IMPROVED RECOVERY AND REDUCED COMPLICATIONS IN CHD

PROVISION OF OPTIMAL NUTRITIONAL SUPPORT

By: Amir Alavi
Regional Medical Manager

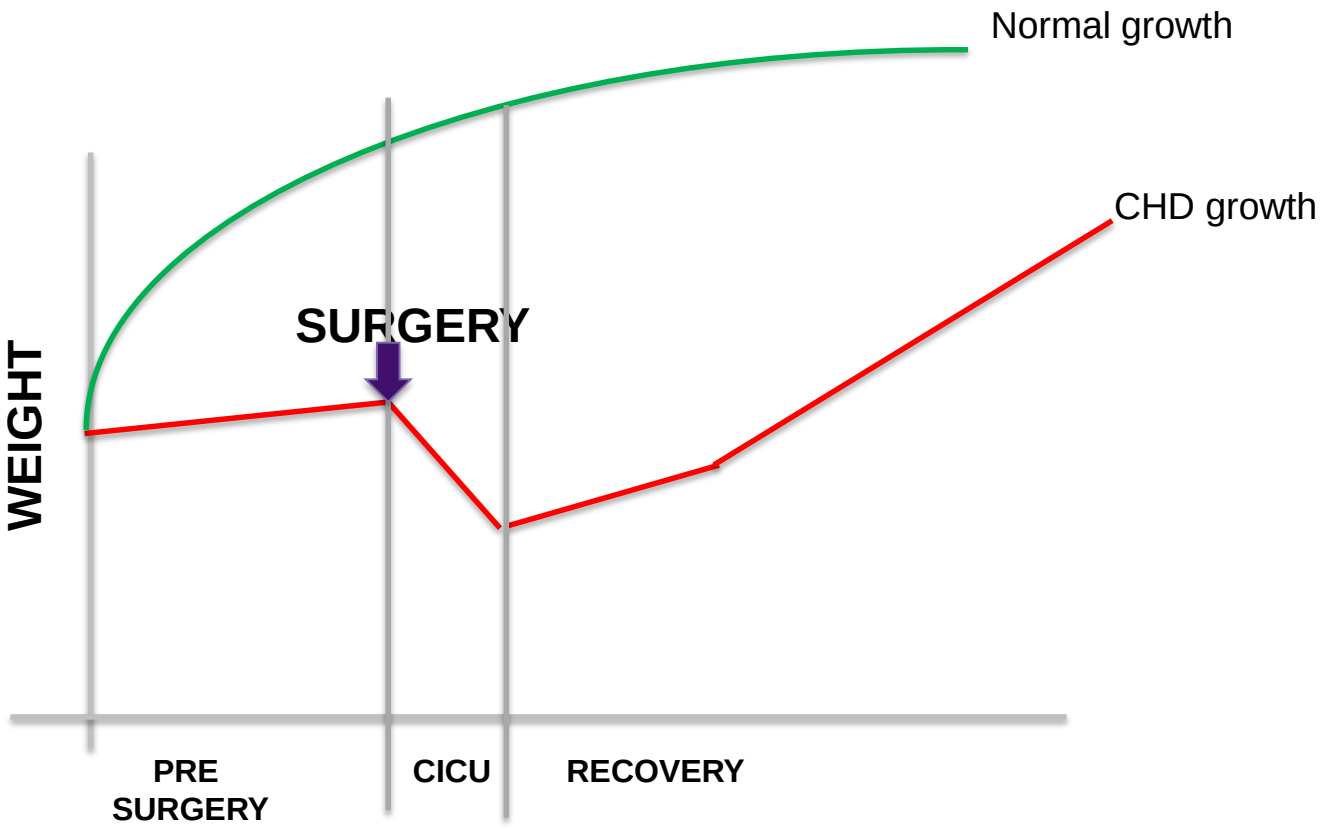
Congenital Heart Defects are most common congenital anomaly in new borns [6]

- Around 12-16 cases of CHD in 1000 live births in Iran
- ~75% will need a surgical procedure [1]
- Success of the surgical procedure depends on many factors including [3,4,5]
  - Diagnosis
  - Procedure – RACHS score
  - Co-morbidities
  - Weight at surgery

1. British stats 2003; 2. Qu Y et al 2016; 3 Curzon et al 2008; 4. Kogon et al 2008; 5.Wallace et al 2011; 6. Fidelia Bode-Thomas 2009

Weight trajectory is seriously compromised at all stages

Infants with CHD have a high risk for growth failure and nutritional imbalance [1-5]



1.Cabrera et al 2010; 2 Pillo-Blocka 2004; 3. Wong 2015; 4. Hassan et al 2015; 5. Leitch CA 2000

