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Weight-Based Neonatal Total Parenteral Nutrition via EHR in a Tertiary Community Hospital

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| Disclosures

The presenter has no real or perceived conflicts of interest related to this presentation

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Learning Objectives

At the end of this session, participants should be able to:

1. Describe neonatal total parenteral nutrition ordering as typical practice
2. Identify opportunities to implement a multidisciplinary parenteral nutrition approach
3. Discuss opportunities for electronic health records to help optimize nutrition for neonates

Henrico Doctors' Hospital

Forest Campus

- Henrico Doctors' Hospital includes three campuses – Forest, Parham, and Retreat
- Henrico Doctors' Forest Campus
 - 340-bed community hospital located in Richmond, Virginia
 - 41 Neonatal Intensive Care Unit (NICU) beds, Level III
 - 4 Pediatric Intensive Care Unit (PICU) beds, Level II
 - 7 Pediatric beds
 - Over 4,400 infant deliveries in Labor and Delivery Unit
 - Over 35,000 Emergency Department visits in 2020
 - Level II Trauma Center
 - The Heart Center
 - Virginia Transplant Center, specializing in kidney transplants
 - Virginia Institute of Robotic Surgery Center
 - The Sarah Cannon Cancer Institute



Women's Hospital Entrance at
Henrico Doctors' Hospital

Source: Henrico Doctor's Hospital Website, LCP360 Production. February 2017.

Total Parenteral Nutrition Errors Recorded in Literature

- Institute for Safe Medication Practices (ISMP)
 - TPN classified as High Alert
 - Mistakes may not be as common but can be serious to patient
 - Safeguards
 - Standardize
 - Ordering
 - Transcribing
 - Preparation
 - Administration
- American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.)
 - Six week infant died after receiving 60 times amount of sodium
 - Order entry error
 - Infant died after 1,000 fold error of Zinc
 - Order entry error
 - Infant died after not receiving dextrose
 - Prescribing error

Source: ISMP. High-Alert Medications in Acute Care Settings. www.ismp.org. 2018.
Grissinger M. Another tragic parenteral nutrition compounding error. 2014.



TPN Errors: Chew On This

Parenteral Nutrition Safety Issues – April 21, 2020

Sacks, et al – 2009

- Incidence of medication errors 15.6 errors/1000 parenteral nutrition prescriptions compounded
 - Prescription process: 1%
 - Transcription process: 39%
 - Preparation process: 24%
 - Administration process: 35%
- Harm of errors
 - Non-harmful: 91%
 - Temporary harm: 8%

Seres, et al – 2006

- Electrolytes – 71%
- Harm of Errors
 - Increased monitoring: 35%
 - Harm: 25%
 - Almost fatal: 3.3%
 - Fatal: 1.5%



Evolution of Total Parenteral Nutrition Ordering – Henrico Doctors' Hospital

| TPN Background

- Henrico Doctors' Hospital
 - Electronic Health Record (EHR)
 - Meditech version 5.62
- Total Parenteral Nutrition (TPN) Format
 - Neonate, Pediatric and Adult formula ordered daily by provider using paper or electronic format
 - Neonate – PremiEHR Electronic Health Record
 - 25% – 75% facility TPNs are for neonatal patients
 - Pediatric – Paper form from intranet forms
 - Adult – Meditech order entry
- TPN outsourced to compounding facility since July 2018
 - Distance 130 miles
 - Average time for delivery 2 – 3 hours
 - Cut off for TPN submission 1200

| TPN Barriers

- Paper
 - Printing of TPN template
 - Manually writing macro/micronutrients
 - Errors in reading, orders unclear
 - Provider name illegible for clarification
 - Dietitian recommendations missed by provider
 - Lost/missing order form
 - Paper TPN form update delays
- Time
 - Provider unaware of time cutoff, TPN submission missed
 - Between 2019 and 2020, 6 infants did not receive TPN
 - Provider/Nurse time spent to scan order
- Ordering
 - Delay/suboptimal nutrition
 - Delay in healing

Assessment Question #1 of 3

What are some methods for neonatal total parenteral nutrition ordering in healthcare?

- a. Hand-written order
- b. Electronic Health Record direct order entry
- c. Electronic Printed order
- d. All of the above

TPN Exploration & Options

| Neonatal TPN Evolution at Henrico Doctors' Hospital

- November 2018 – PremiEHR to be “sun-setted,” neonatal TPN discussion begun

- Ordering

- Hand write using different paper form
 - Second paper TPN form created for consideration
- Build into Excel sheet
- Purchase TPN program
- Direct entry into Meditech using template designed for NICU

- Does the pharmacist and/or dietitian participate?

- Paper form and Excel option perpetuates current obstacles
- Purchasing is costly
 - Workflow and communication remains same

“I already think people's TPNs seem to be left the same a lot more than I'm used to, and I would have to guess that it'd be even more so IF you left this to the MDs.”

