ABCs OF PICU NUTRITION

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Nutritional assessment and support

Who needs nutritional support ?

Everyone

Monitors, Ventilators, Inotropes, Antibiotics, Blood products, I/O charts, ABG, Electrolytes.

FEN?

Nutritionist’s input in PICU rounds.

NABH / JCI accreditation requirement

Nutritional goals being met ?

Nutritional Assessment

Anthropometry

Height, Weight, Head Circumference

Labs

Albumin, Prealbumin, Urea, Creatinine.

How much Calorie and Proteins intake ?

Ideal: Indirect Calorimetry

Theoretical for our scenario

Formula / Tables based requirements

Titrate based on anthropometry/labs

PICU Malnutrition

- Malnutrition:

- Impairs immune function.
- Interferes with wound healing.
- Prolongs hospitalisation.
- Increases risk of infection and death.

PICU Overfeeding

- Overfeeding:
  - Excess CO_2 production & increased minute ventilation
  - Pulmonary oedema & respiratory failure
  - Hyperglycemia, which may increase infection rates
  - Lipogenesis due to increased insulin production
  - Hepatic complications: fatty liver, intrahepatic cholestasis

Balancing Act

DRI vs. BEE

Age	DRI (kcal/kg)	BEE (kcal/kg)
0-3 months	102	54
4-6 months	82	54
7-12 months	80	51
13-35 months	82	56
3 years	85	57
4 years	70	47
5-6 years	65	47
7-8 years	60	47

Daily energy & protein requirements

Total Calories : BEE X Stress Factor

Total Proteins : RDA X Stress Factor

*Table 1. Estimate BEE for weight and sex

Age 1 wk to 10 mths		Age 11 to 36 mths			Age 3 to 16 yrs		
Wt (kg)	MR (kcal/day)	Wt (kg)	MR (kcal/day)		Wt (kg)	MR (kcal/day)	
	M or F		M	F		M	F
3.5	202	9.0	528	509	15	859	799
4.0	228	9.5	547	528	20	953	898
4.5	252	10.0	566	547	25	1046	996
5.0	278	10.5	586	566	30	1139	1092
5.5	305	11.0	605	586	35	1231	1190
6.0	331	11.5	624	605	40	1325	1289
6.5	358	12.0	643	624	45	1418	1387
7.0	384	12.5	662	646	50	1512	1486
7.5	410	13.0	682	665	55	1606	1584
8.0	437	13.5	701	684	60	1699	1680
8.5	463	14.0	720	703	65	1793	1776
9.0	490	14.5	739	722	70	1886	1874
9.5	514	15.0	758	741	75	1980	1973
10.0	540	15.5	778	760			
10.5	566	16.0	797	782			
11.0	593	16.5	816	802			

**Table 2: Determining Stress Factor

Clinical Condition	Stress factor
Maintenance	1.0
Fever	12% per degree > 37
Routine surgery, minor sepsis	1.1
Cardiac failure	1.25
Major surgery	1.2
Sepsis	1.4
Catch-up grpwth	1.5
Trauma (inc TBI)	1.5 – 1.7

Energy Needs: Intubated Infants

Require > BEE

Activity not significant

Calories used predominately for growth

Provide >BEE for infants 0-12 months despite intubation/sedation

(~75-80% of the DRI for age)

0-3 mon (~80kcal/kg)

4-12 mon (~65kcal/kg)

Energy Needs: Intubated Children > 12 months

Goal = BEE

Schofield equation, Harris Benedict equation, ASPEN

3y: ~60kcal/kg

4-8y: ~50kcal/kg

Activity and injury factors not routinely used

BEE x 1.2 for intubated burn pts

Energy Needs: Non -Intubated

Goal = DRIs

Malnourished : Catch up growth needs

(DRI x IBW) ÷ actual wt (kg)

Overweight : BMI for age >85th%ile

(BMI @50th%ile x actual wt) ÷ actual BMI

200 kCal less than average for age

Protein Requirements

Age	DRI (g/kg/day)	PICU (g/kg/day)
0-6 months	1.52	2-3
7-12 months	1.20	2-3
13-23 months	1.05	2-3
2-3 years	1.05	1.5-2
4-13 years	0.95	1.5-2
14-18 years	0.85	1.5

Parenteral Nutrition Calories

- Extubated:
  - provide ~10% < DRIs
  - due to lack of thermogenic effect of food

