (D10W) at the prescribed amino acid and dextrose infusion rate and re-start PN infusion as soon as possible
- ☒ If PN interruption is greater than 72 hours new orders are required
- ☒ If PN is interrupted for less than 72 hours resume at previous target rate
- ☒ If PN interruption is anticipated to be greater than 24 hours, notify Pharmacy

PATIENT CASE

Hyperglycemia

HTTPS://DTC.UCSF.EDU/TYPES-OF-DIABETES/TYPE2/TREATMENT-OF-TYPE-2-DIABETES/SELF-MANAGEMENT-SOLUTIONS/HIGH-BLOOD-SUGAR-FAQS/

You follow up on the patient 36 hours later and notice rate is still at 25 mL/h and serum glucose is consistently above 10 mmol/L.

- How will you manage the hyperglycemia ?

HTTPS://MEDTREND.ORG/WHAT-DOES-YOUR-BLOOD-SUGAR-LEVEL-TELL-YOU/

HOW WILL YOU MANAGE HYPERGLYCEMIA?

- Call the doctor/dietitian/diabetes expert
- Reduce dextrose in PN solution
- Initiate a subcutaneous insulin sliding scale
- Initiate a titratable intravenous insulin infusion
- Initiate long acting insulin
- Add insulin to the PN bag

HYPERGLYCEMIA DISCUSSION

- No single ideal recommendation
- Institution specific, may depend on location and monitoring available
  - E.g. ease of running IV insulin infusion (critical care) versus nursing unit
- Insulin sliding scales not effective alone
- Action may depend on whether patient is on continuous or cyclic regimen
- May depend on if insulin dependent or DM2
- Addition directly to bag may be possible if policies support
- Safety of giving long acting insulin and possible PN interruptions
- Order “while on TPN”

MCCULLOUGH A ET AL. ADDITION OF INSULIN TO PARENTERAL NUTRITION FOR CONTROL OF HYPERGLYCEMIA JPEN; JULY 2018 42(5): 846-854; ASPEN PARENTERAL NUTRITION HANDBOOK

HTTPS://DIABETESWELLBEING.COM/DIABETES-COMPLICATIONS/

COMPLICATIONS OF PN

Mechanical :

- Problems with the catheter, air or fat embolism, thrombophlebitis and thrombosis, infusion pump issues

Infectious :

- Frequent complication
- Predisposed due to
  - compromised immunity, cancer, age
  - use of broad spectrum antibiotics
  - poor nutrition
  - solution contamination
  - hyperglycemia
  - indwelling catheter

COMPLICATIONS OF PN

Metabolic/nutritional :

- Electrolyte abnormalities
- Fluid overload/dehydration
- Hyper/hypoglycemia
- Hyperlipidemia
- Hepatic dysfunction
- Acid-base disorders
- Metabolic bone disease
- Vitamin/trace element deficiencies/toxicities

COMPLICATIONS OF PN

- Metabolic/nutritional
  - **Electrolyte abnormalities**
  - Fluid overload/dehydration
  - **Hyper/hypoglycemia**
  - Hyperlipidemia
  - **Hepatic dysfunction**
  - Acid-base disorders
  - Metabolic bone disease
  - Vitamin/trace element deficiencies

ROLE OF HCP'S WITH PN ?

HTTPS://WWW.DREAMSTIME.COM/MEDICINE-DOCTORS-MEDICAL-PHYSICIAN-HOSPITAL-NURSE-DOCTOR-STETHOSCOPE-MEDIC-HEALTHCARE-WORKERS-PROFESSIONAL-DOCTOR-IMAGE131848297

HOSPITAL PHARMACISTS AND PN

Roles will vary by site (presence of NST or not)

- Distribution role:
  - Compounding solutions
  - Calculations for additives
  - Verifying for compatibility (e.g. calcium/phosphate)
  - Adding medications
  - Backorders!
- Other roles?

- Clinical role:
  - Daily monitoring at initiation of therapy until goal rate achieved
  - Weekly monitoring during therapy
  - Correction of abnormalities
  - Managing complications
  - Collaborating for long-term patients (nutritional deficiencies/home PN)

REFEEDING SYNDROME (RFS)

- Serious complication of nutrition support (PN and EN)
  - Metabolic disturbances occurring when nutrition support is initiated in malnourished individuals
  - Hypophosphatemia is the hallmark of RFS.
- Risks:
  - Underweight or recent unintentional weight loss, malnourished or poor nutritional intake 1-2 weeks, starvation, alcoholism, malabsorption
- Preventable
  - Identify patients at risk
  - Slow titration over 3-5 days
  - Baseline blood work and replacements prior to initiation (especially K, Phos, Mg)
    - May require more than daily serum levels in some cases
  - Consider empiric thiamine replacement
  - Monitor until stable at goal rate

MRS. T.

- 89 female
- 45 kg (recent wt loss)
  - DM2 (no med)
  - HTN
  - AFIB, CHADS 5-6
  - *CrCl* 0.63 mL/sec (37 mL/min)
  - Home medications:
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    - Valsartan 40 mg po daily
    - Furosemide 40 mg po daily
    - Potassium 16 mmol po daily
    - Magnesium oxide 420 mg po bid
    - Vitamin D, calcium, iron

Course in hospital:

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- Day 10 - TPN to start

PATIENT CASE

Refeeding

HTTPS://POOH.FANDOM.COM/WIKI/DONKEY_FOR_A_DAY

BASELINE BLOOD WORK

- Potassium 3.1 mmol/L (normal ~ 3.5-5.5)
- Magnesium 0.54 mmol/L (normal ~ 0.67-1.07)
- Phosphate 0.74 mmol/L (normal ~ 0.78 to 1.48)

- Is Mrs. T at risk for refeeding?
- How will you supplement the electrolytes?