– Neonatal Provider

TPN Exploration of Options

- TPN Options
 - Handwriting paper ordering concern
 - Legibility concerns
 - Nutrient omission
 - Population
 - Barriers remain with paper order systems
 - Purchase of new TPN software system
 - Cost
 - Vetting of safety and pitfalls of program
 - Education required
 - Time to implement
 - Barriers remain with optional order systems
 - EHR build
 - Customize to neonatal needs
 - Current EHR available
 - May expand to pediatrics
 - Real-time submission



| Neonatal TPN Evolution at Henrico Doctor's Hospital

- July – 2019
 - Discussion on Neonatal TPN continues
 - Neonatal TPN planning team developed
 - Clinical pharmacist
 - Clinical pharmacy manager
 - Director of Pharmacy
 - Neonatal ICU Medical Director
 - Neonatal Nurse Director
 - Registered Dietitian
 - Chief Nursing Officer
 - Agreed to modify Meditech adult TPN ordering to neonatal needs
 - Incorporate pharmacist and dietitian
 - Allows real time submission to EHR

Meditech Neonatal TPN Build in Electronic Health Record

Can It Be Done?

- Meditech order entry of Adult TPN in use
 - Standardize order entry template
 - Customizable build similar to previous paper format
 - Real-time submission, available 24 hours a day for processing between 0900 and 1230
 - Order electronically viewable by provider, nurse, pharmacist, dietitian
 - Real-time intervention
- Meditech order entry of Neonatal TPN
 - All of the above plus...
 - Employee time saved
 - Correcting
 - Scanning
 - Retrieving/recall for review
 - Optimize nutrition
 - Days to weeks faster by including ancillary staff
 - Improve extrauterine growth
 - Decreased central line days for surgical patients

Meditech Electronic Medical Record Order Entry Build Begins

Meditech Adult TPN Ordering in EHR – The Conception of Neonatal TPN

Adult TPN entry built as orderable as Set

- TPN consult service, initial and renew available
 - Renew will carry yesterday's TPN
- Option to order now and daily electrolytes, blood glucose checks Q6h

- + Nursing Orders (2/2) 2 reminders	
->Accuchecks Every 6 Hours Until Stable	
<input checked="" type="checkbox"/> + Blood Glucose Monitoring 06/18 N	
->Weights and I/O's - Daily Until Stable	
<input checked="" type="checkbox"/> + Weight: Monitor 06/18 N	
- + Medications : TPN (1/1) 6 reminders	
>>>NOTE: Certain ordered components (i.e. multivitamins, trace elements, lipids, etc.) May be automatically excluded from an order based on the the most current administration schedule for these items, which is adjusted according to product availability and compatibility.<<<	
<input checked="" type="checkbox"/> + zz -TPN Order STAT 06/18 N	
- + Laboratory (9/12) 2 reminders	
->Required Baseline Labs	
<input checked="" type="checkbox"/> + BASIC METABOLIC PROF W/REFLEX STAT 06/18 N	
<input type="checkbox"/> + CBC W/DIFF STAT 06/18 N	
<input type="checkbox"/> + LIVER PROFILE STAT 06/18 N	
<input type="checkbox"/> + TRIGLYCERIDES STAT 06/18 N	
<input type="checkbox"/> + PROTHROMBIN TIME STAT 06/18 N	
<input type="checkbox"/> + PARTIAL THROMBOPLASTIN TIME STAT 06/18 N	
<input type="checkbox"/> + PREALBUMIN STAT 06/18 N	
<input type="checkbox"/> + MAGNESIUM STAT 06/18 N	
<input type="checkbox"/> + PHOSPHOROUS STAT 06/18 N	
Daily Labs X 5 Days	
<input type="checkbox"/> + BASIC METABOLIC PROF W/REFLEX 06/19 AM DAILY X 5	
<input type="checkbox"/> + MAGNESIUM 06/19 AM DAILY X 5	
<input type="checkbox"/> + PHOSPHOROUS 06/19 AM DAILY X 5	

Adult TPN with two Admin screens

Primary Dx	LIVER CANCER	Ht (cm)	182.88	ABW (kg)	103.400	IBW (kg)	77.600		
Anticipated TPN duration	> 48 hours AND								
TPN Indication:	Tleus					Default Last Order?	<input type="checkbox"/>		
Prev day's TPN info				IV line type	CENTRAL				
Kilocalories	1913	Protein (gm)	124.80	TPN Formula Type	CUSTOM				
Dextrose (gm)	268.80	Lipids (gm)	50.00	Infusion Type	CONTINUOUS				
				Continuous Infusion rate (mL/hr)	80				
LIPIDS:				CYCLIC INFUSION:					
Order for today?	<input checked="" type="checkbox"/>	Select Conc:	20%	Begin at		mL/hr over		hrs	
Volume to infuse	250	mL over	24	hrs	Then change to		mL/hr over		hrs
Infuse at	10.4	mL/hr		Then change to		mL/hr over		hrs	
Start time	1800	(if different than TPN)		Start time		Volume to infuse		mL	
Lab results	View PCI		<input type="checkbox"/>	Click to see more Lab results				<input type="checkbox"/>	
Reference	136-145	3.5-5.1	98-107	21.0-32.0	70-110	3.4-5.0	8.5-10.12.5-4.		
DATE	TIME	NA	K	CL	CO2	GLU	ALB	CAL	PHOS