- Intubated:
  - BEE or
  - ~80% DRI

Continuous Monitoring

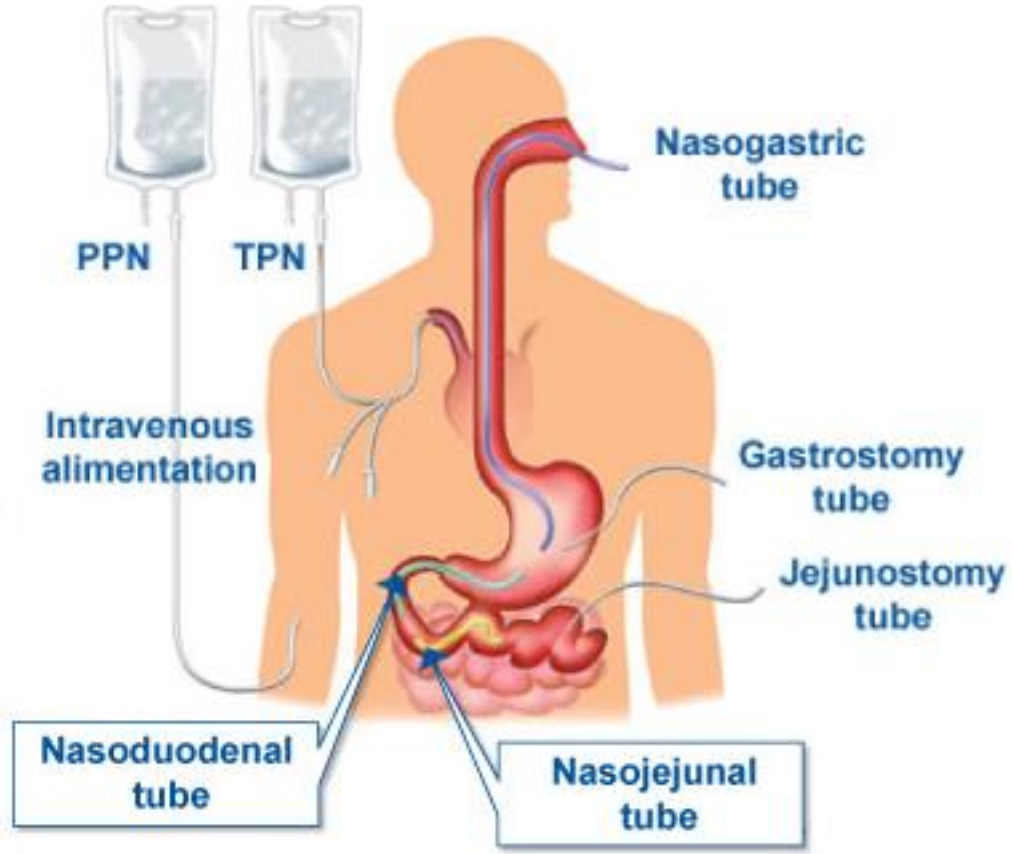
Monitor Anthropometry and Labs

Titrate Calories and Proteins

Fluid Requirement

- Holliday-Segar formula
  - 0-10 Kg : 100ml/kg/day
  - 10-20 Kg : 1000 ml + 50 ml for each Kg > 10 Kg
  - > 20 Kg : 1500 ml + 20 ml for each Kg > 20 Kg
- Other fluids and medications
- Fluid restricted status.

Nutrition : Available Routes



Parenteral Nutrition

PPN vs. TPN

- PPN
  - Peripheral access
  - <900 mOsm/L
  - Max D12.5%
  - Can go up to D15% with non-central PICC
  - Usually requires increased fluid allowance
- TPN
  - Central access
  - No osmolarity limitations
  - Typical max dextrose usually D25%.

Parenteral Dextrose

- 40-60% of total calories / 60-75% of NP calories
- Glucose infusion rate (GIR)
- 3.4kcal/g dextrose
- Increased intake: Hyperglycemia, infections, hepatic steatosis, Refeeding syndrome.

GIR/Dextrose Guidelines

Age	Initiate	Advance	Maximum
<1yr	~6-9mg/kg/min	1-2mg/kg/min	Goal: 10-12mg/kg/min Max: 14mg/kg/min
1-10yr	1-2mg/kg/min >IVF GIR	1-2mg/kg/min	Max: 8-10mg/kg/min
>10yr (adolescents)	1-2mg/kg/min >IVF GIR	1-2mg/kg/min	Max: 5-6mg/kg/min

Parenteral Lipids

- Initiate @ 1g/kg/day, Advance @ 1g/kg/day
  - Maximum:
  - < 1 yr : 3g/kg/day,
  - 1-10 yr : 2-3g/kg/day,
  - >10 yr : 1-2.5g/kg/day

- Usual 20-50 % of calories.< 60% kcal via lipid (ketosis)

- Maximum lipid clearance 0.15g/kg/hr, TG 100-150 mg/dl

- Carnitine supplements for TPN > 2-4/ 52
  - 10mg/kg/day. May go upto 20mg/kg/day (Carnisure, Torrent)

20% Intralipid

- Essential Fatty Acids (EFA)
  - Omega-6 source,
  - Increased inflammation
  - PNALD/IFALD

- Concentrated source of kcal
  - 2kcal/ml

PNALD/IFALD

Avoid macronutrient overfeeding in general

Decrease lipids to 1 g/kg

Omega 3 FA (Fish oil based)(SMOFlipid20%)

GIR ≤ 12.5mg/kg/min

Initiate EN asap (even trophic feeds)

Strict asepsis protocols

Parenteral AA Guidelines

Age	Initiate	Advance	Maximum
<1yr	1-2g/kg/day	1g/kg/day	4g/kg/day
1-10yr	1-2g/kg/day	1g/kg/day	1.5-3g/kg/day
>10yr (adolescents)	1g/kg/day	1g/kg/day	0.8-2.5g/kg/day