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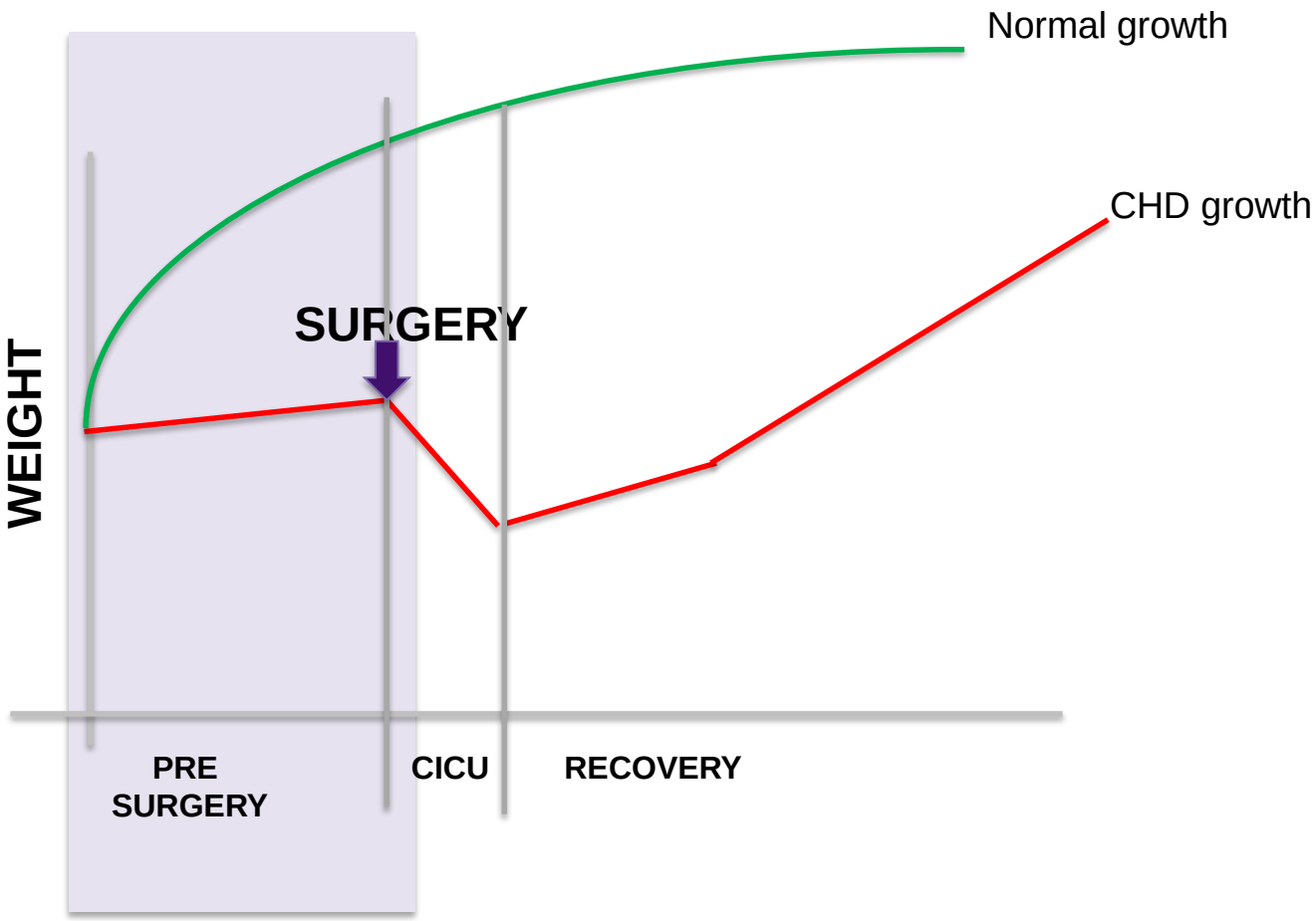


1.Cabrera et al 2010; 2 Pillo-Blocka 2004; 3. Wong 2015; 4. Hassan et al 2015; 5. Leitch CA 2000

Inadequate weight gain can delay surgery and negatively impacts outcomes

Low weight pre-surgery leads to poorer surgical outcomes [1,2,3]

- Increased morbidity and mortality [4,5],
- Increased physiological instability [6]
- Poorer recovery [7]
- Longer hospital stay [7]
- Increased costs associated with hospitalization [7]
- Risk of later neurological problems (stunting in infancy) [8]
- Higher risk of infections [9]

1. Curzon et al 2008; 2. Kogon et al 2008; 3. Wallace et al 2011. 4.Cabrera et al 2010; 5. Hassan et al 2015; 6. Pollack 1985. 7. Pillo-Blocka 2004. 8. Ravishankar 2013. 9 Anderson et al 2011

Multiple feeding challenges can impact the success of surgery and recovery

Fluid restrictions [2]

Uncoordinated sucking and breathing issues [1,3,5]

Vomiting & reflux [1,2,4]

Fatigue & early satiety [2,5]

Reduced nutritional intake and uptake [5]

Poor weight gain [5,6,8]

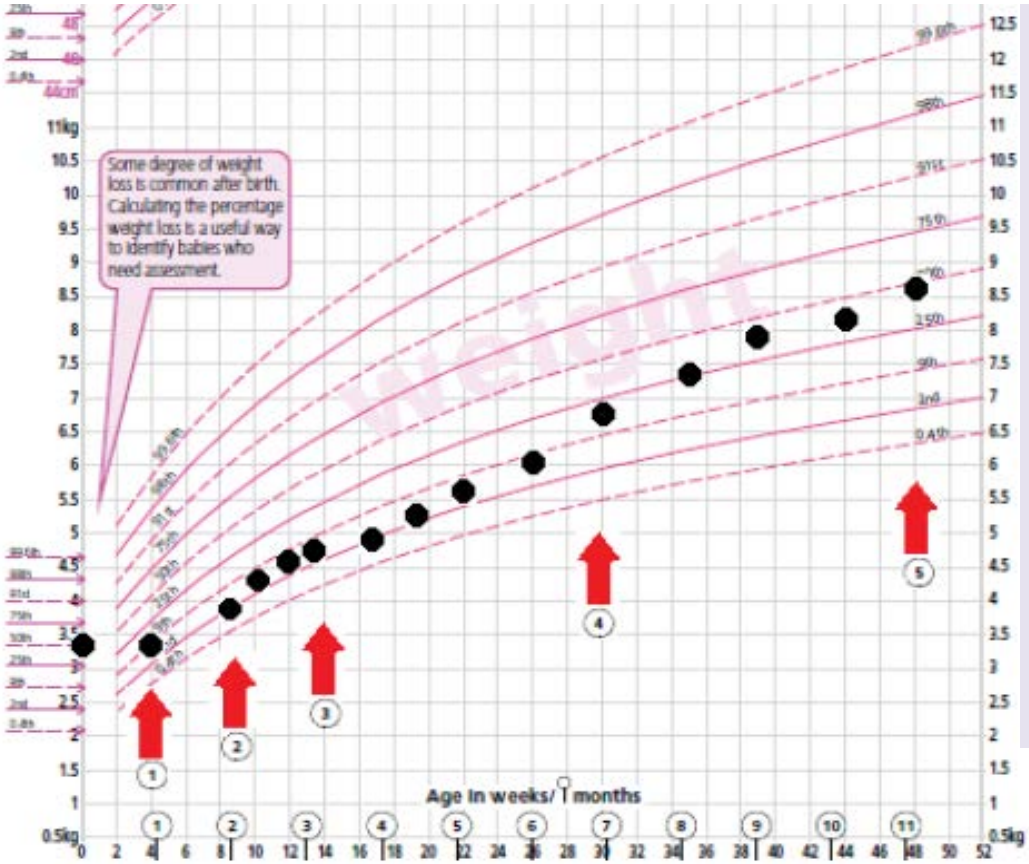
Delay of surgery [7]