BASE SOLUTION:	: CUSTOM													
Amino Acids	6.50 % or 124.80 GM	Hepatitis		% or		GM								
Dextrose	14.0 % or 268.80 GM													
ADDITIVES (per Liter):	ADDITIVES (per day):													
Sodium Chloride		mEq	Multivitamins (10 mL)	<input checked="" type="checkbox"/>	(Y/N)									
Sodium Acetate	35	mEq	Trace elements (1 mL)	<input type="checkbox"/>	(Y/N)									
Sodium Phosphate		mMol	Folic Acid	1	MG									
Potassium Chloride		mEq	Thiamine	100	MG									
Potassium Acetate	30	mEq	Vit K (phytonadione)		MG									
Potassium Phosphate	20	mMol	Regular insulin	10	Units/Liter									
Calcium Gluconate	4.5	mEq	(Other) TRALEMENT		mL/D									
Calcium Chloride		mEq	(Other)											
Magnesium Sulfate	5	mEq	(Other)											
Magnesium Chloride		mEq	(Other)											
: Reference	136-145	3.5-5.1	98-107	21.0-32.0	70-110	3.4-5.0	8.5-10.12.5-4.	Click to see more results	<input type="checkbox"/>					
DATE	TIME	NA	K	CL	CO2	GLU	ALB	CAL	PHOS					
06/18	0747	146	H	3.9	115	H	25.0	141	H	1.2	L	7.6	L	2.8

Neonatal TPN Development – The Conception

- August 2019
 - Division – Gary Bradley, RPh, Division Pharmacy Informatics Specialist
 - Earliest goal for Meditech build is 2020
 - Data gathering on how NICU's in HCA order TPN
 - One site responded with Meditech EHR entry
 - Kendra Spilkin at TriStar Centennial Medical Center
- February 2020
 - Submit paper NICU forms to Division Pharmacy Informatics Specialist, Gary Bradley

Henrico Doctors Hospital			
DAILY FLUID ORDERS			PAGE 1 OF 2
Printed: 3/11/2020 9:22:15AM		Fluids: 148.6199 ml/kg/d	Page 1
		Weight: 4.71 kg	
IV Fluid #1: TPN via UVC to infuse at 11 ml/h over 24 hours (56.1 ml/kg)			
Dextrose:	14.013 gm/kg	(25 gm/100ml)	25%
TrophAmine 10%:	2/3 gm/kg 50	(5.352 gm/100ml)	
NaCl:	1 mEq/kg	(1.784 mEq/100ml)	

Neonatal TPN Development – First Trimester

- How to calculate Fluids?
 - XXX.xxx ml/kg/day
 - Equals TPN volume per day PLUS Fat Emulsion volume per day
- Automatically populate weight
 - Actual weight versus desired dosing weight
 - Express as X.xxx kilogram (kg) and thousandths decimal place
- What entry should we use? Do we want to make a set or single “Fluids” orderable?

Fluid	Compounds	Non-Formulary
TPN	Lookup by Type	Monograph
Prev Page Favorites Full Formulary Next Page		
Medications Fluids		
+ Tpn Neos/Peds		
+ Tpn Tean To Dose		

Neonatal TPN Development – First Trimester

- Size limit in Meditech
 - 92 characters across, 20 lines down
- How do we want to order macronutrients?
 - Fat Emulsion: X Gm/kg/Day
 - Dextrose: X Gm/kg/Day
 - Amino Acids: X Gm/kg/Day
- Include fat emulsions
 - Intralipid®
 - SMOFlipid®
 - Omegavan®

Neonatal Total Parenteral Nutrition

Fluid: mL/kg/day Weight: kg IV line type:

TPN via to infuse at mL/hr over 24 hours. Total Volume: mL

Lipids? (Y/N) Lipids 20% gm/kg to infuse at mL/hr over 24 hours.

Dextrose %
Trophamine 10% gm/kg

Sodium Chloride <input type="text"/> mEq/kg	Heparin <input type="text"/> units/mL
Sodium Acetate <input type="text"/> mEq/kg	MVI Pediatric <input type="text"/> mL/day
Sodium Phosphate <input type="text"/> mEq/kg as Na	NeoTrace-4 <input type="text"/> mL/kg
Potassium Chloride <input type="text"/> mEq/kg	Cysteine HCl <input type="text"/> mg/kg
Potassium Acetate <input type="text"/> mEq/kg	L-Carnitine <input type="text"/> mg/kg
Potassium Phosphate <input type="text"/> mEq/kg as K	Selenium <input type="text"/> mcg/kg/day
Calcium Gluconate <input type="text"/> mg/kg	Chromium <input type="text"/> mcg/kg/day
Magnesium Sulfate <input type="text"/> mEq/kg	Zinc <input type="text"/> mcg/kg/day

Neonatal TPN Development – First Trimester

- How do we express route or line type?
 - Umbilical Venous Catheter (UVC)
 - Umbilical Arterial Catheter (UAC)
 - Central Venous Catheter (CVC)
 - Peripherally Inserted Central Catheter (PICC)
 - Broviac
 - Peripheral Intravenous line

Site of Admin

Select

- 1 UVC
- 2 UAC
- 3 PICC
- 4 Broviac
- 5 CVC

Neonatal Total Parenteral Nutrition

Fluid: 100.5 mL/kg/day Weight: 3.840 kg IV line type: CENTRAL

TPN via UVC to infuse at 5 mL/hr over 12 hours. Total Volume: 60 mL

Lipids? (Y/N) Y Lipids 20% 1.5 gm/kg to infuse at 4 mL/hr over 18 hours.

