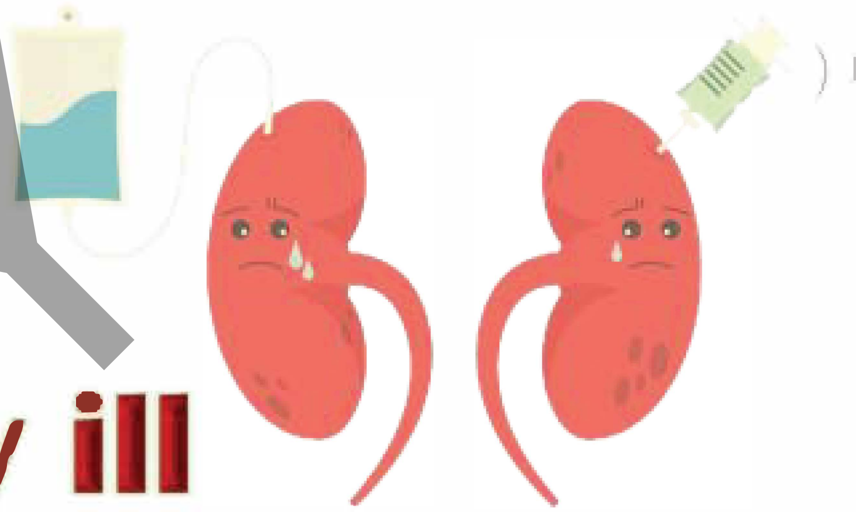
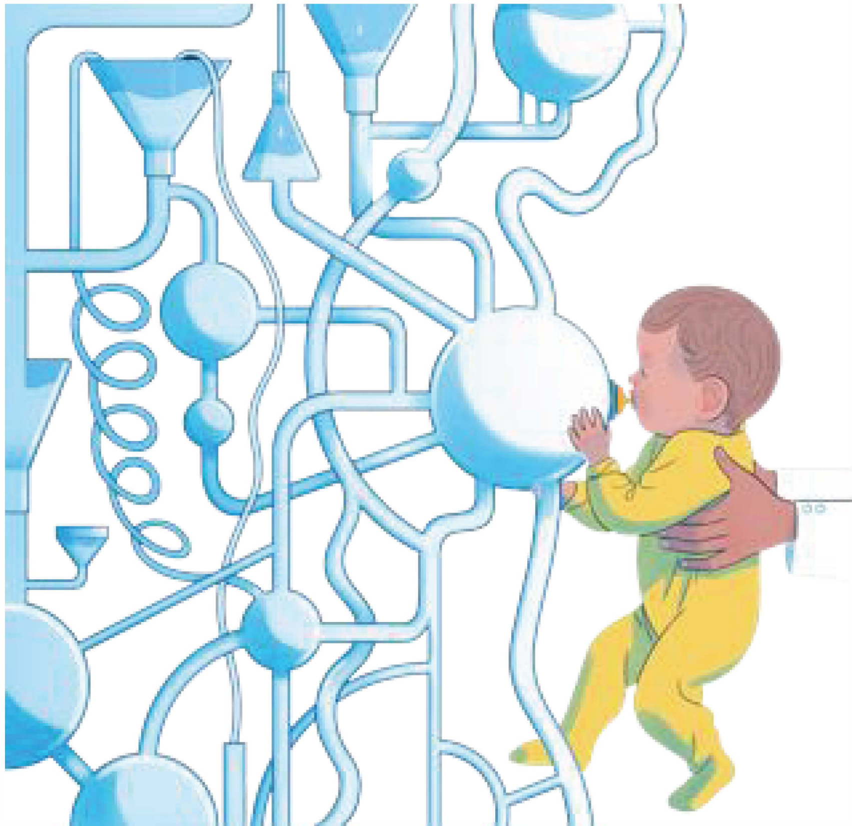
Nutrition of critically ill children with AKI