Poor outcomes, increased mortality [6, 8]

1. Pillo-Blocka 2004; 2. Wong et al 2015; 3. Medoff-cooper & Irving 2009; 4.Kuwata et al 2013; 5. Roman 2011; 6. Curzon et al 2008; 7. Leitch CA et al 2000; 8. Radman et al 2014

Optimizing nutritional intakes improves weight gain and leads to better outcomes

Baby D – Congenital Heart Defect (VSD)*



Baby D born term – normal weight. 4 weeks after discharge on breastmilk weight falling off centile . Diagnosed CHD (VSD)

1. Start top-up breastmilk with Infatrini. Weight increased but inadequate for surgery
2. NG feeding started. Weight increased
3. Surgery took place at 12 weeks. Post surgery weight improved. NG taken out but 2 weeks later weight remained poor.
4. Mum discontinued breast feeding for 100% Infatrini + solids. Weight and length improved.
5. At 12mo back on birth centile. Infatrini discontinued

***Ref: Chris Smith Case study - 2015**

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CHD children often require a nutrient dense formula

"Patients with CHD present unique nutritional challenges, as they generally have higher energy and nutrient needs…" [1]

Requirements include:

- Nutrient Dense
- Low volume
- Well tolerated

"It is recommended that infants with CHD, (which is) known to be associated with FTT are fed on high-energy diets from the time of diagnosis in order to optimize growth.'' [2]

1. *Roman 2011; 2. Jackson & Poskitt 1991*

Use Infatrini pre-surgery to support weight gain and growth

Start infants with CHD on nutrient-dense formula in case of:

1. Fluid restrictions
2. Inadequate weight gain

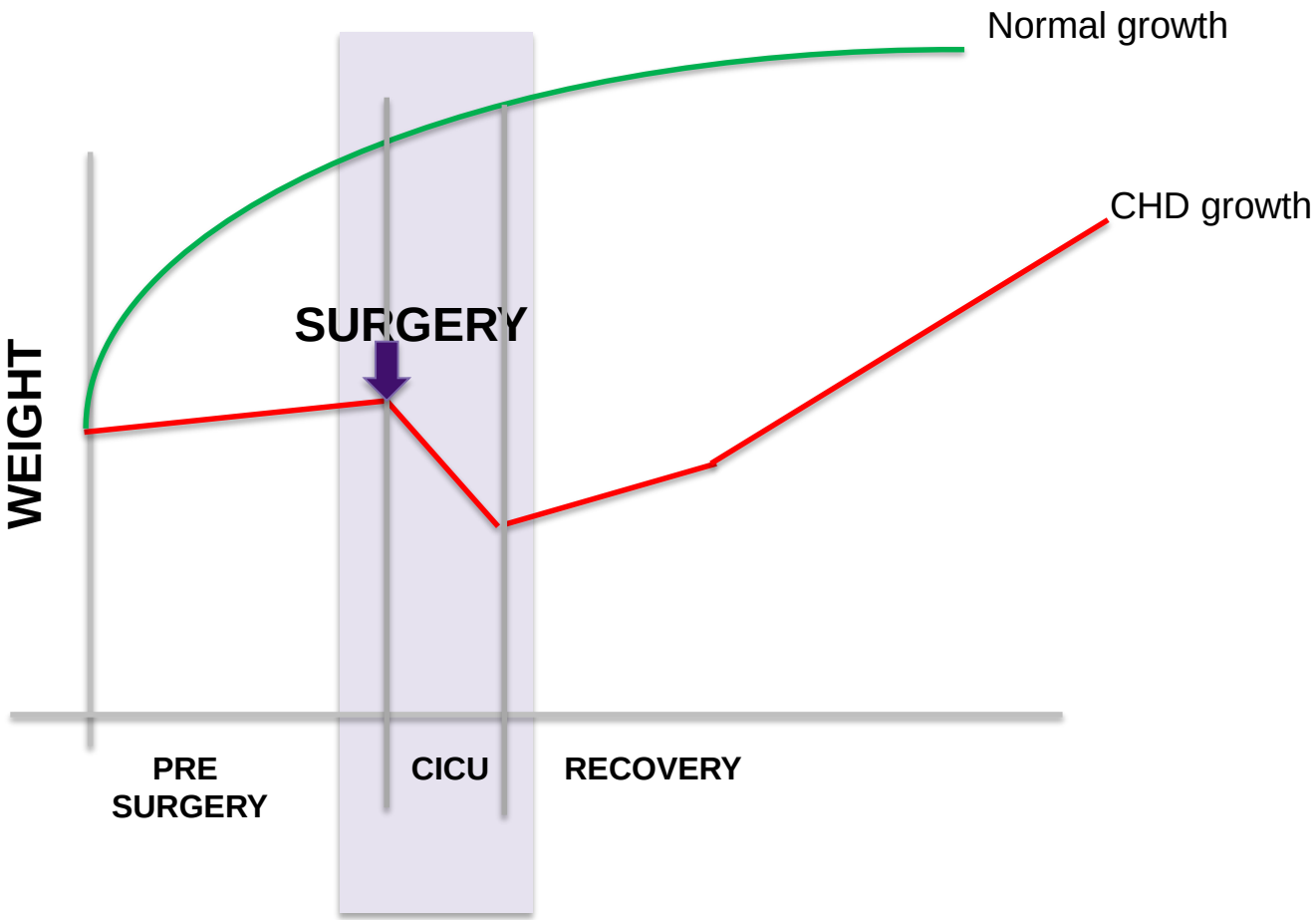
Considerations for usage:

