

The Biology of Malnutrition



Part 5 - Refeeding

Metabolic Response to Refeeding

- Insulin release is stimulated by the presence of carbohydrate and protein in the gut
 - Plays a key role in the switch from using up body stores to using food
 - Stops the release of fat from stores and production of glucose from protein
 - Stops sodium excretion
 - Causes fluid retention in the first few days of refeeding and when the caloric intake is increased

Effects of Refeeding on the Cardiovascular System

- ❑ Increases in heart rate, blood pressure, oxygen consumption, cardiac output and an expansion of plasma volume are seen
- ❑ Response is dependent on amount of calories, protein and sodium given
- ❑ The malnourished heart can easily be given a metabolic demand that is too high for it to supply

Effects of Refeeding on the Cardiovascular System

- Congestive Heart Failure is a common complication of refeeding
 - Cardiac output can't increase enough to meet the needs from the increased plasma volume, increased oxygen consumption and increases in blood pressure and heart rate

Effects of Refeeding on the Respiratory System

- ❑ Excess carbon dioxide production and increased oxygen consumption can result from giving too much glucose and overfeeding
- ❑ A person with malnutrition-induced respiratory muscle wasting can get short of breath
 - Can't sustain an increased ventilatory drive
- ❑ Pulmonary edema may develop in some due to increased water load

Effects of Refeeding on the Gastrointestinal System

- Activity of the brush border enzymes and pancreatic enzyme secretion return to normal with refeeding
- Requires a period of readaptation to food to minimize GI complaints
 - Diarrhea, nausea and vomiting

Metabolic Consequences of Refeeding

- Overfeeding carbohydrate can result in high blood sugars and dehydration
 - Expansion of the extracellular fluid may lead to edema (swelling)
- Phosphorous
 - Blood levels may decrease in the first few days
 - Moves into cells from blood because of need in making phosphorylated compounds in the cell
 - Insulin promotes uptake in liver and muscles
 - Very low levels can lead to respiratory, cardiac, nervous system, and red and white blood cell dysfunction

Metabolic Consequences of Refeeding

□ Potassium

- Refeeding causes a shift of potassium into the cells from the blood and the rebuilding of proteins also incorporates potassium into the cell protoplasm
- Low blood potassium levels may results
 - Can cause irregular heart rhythm

Metabolic Consequences of Refeeding

□ Magnesium

- Goes into the cell from the blood with refeeding and new tissue synthesis
 - Important cofactor in many enzyme systems involving energy storage and utilization and protein synthesis
 - Important for the proper functioning of the CNS, the peripheral neuromuscular system, and the cardiovascular system
- Low blood magnesium levels may cause irregular heart rhythm, hypocalcemia, muscle weakness, and neurologic symptoms

Thiamin Deficiency and Refeeding

- Deficiency may contribute to refeeding syndrome
- Functions as a cofactor in intermediary carbohydrate metabolism
- Amount needed depends on carbohydrate ingested, so feeding carb without adequate thiamin supplementation can lead to deficiency symptoms
 - Mental confusion, ataxia, muscle weakness, edema, muscle wasting, tachycardia and cardiomegaly
- Wernicke's encephalopathy can be precipitated by carbohydrate feeding in thiamine-deficient patients

Recommendations for Refeeding

□ Adults

- Provide calories at estimated basal energy expenditure based on actual body weight
 - No more than 1.2XBEE
 - No more than 150 to 200 gm of glucose
 - 1.2-1.5 gm of protein per kg actual bodyweight
 - 20-30% of calories from fat
- Begin feedings slowly and increase gradually over 5 to 7 days
 - Affects most significant in first few days of refeeding and it may take 1 week to adapt to the increase oxygen demand
- Weight gain is not a goal in the first week of refeeding

Fluid in Refeeding

- ❑ Refeeding results in expansion of the extracellular space and fluid must be given carefully during the first few days to weeks of refeeding
- ❑ Weight gain greater than 1 kg the first week is due to fluid retention
- ❑ Fluid may need to be restricted to 800 to 1000cc/day
- ❑ Increases in blood pressure, heart rate and respiratory rate may be early signs of fluid excess

Electrolytes in Refeeding

- Sodium must be given carefully to prevent overexpansion of the extracellular fluid
- Additional phosphorus is required when refeeding
 - 250-500 mg/day up to 5 to 7 days may be needed to replenish
- Potassium serum levels should be in the high normal range with 80 to 120 mEq/day needed
- Magnesium and thiamin also should be given

Treatment of the Malnourished Child

Essential features of the initial feeding are

- Frequent small feeds of low osmolality and low in lactose
- Oral or nasogastric feeds (never IV feeds)
- 100 kcal/kg/day
- Protein 1-1.5 gm/kg/day
- Liquid: 130 ml/kg/day (100 if child has severe edema)
- Continue with breastfeeding but give scheduled amounts of formula first

Treatment of the Malnourished Child

- Clinical status must be monitored carefully
- Child should be fed every 2 hours for the 1st day or 2, then every 3 hours until day 6
- If child's intake does not reach 80 kcal/kg/day despite frequent feeds, coaxing and re-offering, the remaining feed should be given by nasogastric tube