- **Final Decision:** CENTRAL or PERIPHERAL attribute
 - Example of POP customer defined screen (CDS) below:

```
9 cadTPNN006 2 65 IV line type:
      SAME 79 <ATTRIBUTES>
      IFE=%Z.zcus.cpd.M.tpn.neonatal.lookup(ANS,aa,3,"IV Line Type",
      IFE="CENTRAL","PERIPHERAL")
```

Neonatal TPN Development – First Trimester

- Suggest to default multivitamin (MVI) dose based on weight

- Less than 1 kg = 1.5 mL/Day
- 1 kg – 3 kg = 3.25 mL/Day
- Greater than 3 kg = 5 mL/Day

```
70 cadTPNN038 11 60 MVI Pediatric 71 cadTPNN039 11 80 mL/day
    SAME 74 <ATTRIBUTES>
    DFT=IF{/KG<1 "1.5";/KG>3 "5";"3.25"}
```

- Default Cysteine HCl Dose

- Usual range 20 – 40 mg/Gm Amino Acids

```
74 cadTPNN042 13 61 Cysteine HCl 75 cadTPNN043 13 80 mg/kg
    SAME 74 <ATTRIBUTES>
    DFT=( [ANS,"cadTPNN018"]|0*30)
```

- NeoTrace® removal for cholestasis

- Chromium will auto populate: 0.2 mcg/kg/Day
- Zinc will auto populate: 400 mcg/kg/Day

```
72 cadTPNN040 12 63 NeoTrace-4 73 cadTPNN041 12 80 mL/kg
    SAME 74 <ATTRIBUTES>
    IFE=IF{%Z.zcus.lib.M.populate("cadTPNN048",""),
    IFE=%Z.zcus.lib.M.populate("cadTPNN050","") 1;1}
    DFT="0.2"
```

Neonatal Total Parenteral Nutrition

Fluid: mL/kg/day Weight: kg IV line type:

TPN via to infuse at mL/hr over 24 hours. Total Volume: mL

Lipids? (Y/N) Lipids 20% gm/kg to infuse at mL/hr over 24 hours.

Dextrose %

Trophamine 10% gm/kg

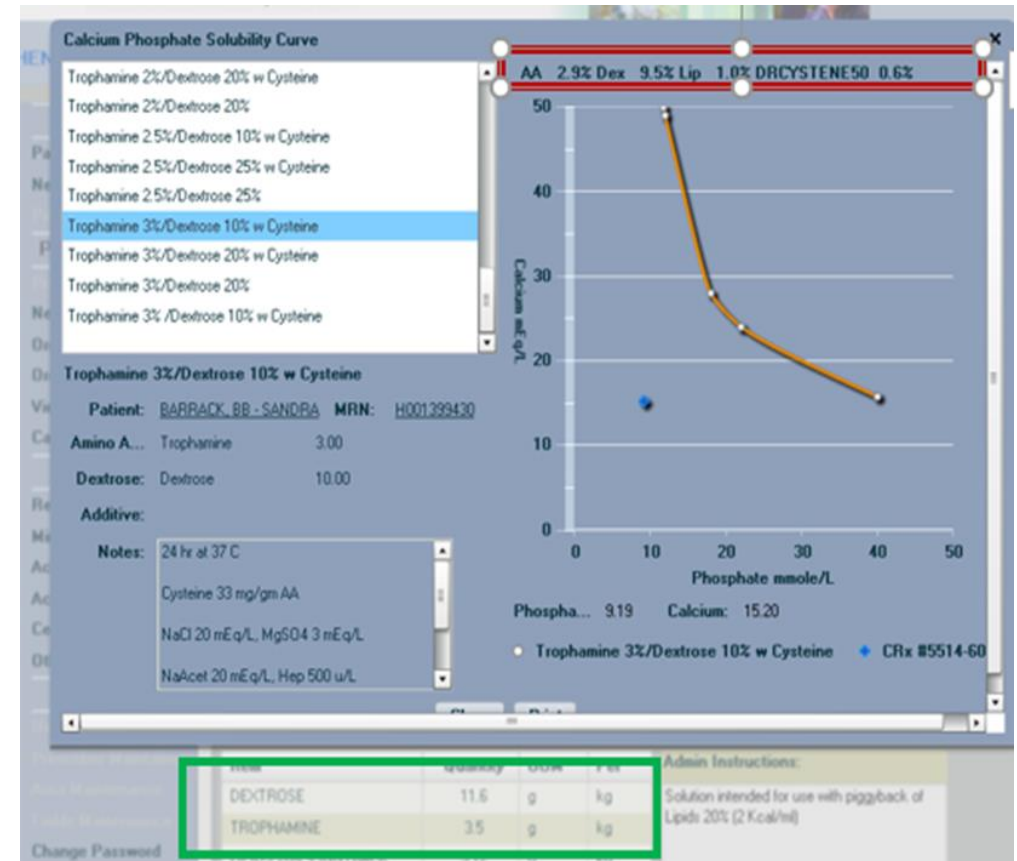
Sodium Chloride <input type="text"/> mEq/kg	Heparin <input type="text"/> units/mL
Sodium Acetate <input type="text"/> mEq/kg	MVI Pediatric <input type="text"/> mL/day
Sodium Phosphate <input type="text"/> mEq/kg as Na	NeoTrace-4 <input type="text"/> mL/kg
Potassium Chloride <input type="text"/> mEq/kg	Cysteine HCl <input type="text"/> mg/kg
Potassium Acetate <input type="text"/> mEq/kg	L-Carnitine <input type="text"/> mg/kg
Potassium Phosphate <input type="text"/> mEq/kg as K	Selenium <input type="text"/> mcg/kg/day
Calcium Gluconate <input type="text"/> mg/kg	Chromium <input type="text"/> mcg/kg/day
Magnesium Sulfate <input type="text"/> mEq/kg	Zinc <input type="text"/> mcg/kg/day