- Top up to breast milk
- Provide small and frequent feeds in case of fatigue and/or early satiety
- NG tube in case of uncoordinated sucking and breathing issues

1. Lambert et al 2010

Weight trajectory is seriously compromised at all stages

Infants with CHD have a high risk of growth failure and nutritional imbalances [1-5]



1.Cabrera et al 2010; 2 Pillo-Blocka 2004; 3. Wong 2015; 4. Hassan et al 2015; 5. Leitch CA 2000;

CICU

Nutritional status and management impacts recovery during CICU

Consequences

1. **Up to 45% are acutely malnourished on admission to the PICU [1]**

- Lower weight at surgery negatively impacts CICU outcomes [2]

2. The majority do not receive their nutritional goals in the PICU[3]

- >77% did not achieve their prescribed enteral nutritional goals by day 7 [3]
- Enteral nutrition (EN) delivery is associated with improved outcomes in critically ill patients [3]

1.. De Souza Menezes et al, Nutrition, 2012; 2. Curzon et al 2008; 3. Martinez EE et al 2014

New evidence shows: right nutritional intervention lowers complications in the CICU and decreases hospital stay

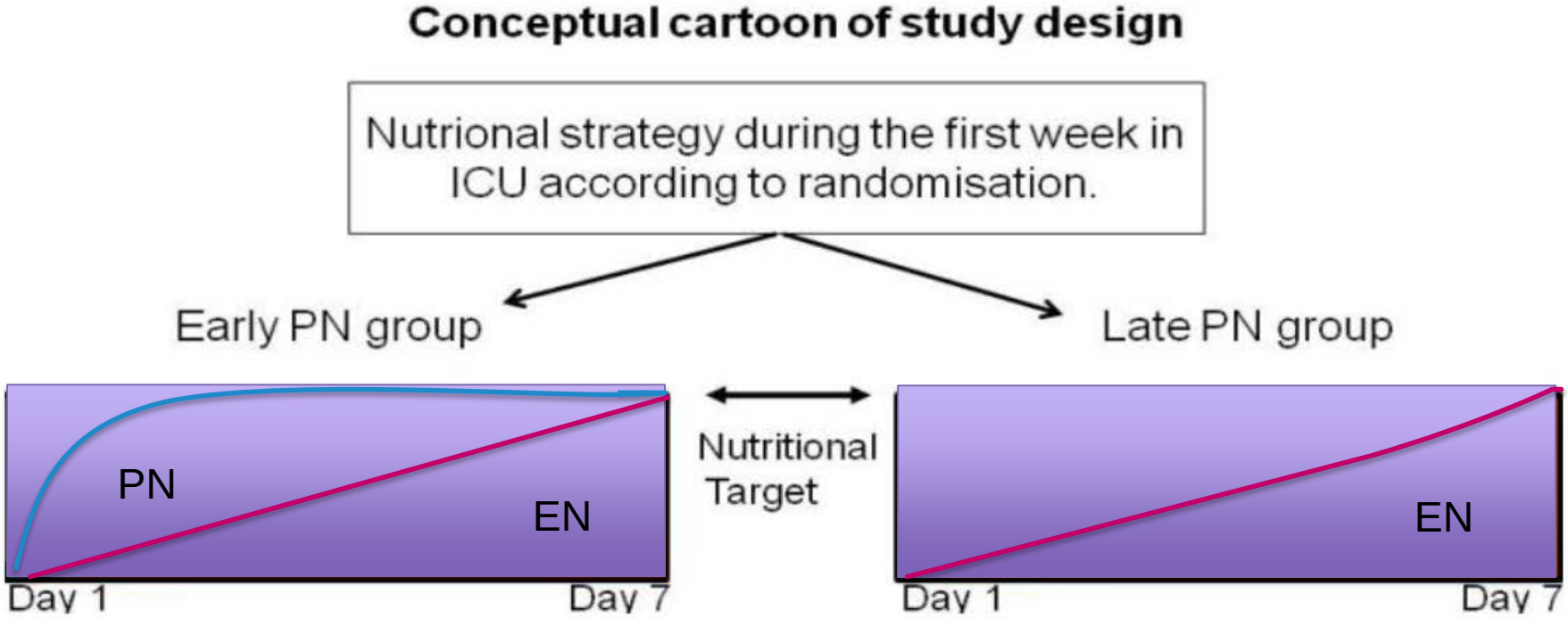
Impact factor 59,5

Early versus Late Parenteral Nutrition in Critically Ill Children

Tom Fivez, M.D., Dorian Kerklaan, M.D., Dieter Mesotten, M.D., Ph.D., Sascha Verbruggen, M.D., Ph.D., Pieter J. Wouters, M.Sc., Ilse Vanhorebeek, Ph.D., Yves Debaveye, M.D., Ph.D., Dirk Vlasselaers, M.D., Ph.D., Lars Desmet, M.D., Michael P. Casaer, M.D., Ph.D., Gonzalo Garcia Guerra, M.D., Jan Hanot, M.D., Ari Joffe, M.D., Dick Tibboel, M.D., Ph.D., Koen Joosten, M.D., Ph.D., and Greet Van den Berghe, M.D., Ph.D.