Treatment of the Malnourished Child

- Return of the appetite is the sign for entering the rehabilitation phase
 - Usually about 1 week after admission
- During this phase very high intakes are encouraged to support a weight gain of $>10\text{g/kg/day}$
 - Must be alert to avoid heart failure (rapid pulse and fast breathing) if intake is high suddenly
- Modified porridges or complementary foods can be used if comparable in energy and pro

Treatment of the Malnourished Child

- Increase each feed by 10 ml until some remains uneaten
 - Likely to occur when intakes reach about 200ml/kg/day
- After a gradual transition, give
 - Frequent feeds, unlimited amounts
 - 150-220 kcal/kg/day
 - 4-6 g/kg/day of protein

Treatment of the Malnourished Child

- Sensory stimulation and emotional support also a part of the therapy, so need to provide:
 - Tender loving care
 - A cheerful stimulating environment
 - Structured play therapy for 15-30 minutes a day
 - Physical activity as soon as the child is well enough
 - Maternal involvement as much as possible (e.g. comforting, feeding, bathing, play)

Oral Rehydration Salts

- ❑ ORS is responsible for saving the lives of millions of children worldwide
- ❑ Inexpensive solution of sodium and glucose used to treat acute diarrhea
- ❑ Since WHO adopted ORS in 1978 as its primary tool to treat diarrhea, the mortality rate for children with this disease has gone from 5 million to 1.3 annually

Formula for concentrated electrolyte/mineral solution (WHO)

Formulas and recipes for severely malnourished children

A3.1 Formula for ReSoMal: rehydration solution for severely malnourished children

ReSoMal recipe

Ingredient	Amount
Water	2 litres
WHO-ORS	One 1-litre packet*
Sucrose	50 g
Electrolyte/mineral solution**	40 ml

* 3.5 g sodium chloride, 2.9 g trisodium citrate dihydrate, 1.5 g potassium chloride, 20 g glucose.

** See section A3.2 (below) for the recipe for the electrolyte/mineral solution. If this cannot be made up, use 45 ml of KCl solution (100 g KCl in 1 litre of water) instead.

ReSoMal contains approximately 45 mmol Na, 40 mmol K, and 3 mmol Mg per litre. For the use of ReSoMal in the management of dehydration in severely malnourished children, follow the guidelines given in Chapter 7 section 7.2.3.

A3.2 Formula for concentrated electrolyte/mineral solution

This is used in the preparation of starter and catch-up feeding formulas and ReSoMal. Sachets containing premixed electrolytes and minerals are produced by some manufacturers. If these are not available or affordable, prepare the solution (2500 ml) using the following ingredients:

	g	mol/20 ml
Potassium chloride: KCl	224	24 mmol
Tripotassium citrate	81	2 mmol
Magnesium chloride: MgCl ₂ ·6H ₂ O	76	3 mmol
Zinc acetate: Zn acetate·2H ₂ O	8.2	300 µmol
Copper sulfate: CuSO ₄ ·5H ₂ O	1.4	45 µmol
Water: make up to	2500 ml	

If available, also add selenium (0.028 g of sodium selenate, NaSeO₄·10H₂O) and iodine (0.012 g of potassium iodide, KI) per 2500 ml.

Recipes of refeeding formulas F-75 and F-100 (WHO)

A3.3 Recipes of refeeding formulas F-75 and F-100

	F-75 ^(a) (b) (starter)	F-75 ^(c) (starter: cereal- based)	F-100 ^(d) (catch-up)
Dried skimmed milk (g)	25	25	80
Sugar (g)	100	70	50
Cereal flour (g)	-	35	-
Vegetable oil (g)	27	27	60
Electrolyte/mineral soln (ml)	20	20	20
Water: make up to (ml)	1000	1000	1000
Contents per 100 ml			
Energy (kcal)	75	75	100
Protein (g)	0.9	1.1	2.9
Lactose (g)	1.3	1.3	4.2
Potassium (mmol)	4.0	4.2	6.3
Sodium (mmol)	0.6	0.6	1.9
Magnesium (mmol)	0.43	0.46	0.73
Zinc (mg)	2.0	2.0	2.3
Copper (mg)	0.25	0.25	0.25
% energy from protein	5	6	12
% energy from fat	32	32	53
Osmolality (mOsm/l)	413	334	419

http://www.who.int/child-adolescent-health/publications/referral_care/app3/app3.htm

Refeeding formulas - WHO

- Starter formula may be made with fresh cow's milk
 - 300 ml milk
 - 100 g sugar
 - 20 ml oil
 - 20 ml electrolyte/mineral solution
 - Water to make 1,000 ml

Refeeding formulas

- Catch up formula can be made using fresh cow's milk
 - 880 ml milk
 - 75 gm sugar
 - 20 ml oil
 - 20 ml electrolyte/mineral solution
 - Water to make 1,000 ml

Other Issues Regarding Malnutrition and Catch up Growth

- ❑ There is an association between low growth in the first year and an increased risk of CHD
- ❑ Blood pressure has been found to be highest in those with retarded fetal growth and greater weight gain in infancy
- ❑ Short stature is associated with an increased risk of CHD and stroke and to some extent diabetes