Calorie contribution : 4kcal/g AA

PN Electrolyte Dosing Guidelines

Electrolyte	Preterm Neonates	Infants/ Children	Adolescents/ Children >50kg
Na	2-5meq/kg	2-5meq/kg	1-2meq/kg
K	2-4meq/kg	2-4meq/kg	1-2meq/kg
Ca	2-4meq/kg	0.5-4meq/kg	10-20meq/day
Phos	1-2mmol/kg	0.5-2mmol/kg	10-40mmol/day
Mg	0.3-0.5meq/kg	0.3-0.5meq/kg	10-30meq/day

IV Phosphate is now available (3mmol/ml Phosphorus +4.5mEq/ml Potassium)
Potphos (Neon)

How to order TPN

1. Calculate: Fluid volume available for TPN
2. Calculate: Estimated energy requirement
3. Calculate: Protein Requirement and protein calories
4. Calculate: Lipid Requirement and lipid calories.
5. Calculate: Carbohydrate Requirement and check GIR
6. Calculate Additives (Electrolytes, Minerals, Vitamins)
7. Calculate Osmolality:
    1. ((g Aminoacid/L X10) + (g Dextrose/L X 5) +(Na+K+Ca in mEq/L)X2)

15 Kg Child for TPN

3Y/M, 15 Kg, TPN.

Normal labs.

Goal : Age appropriate weight gain.

TPN Calculation

- Fluid requirement:
  - Fluid = 1000ml + 50 ml X 5 kg = 1250 ml
- Estimated energy requirement:
  - 15 X 85 Kcal/kg = 1275 Kcal
- Protein requirement:
  - Protein = 15 X 3g/day = 45 grams
  - Protein calories = 45g x 4 Kcal/g = 180 Kcal.

TPN Calculation

- Lipid Requirement:
  - 15 X 3 g/kg = 45 g
  - Lipid calories:
  - 45 g X 10 Kcal/g = 450 Kcal (35% of EER)

- Carbohydrate calories:
  - EER – (Protein calories + Lipid calories)
  - 1275 – (180+450) = 645 Kcal (51% of EER)
  - Carbohydrate requirement:
  - 645 Kcal / 3.4 Kcal/g = 190 g Carbohydrate

TPN Calculation

- GIR:
  - 190 g = 190,000 mg
  - 190,000 mg/ 15 kg = 12667 mg/kg/day
  - 12667/ 1440 min in a day = 8.8 mg/kg/min

- Final PN solution will contain
  - 45 g AA (14% EER)
  - 45 g IVFE 20% (35 % EER)
  - 190 g Glucose (51% EER)

TPN Calculation

- Total PN volume
  - 45 g from 10% AA → 450 ml 10% AA
  - 45 g from 20% IVFE → 225 ml 20% IVFE
  - 190 g from 50% Glucose →380 ml 50% D
  - Na= 30 mEq (2 mEq/kg) = 60 ml 3% Nacl
  - K = 30 mEq (2 mEq/kg) = 15 ml Kcl (Potclor)
  - Total Volume: 450+225+380 +60+15 = **1130 ml**.
  - Still have **120 ml for meds**
- Final Dextrose Concentration = 16.8%(190g/1130 ml)
- Final Osmolality = (450 + 950 + 120) = 1520 mOsm/L
- MVI: 2.5 ml

Enteral Nutrition

Introduction of EN

Patient considered for Enteral Nutrition ?

Nil enterally?

- Discuss with PICU Consultant
- High Risk Abdomen(<48 hours post heart surgery, > 2 inotropes, open chest, central cooling, < 24 hours of cardiac arrest)
- Consider PN
- Reass for EN daily

Absolute Risk

- Mechanical Bowel Obstruction
- Current confirmed NEC
- Significant GI bleed
- Ischaemic Bowel

Relative risk

- Suspected NEC
- High Risk Abdomen (<48 hours post heart surgery, > 2 inotropes, open chest, central cooling, < 24 hours of cardiac arrest)
- Abdominal distension
- Ileus
- High output stoma
- Complex GI surgery
- Intractable diarrhoea

Discuss with PICU Consultant --- Decide EN +/- PN

Commence enteral feed at 0.5-1.0ml/kg/hr.
If restarting following a high GRV, recommence at previously tolerated rate.
If restarting a feed following a period of fasting, recommence at previously tolerated rate where appropriate.

Feed at this rate for 4 hours

Check for Gastric Residual Volume (GRV). Is it >5ml/kg or 200 ml ?

No

Replace GRV. Increase feed by 0.5ml/kg/hr & continue at this rate for 4 hrs. Recheck GRV. Is it > 5ml/kg or 200ml.

No

Replace GRV. Recheck GRVs every 4 hours and increase at 0.5ml/kg/hr until maximum fluid allowance or target rate of feed reached.

Yes

Replace GRV. Stop feeding for 2 hrs. Recheck GRV. Is it > 5ml/kg or 200 ml.

Yes

Treat constipation, hypokalemia
Consider prokinetics, decreasing opiates, Osmolality, decreasing rate
Consider NJ tube/PN

Thank you