Study outline

In a multicenter, randomized, controlled trial with 1440 critically ill children investigators from 3 major centres (Canada, Belgium & Netherlands) looked at whether withholding parenteral nutrition for 1 week (i.e., providing late parenteral nutrition) was clinically superior to providing early parenteral nutrition (day one of surgery).



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PEPaNIC study outcomes

Early PN intervention vs late PN intervention results in:

- Increased infections (ca. 18,5% versus 10,7%)
- Increased PICU stay (9.2 vs 6.5 days)
- Higher ventilation time
- Increased hospital stay (average 4 days longer)

Children with high risk of undernutrition (STRONGKids score >4) were most at risk when given early PN

Conclusions:
In critically ill children, withholding parenteral nutrition for 1 week in the PICU was clinically superior to providing early parenteral nutrition.

" Early Enteral Nutrition improves [PICU] outcomes" [1]

"Enteral nutrition exerts beneficial effects on intestinal trophism, intestinal secretion, intestinal translocation, and other functions"[2]

1. Skillman & Mehta 2012; 2. Kreymann et al – ESPEN guidelines ICU 2006

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Enteral Nutrition in CICU improves outcomes

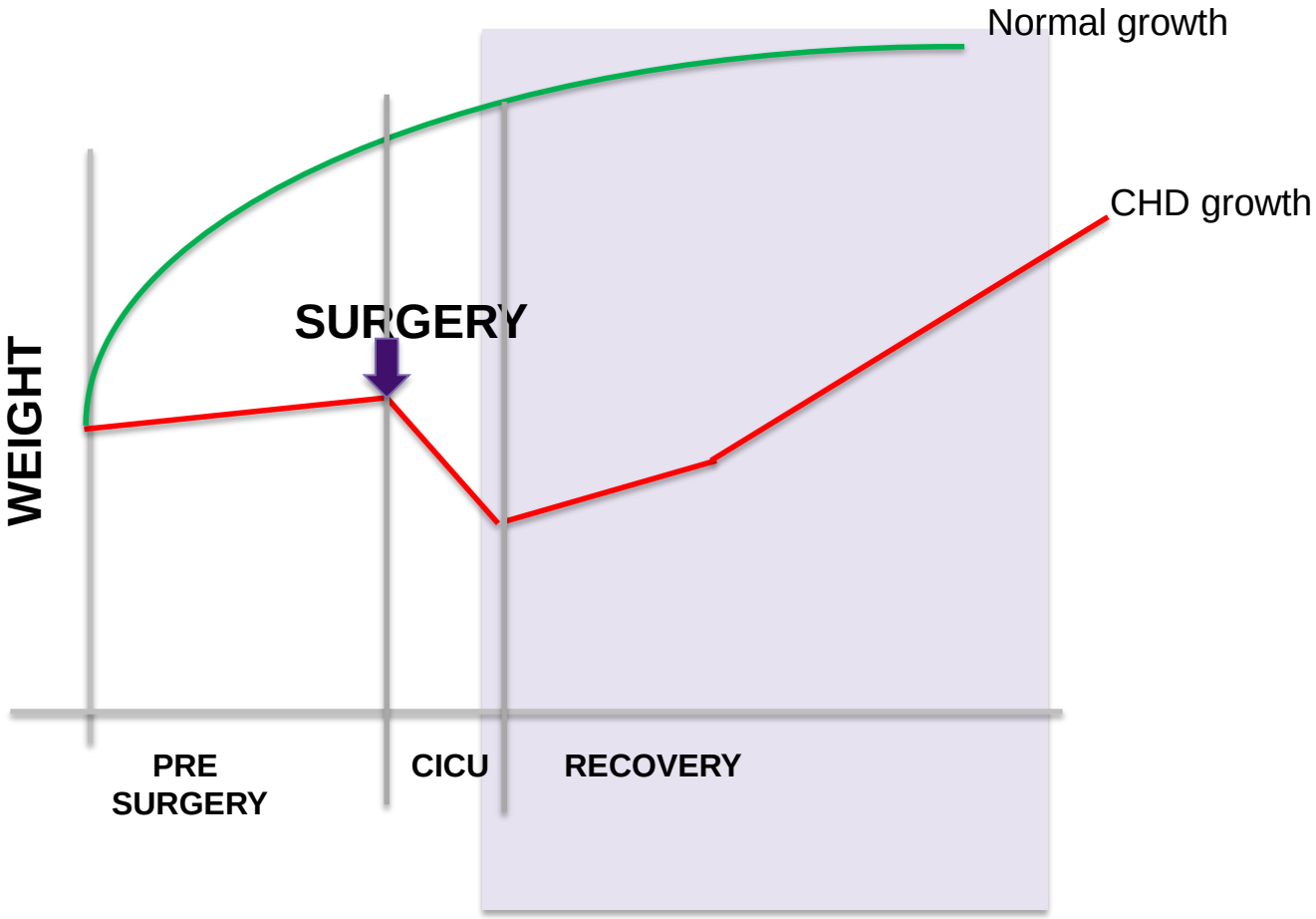
Early EN reduces morbidity and mortality through:

- Improved gut blood flow and is well tolerated in most PICU children [1, 2, Skillman & Mehta 2012]
- Reduced duration of mechanical ventilation [2]
- Reduced risk of infections due to less PN use [Skillman & Mehta 2012]
- Reduced costs due to less PN use (Skillman & Mehta 2012]