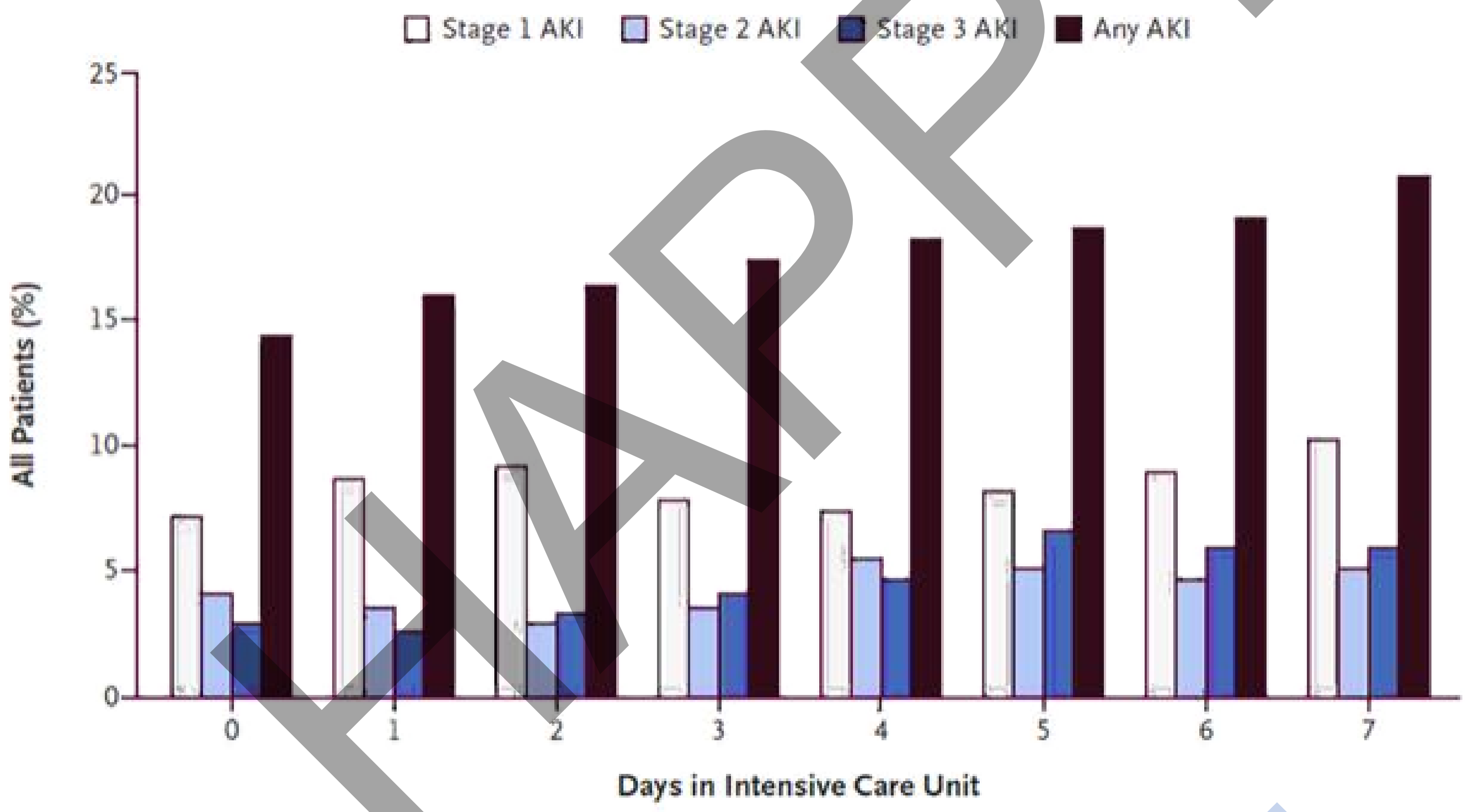
Prof.
Happy Sawires (MD, FESPN)
Professor of Pediatrics
Cairo University