PT'S RISK FACTORS FOR REFEEDING

- Low electrolytes at baseline
- 10 days NPO
- Low weight (? Preexisting malnutrition)
- Malabsorption 2nd BO

HOW DO YOU REPLACE THE ELECTROLYTES?

- Increase in PN solution
- IV replacement
- Oral replacement

RFS DISCUSSION - PREVENTION

- Identify patients at risk
- Baseline blood work and replacements prior to initiation (especially K, Phos, Mg)
  - May require more than daily serum levels in some cases
- Slow titration of carbohydrate over 3-5 days
- Consider empiric thiamine replacement
- Monitor until stable at goal rate

WALMSLEY, RS. REFEEDING SYNDROME: SCREENING, INCIDENCE AND TREATMENT DURING PARENTERAL NUTRITION. JOURNAL OF GASTROENTEROLOGY AND HEPATOLOGY. 2013; 28 (SUPPL 4): 113-117

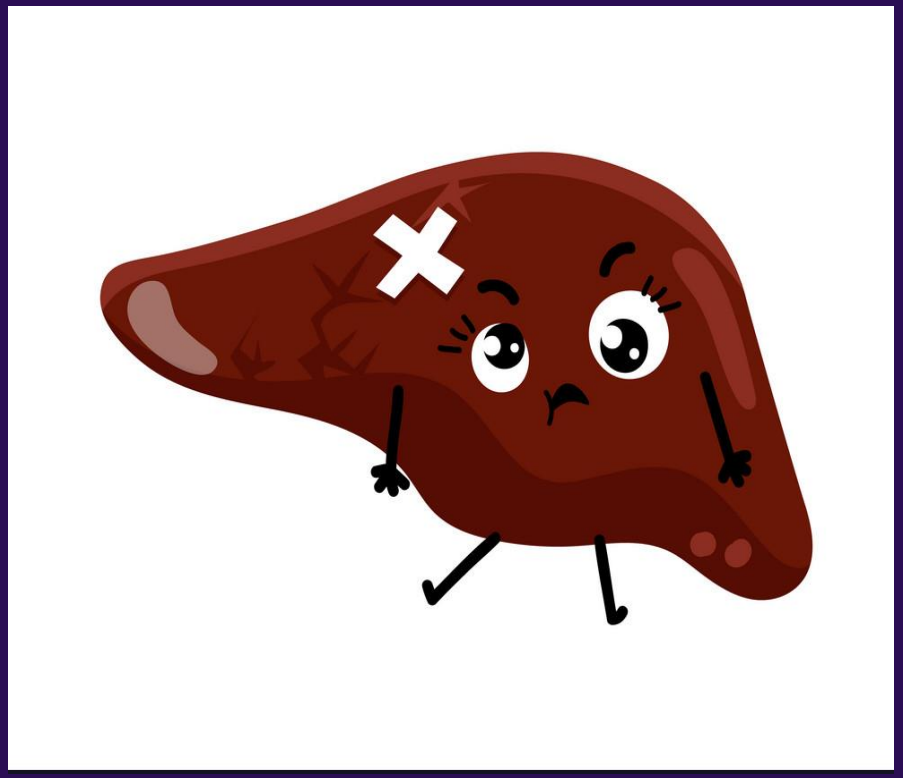
SHOULD WE HAVE GIVEN THIAMINE ?

YES

NO

MAYBE

I DON'T KNOW



PATIENT CASE

Hepatic complications

HTTPS://WWW.VECTORSTOCK.COM/ROYALTY-FREE-VECTOR/HUMAN-SICK-LIVER-CARTOON-CHARACTER-VECTOR-19187441

DAY 23 PN

- Patient at goal rate
- Hyperglycemia under control with insulin glargine
- Electrolytes stable within normal limits with PN solution
- This morning's bloodwork shows abnormal liver panel with increases in transaminases, alkaline phosphatase and bilirubin.
- The team asks you how to manage PN associated abnormal liver panel.

- Assuming there are no other reasons for the changes, what options can you propose to the team?

HEPATIC COMPLICATIONS DISCUSSION

- Less common complication in the short term patient
- Usually around 30 days of therapy (between 1 and 4 weeks)
- Mild elevations in serum liver enzymes, usually less than three times the upper limit of normal rarely leading to development of liver disease
- Can be caused by “overfeeding” causing steatosis
- In patients NPO – bypassing the GI tract not ideal

HEPATIC COMPLICATIONS
OPTIONS FOR PN MODIFICATION

- PNALD – PN associated liver disease includes cholestasis, cholelithiasis and hepatic steatosis.
- Consider reductions in carbohydrate
- Reduce amount of fat emulsion
- Change to a different fat emulsion with less soy content
- Cycling TPN - limited evidence but thought to reduce prolonged hyperinsulinemia
- Allow PO intake if possible or EN

OPTIMAL HOSPITAL PHARMACIST ROLE ?

- Centre specific
- Depends on staffing and number of PN patients
- Identify roles within the team to avoid duplication

SUMMARY

- PN is nutrition support, not meant to be medication delivery or electrolyte replacement (can optimize to a certain extent only)
- Ideally Nutrition Support Teams exist for collaborative practice
- Need regular monitoring, especially at initiation and with nutrition transitions
- Most common abnormalities are refeeding, and glycemic control
- Long term patients may require additional monitoring if longer than 1 month of PN
- Peripheral PN less desired, however formulations do exist with 3-in-1 products
- Look for trends in lab values – frequent errors with blood draws if line contaminated
- Should start slow and taper off
- Check volume – e.g. dehydration if PN only source and ongoing losses may need hydration
- Other future topics – optimal vitamin K, choice of lipids, adjusting micronutrients, compatibilities/stabilities….

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