1. Panchal AK et al 2016; 2. Amanollahi & Azizi 2013;4 ASPEN 2012? 6. Briassiolis et al 2001

Weight trajectory is seriously compromised at all stages impacting long term growth

Malnutrition [<-2SD WFA (weight for age)] persisted in 27% of patients post surgery[6]



1.Cabrera et al 2010; 2 Pillo-Blocka 2004; 3. Wong 2015; 4. Hassan et al 2015; 5. Leitch CA 2000; 6. Vaidyanathan et al 2009

Chronic poor weight negatively impacts recovery and has long term consequences

Poor weight negatively impacts recovery

- Higher incidence of infections [1]
- Readmission to CICU
- Longer hospital stay[1]
- Poor weight at surgery increased mortality 12 months later![5]

Chronic low weight leads to poor growth

Poor early growth is associated with long term consequences

- Neurodisability [2,4]
- Stunting [2,3]
- Learning and behavioural problems [3]

1. Elbarbary et al 2014; ; 2 Ravishankar et al 2013; 3. Marino et al 2015; 4. Musatto et al 2014; 5. Mitting et al 2015

There are multiple reasons for sub-optimal recovery following surgery

Undernutrition at surgery [1, 3, 4,7]

Extended CICU stay [6]

RACHS score [1, 2,4]

Fluid restriction [1]

Feeding intolerance [1]

Inadequate nutrient intake, increased requirements

Risk of infections & poor wound healing, prolonged hospital stay [3,4,5]

Prolonged recovery

Poor long term outcomes including growth

1. Wong et al 2015. 2. Curzon et al 2008; 3. Anderson et al 2009, 2011. 4 .Roman 2011.5. Wallace et al 2011; 6. Radman et al 2014. 7. Mitting et al 2015

CHD children often require aggressive feeding during recovery

"Patients with CHD present unique nutritional challenges, as they generally have higher energy and nutrient needs…" [1]

AND…

"After heart surgery, children face significant challenges that impair adequate provision of nutrients." [2]

Requirements include:

- Nutrient Dense
- Low volume
- Well tolerated

1. Roman 2011; 2 Cabrera et al 2010;

Use nutrient-dense formula post surgery to support weight gain and growth

Aggressive NS is needed post surgery

- Aim for 120-150% of requirements
- Protein 50% higher than healthy children
- Use nutrient dense formula to achieve needs
- Feed often
- Monitor weight weekly (parents) if poor growth and then monthly as they progress

Considerations for usage:

- Top up to breast milk
- Provide small and frequent feeds in case of fatigue and/or early satiety
- NG tube in case of incoordinated sucking and breathing issues

1. Lambert et al 2010

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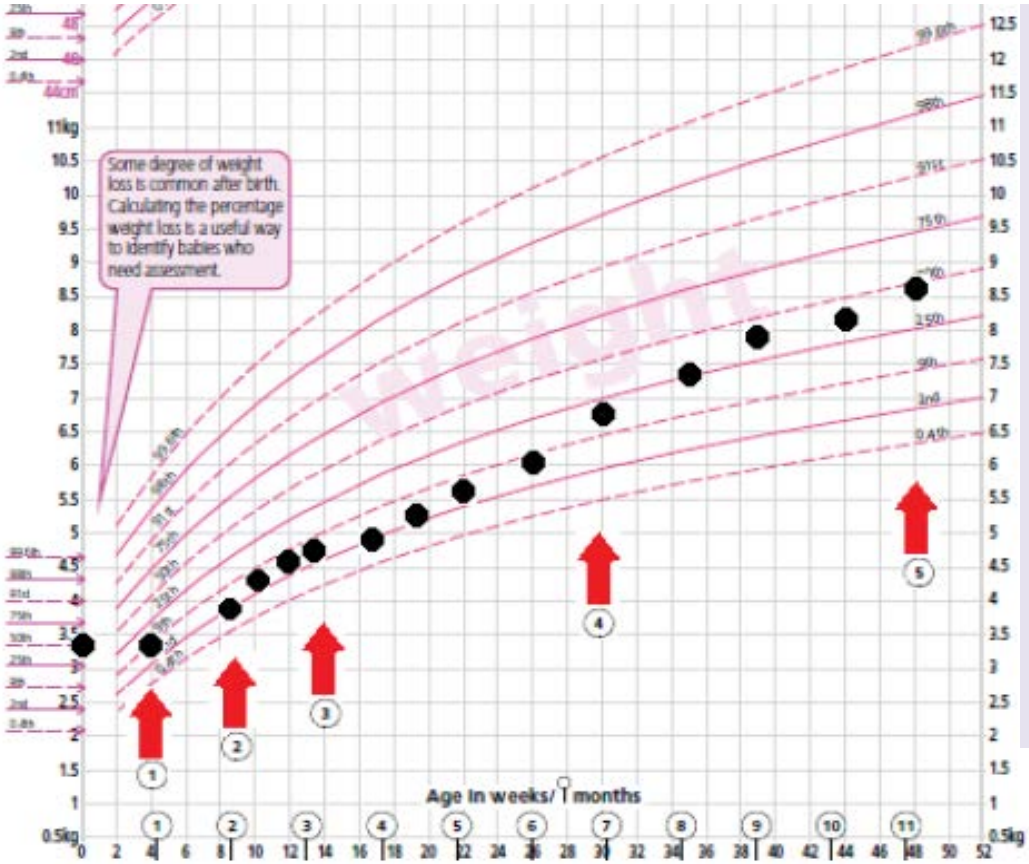