Neonatal TPN Development – Second Trimester

Calcium/Phosphate precipitation concern

- Identified a lack of pharmacy understanding
 - Importance of curve
 - Misunderstanding reading curve in CAPS/ABACUS
- Begin education with pharmacists
 - Handouts
 - Emails
 - One-on-one communication
 - Huddle/Staff meeting discussions
- Compounding pharmacy requires site review of all calcium/phosphate ratio 30 or greater
- **How do we ensure provider review of precipitation risk while ordering TPN in Meditech?**

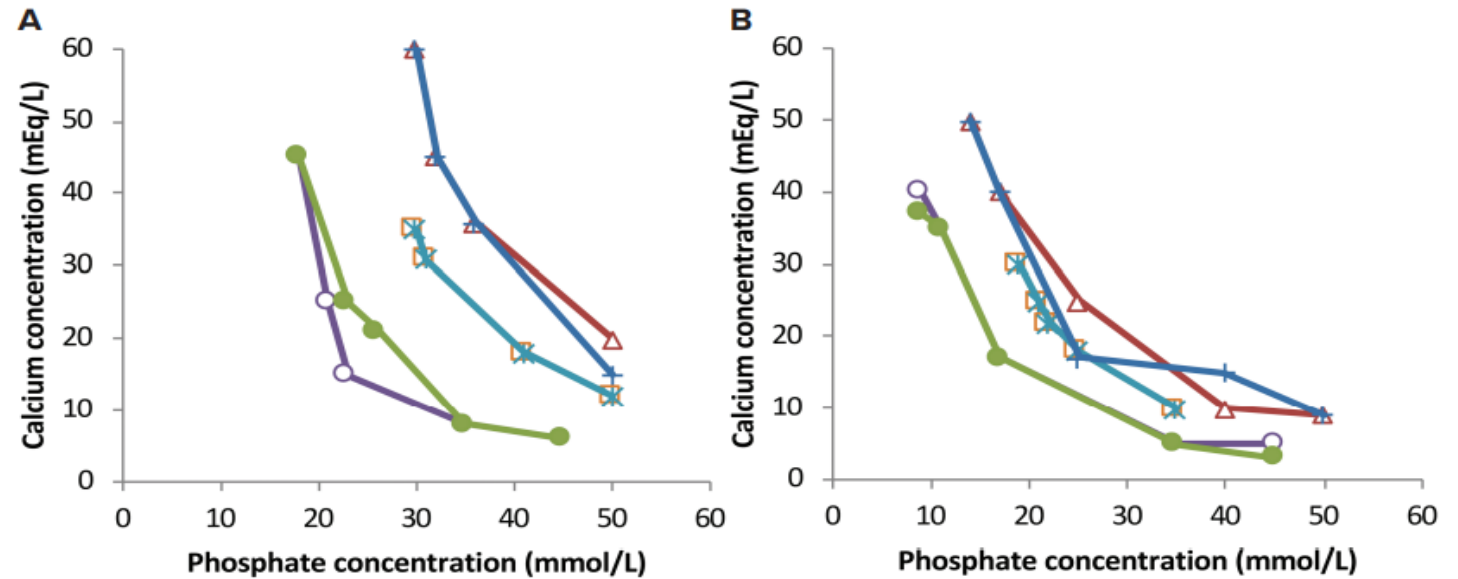
Education begins for pharmacy staff



Neonatal TPN Development – Second Trimester

Calcium/Phosphate precipitation concern

- Identify a numerical value in “mEq/L” of calcium and “mMol/L” phosphate that will capture higher content of Trophamine® based on graph below
- Numerical value of 50 will alert the provider to decrease components based on Owen, et al.
- Change calcium on neonatal and pediatric TPN to calcium “mEq/kg”
 - Conversion chart created
- Create calcium and phosphate calculation



(A) Curves for admixtures with L-cysteine 40 mg/g amino acid. (B) Curves for admixtures without L-cysteine.
○ 1% Troph + 10% D; □ 2% Troph + 20% D; △ 3% Troph + 20% D; ● 1% Prem + 10% D; * 2% Prem + 20% D; + 3% Prem + 20% D
D, dextrose; Prem, Premasol; Troph, Trophamine.