Other Issues Regarding Malnutrition and Catch Up Growth

- ❑ The risk of stroke and cancer mortality at several sites is increased if shorter children show an accelerated growth in height
- ❑ An association of low growth in childhood and an increased risk of CHD has also been described, irrespective of size at birth
- ❑ In most studies the association between LBW and HBP is particularly strong if adjusted to current body size, suggesting importance of weight gain after birth

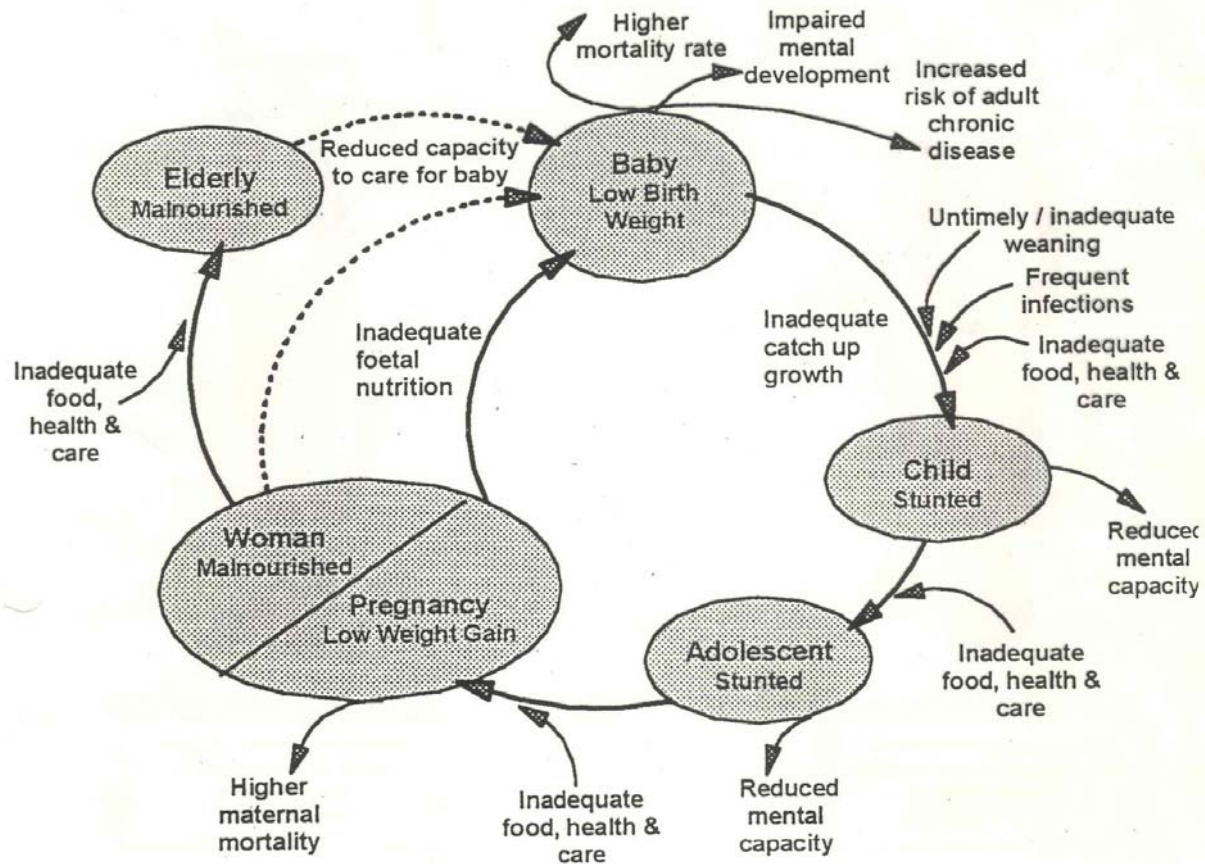
Other Issues Regarding Malnutrition and Catch up Growth


- Studies of children and health risk found that in the thinnest children, the more obese they became as adults, the greater was their risk of developing chronic diseases
 - No excess adult health risk was found from childhood or adolescent overweight

Other Issues Regarding Malnutrition and Catch up Growth

- In developing countries, the overfeeding of stunted populations should be avoided
 - Programs need to consider appropriate energy for children who are low weight-for-age but normal weight-for-height
- Education needs to be provided that stresses that overweight and obesity do not represent good health

Where Do We Begin?



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- “The provision of safe and nutritious food is now recognized not only as a human need but also as a basic right.”
 - WHO Technical report Series 916 – Diet, Nutrition and The Prevention of Chronic Diseases

References

- Diet, Nutrition and The Prevention of Chronic Diseases
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- 4th Report on The World Nutrition Situation – Nutrition Throughout the Life Cycle
 - <http://www.ifpri.org/pubs/books/4thrpt/4threport.pdf>

References

- ❑ Final Report to ACC/SC Ending Malnutrition by 2020: an Agenda for Change in the Millennium
- ❑ Zaloga, Nutrition in Critical Care
- ❑ Grosvenor and Smolin, Nutrition from Science to Life