AGENDA

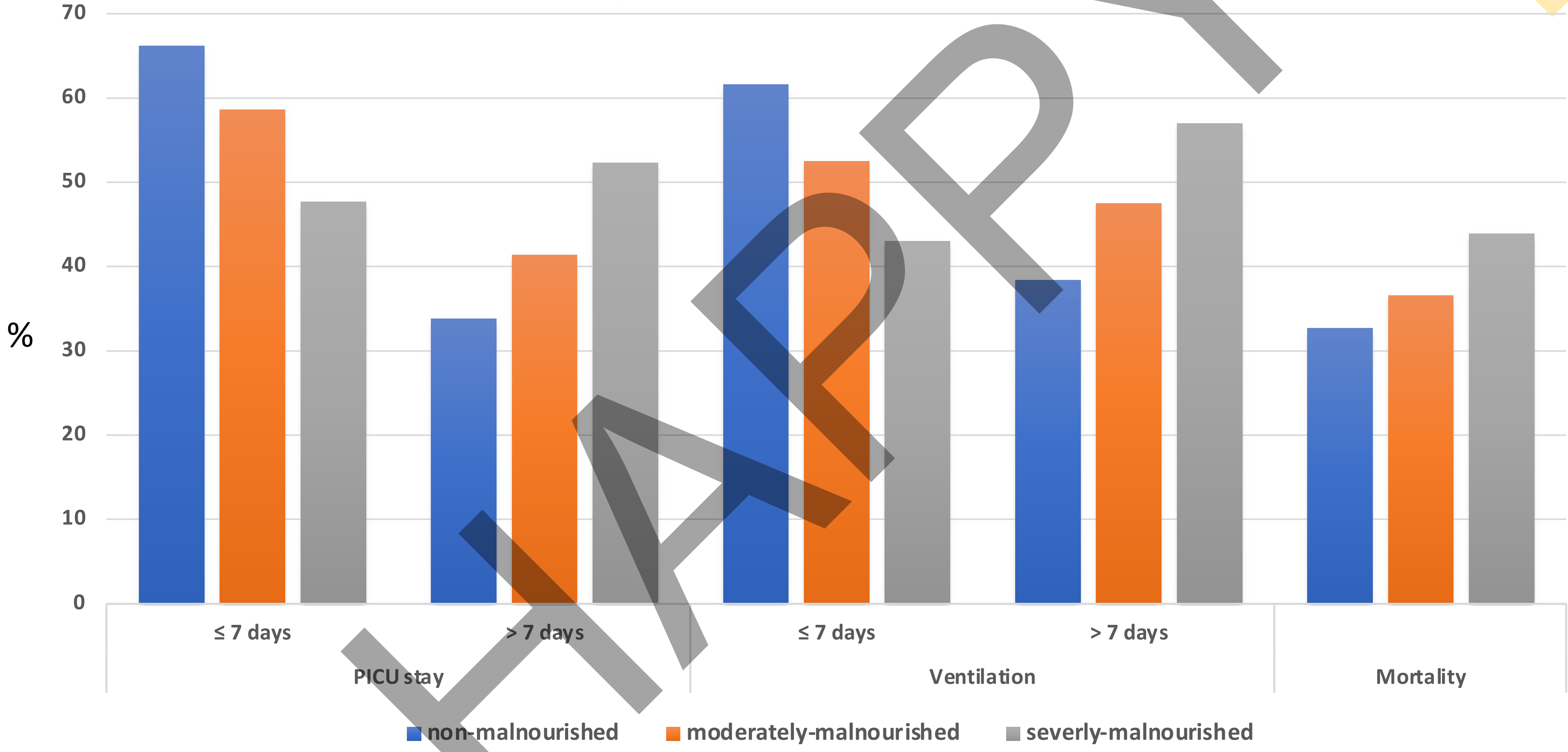
- Metabolic & hormonal derangement
- Assessment of nutritional status
- Early enteral nutrition
- Monitoring tolerance of feeding
- Managing the barriers