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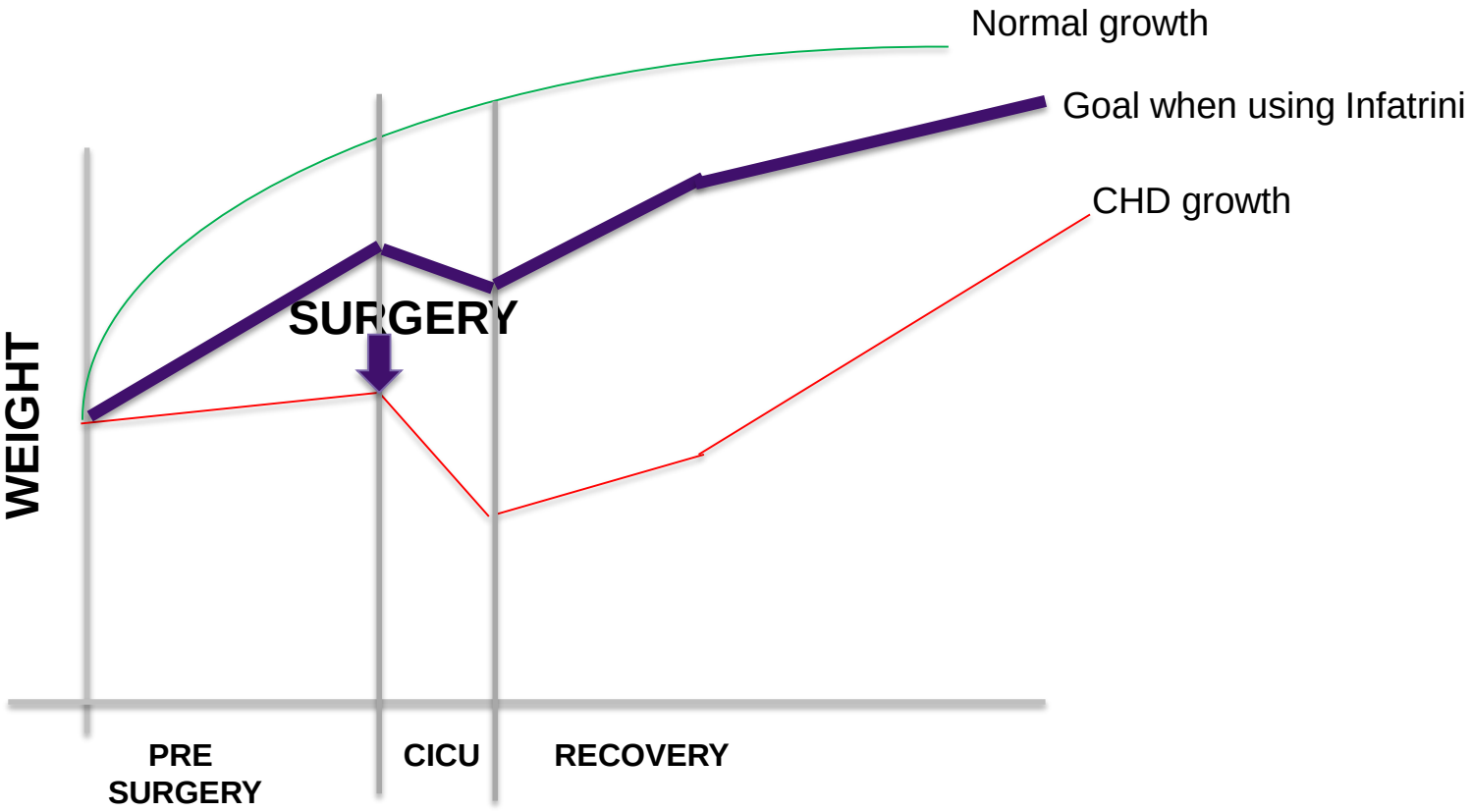
Infatrini, to support improved recovery and reduced complications in infants with CHD



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Determination of estimated nutrition needs for the infant with CHD

	Critical care	*Step-down/acute care*
Energy	Determine by indirect calorimetry, if available	120–150 kcal/kg; 140–200 kcal/kg for catch-up growth
	Provide REE (~55–60 kcal/kg) in the first 3–5 days after surgery or until CRP is <2 mg/dl	Catch-up growth equation (kcal/kg): $\frac{\text{Kcal/kg for weight age} \times \text{ideal body weight}}{\text{current weight}}$
Protein	Term: 3–3.5 g/kg Preterm or LBW: 3–4 g/kg	
Fluid	As per critical care fluid restriction (generally 50–80% MIVF with liberalization after medication wean and sternal closure)	<3 kg: 120 mL/kg >3 kg: 100 mL/kg Consider +10–15% to compensate for increased losses with tachypnea, diarrhea, emesis, and diuresis
Micronutrients	Potassium: 2–5 mEq/kg	
	Sodium: at least 2–3 mEq/kg even if sodium restriction is required	
	Supplement iron and vitamin D in breastfed infants and those with low formula intakes	

Abbreviations: REE = resting energy expenditure; CRP = c-reactive protein; LBW = low birth weight; MIVF = maintenance intravenous fluids

Forchielli ML, McColl R, Walker WA, et al. Children with congenital heart disease: a nutrition challenge. *Nutr Rev.* 1994;52:348-353; Leitch CA. Growth, nutrition and energy expenditure in pediatric heart failure. *Prog Pediatr Cardiol.* 2000;11:195-202; Leitch CA. Growth, nutrition and energy expenditure in pediatric heart failure. *Prog Pediatr Cardiol.* 2000;11:195-202; Owens JL, Musa N. Nutrition support after neonatal cardiac surgery. *Nutr Clin Pract.* 2009;24:242-249; Mehrizi A, Drash A. Growth disturbance in congenital heart disease. J Pediatr. 1962;61:418-429