Neonatal TPN Development – Second Trimester

Calcium/Phosphate Precipitation Alert

- Calcium calculations based on total “mEq/kg” and the total volume TPN
- Converted total electrolytes in mEq of Calcium, Sodium, Potassium to 1000 ml

$$\frac{\text{Total mEq electrolyte}}{\text{Total volume TPN}} = \frac{A}{1000 \text{ ml}}$$

- Template for phosphate recorded mEq/kg of Na⁺ or K⁺ in a background equation require conversion to mMol/kg for precipitation calculation

– NaPhos = 4 mEq Sodium : 3 mMol Phosphate per mL

- Sodium Phosphate converted from mEq to mMol of phosphate per 1000 ml

$$\text{“Y” Sodium mEq} \rightarrow \frac{(Y \times 3)}{4} \text{ to convert Phosphate in mMol}$$

– KPhos = 4.4 mEq Potassium : 3 mMol Phosphate per mL

- Potassium phosphate converted from mEq to mMol of phosphate per 1000ml

$$\text{“Z” Potassium mEq} \rightarrow \frac{(Z \times 3)}{4.4} \text{ to convert Phosphate in mMol}$$

- Add “Y” plus “Z” above to give total mMol/1000 ml of phosphate

– Add calcium mEq per 1000 ml PLUS phosphate mMol per 1000 ml to calculate number for “Ca:Phos Precip” field

- Alert message of 55 or more to alert prescriber of risk for precipitation

Neonatal TPN Development – Second Trimester

Calcium/Phosphate Precipitation Alert

Neonatal TPN Choose one (Y): NICU *or* PEDS/PICU
 Weight: 2.278 kg TPN dosing weight: 2.278 kg IV line type: CENTRAL
 Lipids?(Y/N) - Intralipid 20% - 3.5 gm/kg to infuse over 24 hours. (39.9 mL/day at 1.661 mL/hr)
 TPN to infuse at 4.5 mL/hr over 24 hours. TPN total volume: 108.0 mL

Sodium Phosphate	2	mEq/kg as Na (31.6 mMol/L)	Cysteine HCl		mg/kg
Potassium Chloride		mEq/kg	L-Carnitine		mg/kg
Potassium Acetate		mEq/kg	Selenium		mcg/kg/day
Potassium Phosphate	1	mEq/kg as K (14.4 mMol/L)	Chromium		mcg/kg/day
Calcium Gluconate	1	mEq/kg (21.1 mEq/L)	Zinc		mcg/kg/day
Magnesium Sulfate		mEq/kg	Other:		
			Other:		

Ca:Phos Precip 67.1

- Both POP and MOTHER CDS required for calculation, pop-up and “Cal:Phos Precip” field

- Message alert executed from attribute

- Hidden POP CDS where calcium, phosphate and message attributes are linked:

```
67 cadTPNN073 20 6 Ca:Phos Precip
SAME 21 Y <ATTRIBUTES>
IFE=IF{(/NA.PHOS+/K.PHOS+/CA.GLU)^/CA.PHOS,
IFE=P(R,S,/CA.PHOS:1D^[ANS%0,/S.LAST.QUERY]|0)^#, ""},
IFE=IF{/CA.PHOS>55 @W.return("Warning review with pharmacy when Ca:Phos
IFE=value is greater than 55, precipitate can occur in TPN solution.");""}
```

Neonatal TPN Development – Second Trimester

Caloric Calculations

- Glucose Infusion Rate (GIR) calculation

- Neonatal Goal 4-6 mg/kg/min at birth

$$\frac{\% \text{ Dextrose} \times \text{Rate}}{6 \times \text{weight (kg)}} \quad \text{Example: } \frac{D12.5\% \times 8.5 \text{ ml/hr}}{6 \times 3.1 \text{ kg}} = \text{GIR} = 5.71 \text{ mg/kg/min}$$

- Calculate kilocalories of macronutrients

- Carbohydrate (CHO)

- (Dextrose% x TPN volume) x 3.4
- Example: Dextrose 12.5% @ 3.5 ml/hr x 24 hrs

$$\text{kcal} = [(3.5 \times 24) \times 0.125] \times 3.4 = 34.68 \text{ kcal}$$

- Protein (With POP CDS example)

- Example: Amino Acids 3.5 g/kg, dosing weight 1.5 kg

$$\text{kcal} = (3.5 \times 1.5) \times 4 = 21 \text{ kcal}$$

31 cadTPNN059 7 35 Protein: SAME 44

32 cadTPNN060 7 52 kcal

<ATTRIBUTES>

IFE=IF{(/AA.GMKG*/KG*4)^/AA.KK,

IFE=P(R,S,/AA.KK:2D^/[ANS%0,/S.LAST.QUERY]|0)^#, ""}

- Fat Emulsion 20%

- Total fat volume x 2 OR 10 kcal/gram for 20% emulsion
- Example: Fat emulsion 1.5 g/kg, dosing weight 1.5 kg

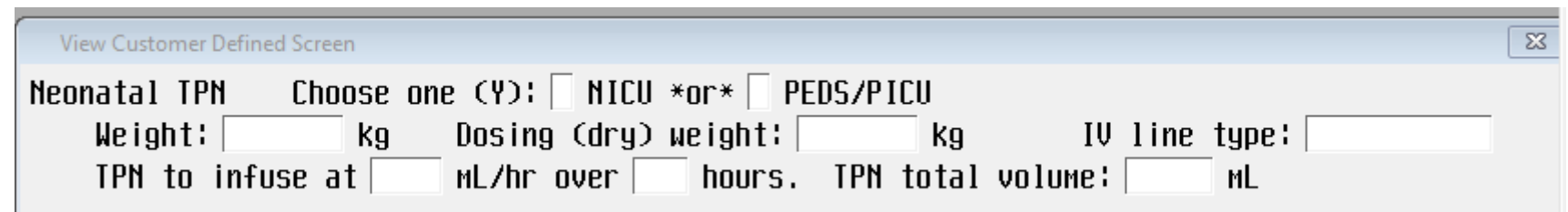
$$\text{kcal} = (1.5 \times 1.5) \times 10 = 22.5 \text{ kcal}$$