Pediatric AKI:
A common problem in critically ill children



N Engl J Med. 2017; 376(1):11-20

Impact of malnutrition on the outcome of critically ill children with AKI



Indian J Pediatr 2015; 82(7):601–605

Pathogenesis of PEW in critically-ill children with AKI

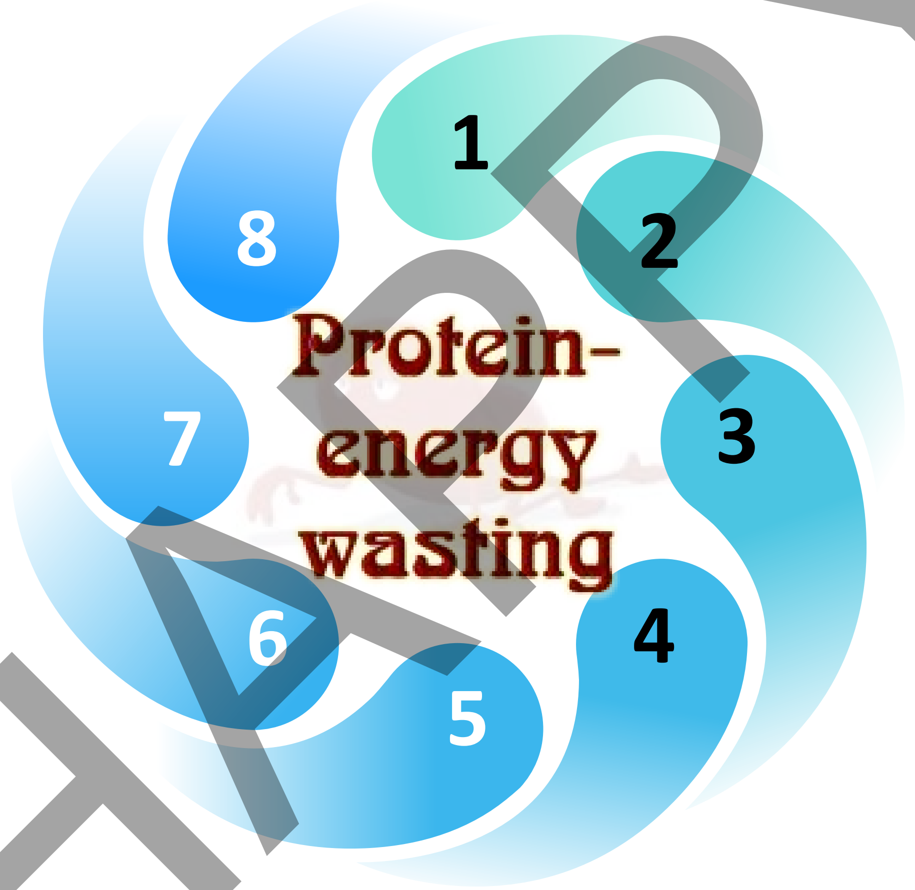
8 Loss of nutrients in RRT

7 Proteases

(ubiquitine–proteasome system, etc.).

6 SIRS/ acute phase reaction

5 Resistance/ suppression of growth anabolic factors



1 Inadequate supply of nutrients

2 Uremic toxins & metabolic acidosis

3 Insulin resistance

4 ⇑ secretion of cetabolic hormones

Glucocorticoids, catecholamines, glucagon

NDT Plus. 2010;3(1):1-7

Nutritional assessment of critically-ill infants & children

A	B	C	D
Anthropometry	**Biochemical**	**Clinical**	**Dietary**
Weight, height/length, growth charts, classify patients (stunted, wasting, etc…)	Albumin, Hb, Ca, P, Na, K and serum Fe	Dehydration / overload Signs of wasting Pallor / vitamin deficiency	Calories & protein required Type of feed Rate / volume of feed Route of feed
Challenges	**Challenges**	**Challenges**	
Wt. is not a proper way in AKI (dehydration/overload) >>> MUAC	Albumin ($t\frac{1}{2}$ = 20 D) (false indicator in NS) >> pre-albumin ($t\frac{1}{2}$ = 2 D) transferrin ($t\frac{1}{2}$ = 8 D)	All are subjective Considered late markers	

Pediatr Nephrol. 2017; 32:589–601

Derangement | **Assessment** | EEN | Monitoring | Barriers

Pediatr Nephrol 2023. doi: 10.1007/s00467

Energy Requirements

Catabolism & muscle protein breakdown is not reversed with increased provision of nutrients during critical illness

Energy requirements should not exceed the resting energy expenditure (REE)

Modify the energy prescription for dialysis-related net gain or loss of energy

- If fever > 38°C, REE can be increased
- If deeply sedated, REE can be decreased
- Consider:

  - Citrate and lactate provide (3-3.6 kcal/g)

  - APD provide calories from glucose-containing dialysis solution

Energy Requirements

How to determine REE?

Indirect Calorimetry

measuring O_2 uptake and CO_2 production of a spontaneously breathing subject (dilution method with canopy hood)

Alternatives:

- WHO
- Schofield w
- Schofield w/l

	Age	Boys	Girls
WHO	0–3 y	60.9×(w kg)−54	61.0×(w kg)−51
	3–10 y	22.7×(w kg)−495	22.5×(w kg)+486
	10–18 y	22.7×(w kg)+651	12.2×(w kg)+746
Schofield w	0–3 y	59.5×(w kg)−30	58.3×(w kg)−31
	3–10 y	22.7×(w kg)+505	20.3×(w kg)+486
	10–18 y	17.7×(w kg)+658	13.4×(w kg)+692
Schofield w/l	0–3 y	0.167×(w kg)+1517.4×(l m)−616.6	16.252×(w kg)+1023.3×(l m)−413.5
	3–10 y	19.6×(w kg)+130.3×(l m)+414.9	16.25×(w kg)+161.8×(l m)+371.2
	10–18 y	16.97×(w kg)+137.2×(l m)+515.5	8.365×(w kg)+465×(l m)+200.0