Nutrition-related goals for the pediatric CHD patient

- **Pre-operative neonatal period**
  - *Provide adequate nutrition (preferably via EN) to meet the patient's needs until surgery*
- **Post-operative critical care**
  - *Initiate nutrition support as soon as possible to prevent development/ worsening of malnutrition, minimize the loss of LBM, and to support functioning of vital organs*
  - *Avoid refeeding syndrome in the infant with significant malnutrition*
  - *Avoid overfeeding, which can cause difficulty in weaning from the ventilator*
  - *Reduce unnecessary cessation of EN*

Forchielli ML, McColl R, Walker WA, et al. Children with congenital heart disease: a nutrition challenge. *Nutr Rev.* 1994;52:348-353; Leitch CA. Growth, nutrition and energy expenditure in pediatric heart failure. *Prog Pediatr Cardiol.* 2000;11:195-202; Owens JL, Musa N. Nutrition support after neonatal cardiac surgery. *Nutr Clin Pract.* 2009;24:242-249.; Hagau N, Culcitchi C. Nutritional support in children with congenital heart disease. *Nutr Ther Metab.* 2010;28:172-184.

Nutrition-related goals for the pediatric CHD patient

- **Step-down/acute care**
  - *Provide adequate nutrition to meet needs and correct nutrient or electrolyte deficiency*
  - *Transition from PN to 100% EN*
  - *Transition EN to oral or combination oral/supplemental EN; develop EN or oral schedule appropriate for home*
  - *Demonstrate age-appropriate or catch-up weight gain and growth*
  - *Parents/caregivers demonstrate competency in delivering appropriate nutrition prior to discharge*
- **Post-discharge/home setting**
  - *Demonstrate age-appropriate or catch-up weight gain and growth*
  - *Demonstrate age-appropriate feeding behaviors*

Forchielli ML, McColl R, Walker WA, et al. Children with congenital heart disease: a nutrition challenge. *Nutr Rev.* 1994;52:348-353; Leitch CA. Growth, nutrition and energy expenditure in pediatric heart failure. *Prog Pediatr Cardiol.* 2000;11:195-202; Owens JL, Musa N. Nutrition support after neonatal cardiac surgery. *Nutr Clin Pract.* 2009;24:242-249.; Hagau N, Culcitchi C. Nutritional support in children with congenital heart disease. *Nutr Ther Metab.* 2010;28:172-184.

What is current clinical practice?

- Increase volume
- Fortification with energy supplements
- Concentrate formula
- High energy/protein formula

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Increase volume of standard infant formula

This is not a realistic option as a low volume is often needed in these children e.g.

- Cardiac infants
- Poor feeders are unable to take volumes prescribed

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Fortification

Issues associated with fortification using glucose +/or fats	
Unbalanced feed – PE% is ↓ – ~5.5PE%[1]	Mixing feeds risk feed contamination[2,3]
Dilute nutrient composition – micronutrients and vitamins are approximately 50% lower[1]	Preparation errors[1]
Increases osmolality[4]	Time consuming

1) Clarke et al 2007; 2) Mathus-Vlieger 2006; 3) Beattie TK et al 1999; 4) Evans et al 2006

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Concentrate standard infant formula

Issues when concentrating the nutrients:

- Preparation errors – add in an extra scoop!
- ↑ electrolyte & ↑ pRSL* – >35mOsmol/100kcal risks hypertonic dehydration in some sick infants (recommended 20–26/100kcal)[1] *(unable to tell level in concentrated formula)*
- Difficult to make up to 100kcal/100ml – protein up to 2.3g/kg but osmolality can reach close to 500mOsmol/kg (487mOsmol)[2] (recommended <400mOmol/kg for sick infants[3])
- Time consuming
- Protein energy % stays the same

**Potential Renal Solid Load*

1) Fomon & Zeigler 1999; 2) Numico Research – data on file 2007; 3) GOSH 2000

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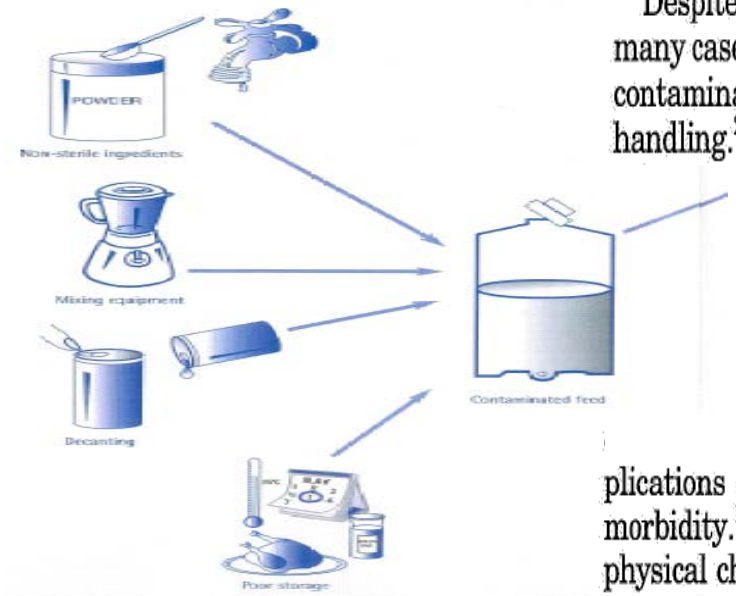
Mixing of feeds causes contamination and therefore is a risk of infectious complications

Main sources and routes of microbial contamination in enteral feeding systems



Despite continuously improving feeding systems, many cases have been reported in which feedings became contaminated with microorganisms, very likely during handling.[2–4,8–12]

...this might be catastrophic as infectious complications are associated with increased mortality and morbidity.[19,20] Finally, changes in nutrition value and physical characteristics of the feeding may occur.[21]

Infection Control Nurse Association – www.icna.co.uk; Mathus-Vliegen 2006

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Thank you

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