- Total kcal: 78.18 kcal

Neonatal TPN Development – Third Trimester

Change Weight Options

- Initial programming does not allow for modifiable weight, current weight defaults
 - Previous version defaulted weight but given option to modify
- Not all actual patient weights are usable
 - Infants loose 7 – 15% total body weight in first seven days of extrauterine life
 - Septic infants may third-space
 - Dose TPN from weight day before illness
 - Surgical infants may not be weighted for weeks
 - Infants born with Hydrops fetalis may have 2,000 grams or more of fluid at birth
 - Some may have been removed emergently in delivery room or upon admission



View Customer Defined Screen

Neonatal TPN Choose one (Y): NICU *or* Peds/PICU

Weight: kg Dosing (dry) weight: kg IV line type:

TPN to infuse at mL/hr over hours. TPN total volume: mL

Neonatal TPN Development – Third Trimester

Caloric Calculations

- Calculate ratio of macronutrients in percent using final TPN and fat emulsion volume
 - Example: final volume 163.46 ml, CHO 55.08 gm, Amino Acids 23.3 gm, Fat 85.05 gm
 - CHO: $55.08/163.46 \times 100 = 33.7\%$
 - AA: $23.3/163.46 \times 100 = 14.3\%$
 - Fat: $85.05/163.46 \times 100 = 52.0\%$
 - Total percentage = $33.7\% + 14.3\% + 52.0\% = 100\%$

Neonatal TPN Choose one (Y): NICU *or* PEDS/PICU
 Weight: kg TPN dosing weight: kg IV line type:
 TPN to infuse at mL/hr over hours. TPN total volume: mL

Lipids?(Y/N) - - gm/kg to infuse over hours. (mL/hr)

Dextrose	<input type="text" value="11"/> %	CHO:	<input type="text" value="26.93"/> kcal (<input type="text" value="47.9"/> %)	GIR:	<input type="text" value="7.33"/> mg/kg/min
Trophamine 10%	<input type="text" value="3.5"/> gm/kg	Protein:	<input type="text" value="10.50"/> kcal (<input type="text" value="18.6"/> %)		
		Fat:	<input type="text" value="18.75"/> kcal (<input type="text" value="33.3"/> %)	Total:	<input type="text" value="56.18"/> kcal

Sodium Chloride	<input type="text"/> mEq/kg	Heparin	<input type="text" value="0.5"/> units/mL
Sodium Acetate	<input type="text"/> mEq/kg	MVI Pediatric	<input type="text" value="1.5"/> mL/day
Sodium Phosphate	<input type="text"/> mEq/kg as Na (<input type="text" value="0.0"/> mMol/L)	NeoTrace-4	<input type="text" value="0.2"/> mL/kg
Potassium Chloride	<input type="text"/> mEq/kg	Cysteine HCl	<input type="text" value="105.0"/> mg/kg
Potassium Acetate	<input type="text"/> mEq/kg	L-Carnitine	<input type="text"/> mg/kg
Potassium Phosphate	<input type="text" value="1"/> mEq/kg as K (<input type="text" value="7.1"/> mMol/L)	Selenium	<input type="text" value="2"/> mcg/kg/day
Calcium Gluconate	<input type="text" value="2"/> mEq/kg (<input type="text" value="20.8"/> mEq/L)	Chromium	<input type="text"/> mcg/kg/day
Magnesium Sulfate	<input type="text" value="0.2"/> mEq/kg	Zinc	<input type="text"/> mcg/kg/day
		Other:	<input type="text"/>
Fluid:	<input type="text" value="108.500"/> mL/kg/day	Ca:Phos Precip	<input type="text" value="27.9"/> Other: <input type="text"/>

Assessment Question #2 of 3

What types of calculations would your Neonatal TPN ideally contain via electronic medical record to optimize nutrition for neonates?

- a. Glucose Infusion Rate
- b. Calcium/Phosphate precipitation estimate
- c. Total fluid calculation in “ml/kg/day”
- d. All of the above

| Neonatal TPN Development – The Birth

- Testing complete August 2020
- Nursing, Physician and Pharmacist education complete by September 2020
- Go-Live ordering starting September 30, 2020

| Neonatal TPN Development – The Birth

Findings After Roll Out

- Birth Pains
 - F9, F10, F11, F12 and Enter keys most reliable to capture all required windows, point and click resulted in missing duration in several cases
 - Editing macronutrients may cause gram, percent, and final kcal to default to Zero
- Beauty of Birth
 - Feedback – Nursing
 - Dextrose in percent
 - Corrected fat emulsion discrepancies in “gm/kg/day” and rate
 - Eliminate scanned order
 - No missing TPN orders
 - Feedback – Pharmacy
 - Immediate submission to pharmacy
 - Editing simplified
 - Feedback – Physician
 - Immediate submission to pharmacy
 - Multidisciplinary approach to optimizing TPN