WHO, World Health Organization; *REE*, resting energy expenditure; *w*, weight; *l*, length

Pediatr Nephrol 2023. doi: 10.1007/s00467

Protein Requirements

01 ⇑ protein intake above the SDI to limit -ve protein balance

02 Dialysis: further increased to account for dialysis losses

03 V. high BUN: a temporary ⇓ ptn intake to the lower end of the SDI

Reference to the SDI for height

Month	SDI protein (g/kg/day)
0	1.52–2.5
1	1.52–1.8
2	1.4–1.52
3	1.4–1.52
4	1.3–1.52
5	1.3–1.52
6–9	1.1–1.3
10–11	1.1–1.3
12	0.9–1.14
Year	
–	
2	0.9–1.05
3	0.9–1.05
4–6	0.85–0.95
7–8	0.9–0.95
9–10	0.9–0.95
11–12	0.9–0.95
13–14	0.8–0.9
15–17	0.8–0.9

Pediatric Nephrology (2020) 35:519–531

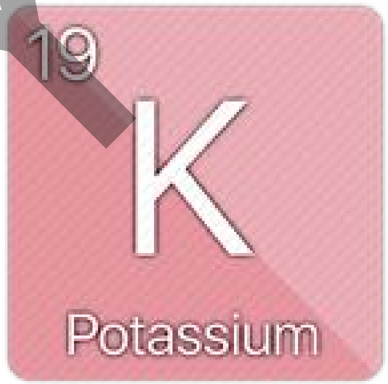
Another target

~ 10% of K excreted through intestine

~ 90% of K excreted through urine

UNTIL

GFR < 10-15 ml/min/1.73 m^2



K intake should be limited for critically-ill children who have, or are at risk of hyperkalemia

KDOQI Clinical Practice Guideline for Nutrition in Children with CKD; 2009

Low electrolyte formula

(Renastart)

Rationale

- To maintain K level within normal range **(low K)**
- To limit P intake in CKD patients **(lower P than standard formula)**
- To maintain Na level **(higher Na)** — consider that in critically-ill
- Adequate caloric intake to achieve optimum growth **(high calories)**

Tips

1. **In dialysis patients:** additional supplemental water-soluble vitamins, selenium, copper, zinc, and carnitine

2. **Avoid vitamin A:** with ⇓ GFR >>> high levels of retinol

3. Nutritional electrolyte delivery should be individualized

4. **Na & fluid status:** continuous monitoring

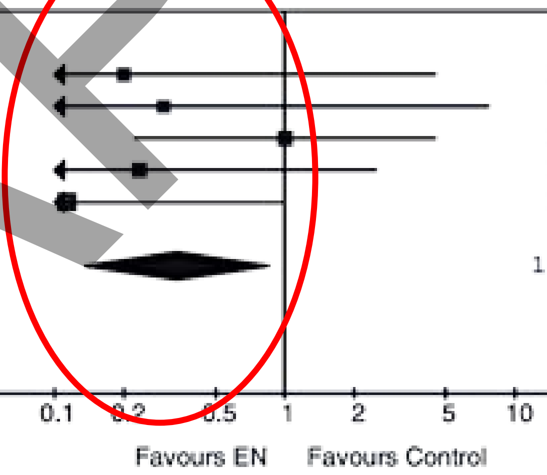
Pediatr Nephrol 2023. doi: 10.1007/s00467

Early initiation of nutrition in acute phase of critical illness

- **Is it beneficial to initiate early feeds in the acute phase of critical illness?**
- Meta-Analysis, 6 small trials, 234 patients
- Survival benefit with EEN (24 h) as compared to delayed initiation

Study or sub-category	early EN (<24 h) n/N	Control n/N	OR (fixed) 95% CI	Weight %	OR (fixed) 95% CI
Chiarelli 1990	0/10	0/10			Not estimable
Kompan 1999	0/17	2/19		13.40	0.20 [0.01, 4.47]
Kompan 2004	0/27	1/25		8.89	0.30 [0.01, 7.63]
Nguyen 2008	6/14	6/14		19.95	1.00 [0.22, 4.47]
Chuntrasakul 1996	1/21	3/17		18.38	0.23 [0.02, 2.48]
Pupelis 2001	1/30	7/30		39.38	0.11 [0.01, 0.99]
Total (95% CI)	119	115		100.00	0.34 [0.14, 0.85]

Total events: 8 (early EN (<24 h)), 19 (Control)
Test for heterogeneity: Chi² = 3.20, df = 4 (P = 0.52), I² = 0%
Test for overall effect: Z = 2.31 (P = 0.02)



Intensive Care Med. 2009; 35(12):2018-27

Early Enteral Nutrition (EEN)

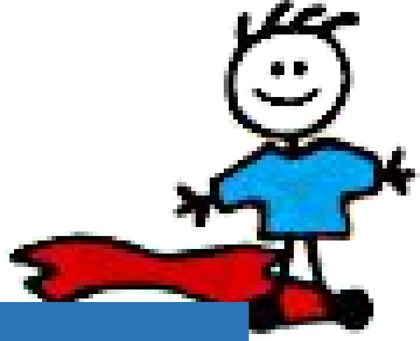
- EEN (within 48 h) once hemodynamically stable.

- Feeding > 72 h has shown ⇑ risk of:
  - gut permeability
  - bacterial translocation
  - increased SIR

Contraindication of EEN

- Unstable (frequent resuscitation or ? Vasopressor manipulation)
- NPO for a procedure
- GIT problems
- Anticipated intubation or extubation within 6 h

Pediatr Nephrol 2023. doi: 10.1007/s00467



Rate of feeding

- Depends on age/size
- Start 50-60% of maintenance volume 4 age
- **Goal to be achieved within 2-3 days**

Types of feeds

- Breast milk (?)
- **Expressed breast milk**
- **Standard infant formula**
- **Special formulas…**

Route of feeding

- Oral
- **NG tube feeding**
- **Jejunal tube feeding**
- Parenteral

Pediatr Nephrol 2023. doi: 10.1007/s00467

Parenteral Nutrition (PN)

For children without malnutrition or risk for nutrition deterioration, when EN cannot started, PN may be withheld for up to 1 week provided micronutrients are delivered.

PN should be initiated when EEN cannot provide all nutritional requirements for infants/children at risk of malnutrition or nutritional deterioration

Regardless of nutritional status, those receiving KRT that causes significant nutrient losses, initiation of PN before 1 w should be considered when EEN cannot be started

Pediatr Nephrol 2023. doi: 10.1007/s00467

Route of feeding

NO CONSENSUS

Continuous drip	Bolus feeding
– Less time consuming – Easier to monitor – May delay gastric emptying – May reduce gall bladder contraction	– More physiological – Difficult to monitor – Additional nursing time – Not suitable for ICU

Concentration of feeds

when the calories cannot be achieved because of fluid restrictions

Maximum concentrations cannot be exceeded

Carbohydrate concentrations [g/100ml]

- < 6 mths: 10 -12%
- 6-12 mths: 12- 15%
- 1-2 yrs: 15 – 20%
- children: 20 – 30%

Fat concentrations [g/100ml]

- Infants: 5 – 6 %
- Children: 7%

In infancy Per 100 ml
Infant formula (standard dilution[1])
Mature breast milk[2]
Renastart 13.5% dilution[3]
Renastart 15% dilution[3]
Renastart 20% dilution[3]
For over 1 year of age Per 100 ml
Renastart 20% dilution[3]
Renastart 30% Dilution[3]
Renastart 40% Dilution[3]

Monitor tolerance of feeding

Input

Fluids, nutrition, medications, biologics, etc..

Output

Vomiting, stools, urine, NGA

Others

Abdominal distension, weight daily

Managing barriers to feeding

01 Fluid restriction

- Common in renal patients with AKI
- Prioritize the use of fluids for nutrition
- Use energy dense formula

02 Vomiting

- Medications: PPI, ondansetrone
- NJT feeding

03 Feeding interruptions

- For procedures / trials of extubation
- Feeding restarted gradually to achieve the full volume (days)
- NJT feeding may assist in reducing time periods if many procedures

CONCLUSION

- Proper assessment is needed before start of enteral nutrition
- EEF should be considered unless contraindications
- Monitor input and output
- Don’t forget that improvement of the general condition will lead ultimately to improvement of nutritional status of the patient


thank you!