Neonatal TPN Development – The Birth

Findings After Roll Out

- Beauty of Birth
 - Increased Pharmacist and Dietitian involvement
 - Increase job satisfaction, teamwork
 - Fat emulsion/medication compatibilities easily addressed
 - Optimized kcal without fluid increase – 20 charts retrospectively reviewed
 - 10 patients had increase of 2 – 25.3 kcal/kg/day without total fluid increase
 - 1 patient had no change in kcal, but was fluid restricted by 20 ml/kg/day
 - Template modifications
 - Nutrients in template easily modifiable within days
 - Addition of Omegaven® fat emulsion
 - Change to MVI Pediatric to MVI Ped compounded cocktail
 - Adding Vitamin K (mcg/day) during multivitamin shortage
 - Extra free space for “additives” used for communication between order entry and transcription
 - Template layout optimization to reduce key strokes

Neonatal TPN Development – The Growth

Original Neonatal TPN Format

Neonatal TPN Choose one (Y): NICU *or* Peds/PICU
 Weight: 0.750 kg TPN dosing weight: 0.75 kg IV line type: CENTRAL
 TPN to infuse at 2.6 mL/hr over 24 hours. TPN total volume: 62.4 mL

Lipids?(Y/N) - Intralipid 20% - 2.5 gm/kg to infuse over 24 hours. (0.39 mL/hr)
 Dextrose 11 % CHO: 26.93 kcal (47.9 %) GIR: 7.33 mg/kg/min
 Trophamine 10% 3.5 gm/kg Protein: 10.50 kcal (18.6 %)
 Fat: 18.75 kcal (33.3 %) Total: 56.18 kcal

Sodium Chloride	<input type="text"/>	mEq/kg	Heparin	0.5	units/mL
Sodium Acetate	<input type="text"/>	mEq/kg	MVI Pediatric	1.5	mL/day
Sodium Phosphate	<input type="text"/>	mEq/kg as Na (0.0 mMol/L)	NeoTrace-4	0.2	mL/kg
Potassium Chloride	<input type="text"/>	mEq/kg	Cysteine HCl	105.0	mg/kg
Potassium Acetate	<input type="text"/>	mEq/kg	L-Carnitine	<input type="text"/>	mg/kg
Potassium Phosphate	1	mEq/kg as K (7.1 mMol/L)	Selenium	2	mcg/kg/day
Calcium Gluconate	2	mEq/kg (20.8 mEq/L)	Chromium	<input type="text"/>	mcg/kg/day
Magnesium Sulfate	0.2	mEq/kg	Zinc	<input type="text"/>	mcg/kg/day

Fluid: 108.500 mL/kg/day Ca:Phos Precip 27.9

Updated Neonatal TPN Format

Neonatal TPN Choose one (Y): NICU *or* Peds/PICU
 Weight: 2.278 kg TPN dosing weight: 2.278 kg IV line type: CENTRAL
 Lipids?(Y/N) - Intralipid 20% - 3.5 gm/kg to infuse over 24 hours. (39.9 mL/day at 1.661 mL/hr)

TPN to infuse at 4.5 mL/hr over 24 hours. TPN total volume: 108.0 mL
 Dextrose 7.5 % CHO: 27.54 kcal (22.8 %) GIR: 2.46 mg/kg/min
 Trophamine 10% 1.5 gm/kg Protein: 13.67 kcal (11.3 %)
 Fat: 79.73 kcal (65.9 %) Total: 120.94 kcal

Fluid: 64.910 mL/kg/day

Sodium Chloride	1	mEq/kg	Heparin	<input type="text"/>	units/mL
Sodium Acetate	<input type="text"/>	mEq/kg	MVI Pediatric	3.25	mL/day
Sodium Phosphate	<input type="text"/>	mEq/kg as Na (<input type="text"/> mMol/L)	NeoTrace-4	0.2	mL/kg
Potassium Chloride	<input type="text"/>	mEq/kg	Cysteine HCl	<input type="text"/>	mg/kg
Potassium Acetate	<input type="text"/>	mEq/kg	L-Carnitine	<input type="text"/>	mg/kg
Potassium Phosphate	1	mEq/kg as K (14.4 mMol/L)	Selenium	<input type="text"/>	mcg/kg/day
Calcium Gluconate	1	mEq/kg (21.1 mEq/L)	Chromium	<input type="text"/>	mcg/kg/day
Magnesium Sulfate	<input type="text"/>	mEq/kg	Zinc	<input type="text"/>	mcg/kg/day

Ca:Phos Precip

- Interchange fat emulsion and TPN rate
- Transfer fluid calculation above micronutrients
- Relocate calcium/phosphate precipitation

| TPN Development – Toddler Walking

- Further optimize neonatal safety by adding maximum macronutrient and micronutrient values
- Explore carry-over feature for neonatal TPN to allow ingredients to populate from one day to the next on stable, chronic infants
- Further discuss osmolality build in neonatal TPN
 - May be too large POP CDS build
- Pediatric TPN in conception and next build
- Addition of “Cal:Phos Precip” field in Adult TPN

Assessment Question #3 of 3

Which of the following situations would be an example of a best practice in implementing a multidisciplinary parenteral nutrition approach?

- a. Provider handwrites TPN upon arrival to unit at 0800.
- b. TPN entered via EHR at 0830, dietitian recommendations obtained and implemented the following day.
- c. Provider assesses infant with nurse, incorporates dietitian and pharmacist input. TPN is entered via EHR at bedside.
- d. Pharmacist enters TPN in HER and does not discuss feeding changes with dietitian.

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Thank you...

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