

# Malnutrition, Micronutrient Deficiency and the relationship to Perinatal Infection



Debbie Abel, MS RD

## Points of Discussion

- History of Nutrition: Malnutrition, Infection, and Immunity
- Malnutrition
- Nutrition and Perinatal Infection
- Micronutrient Deficiency

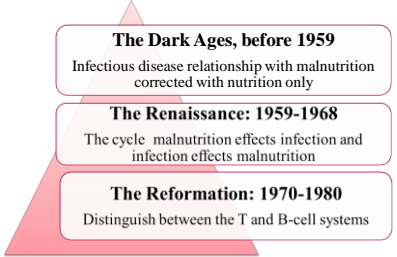


10/11/2011

# History of Nutrition: Malnutrition, Infection, and Immunity



## History of Nutrition: Malnutrition, Infection, and Immunity

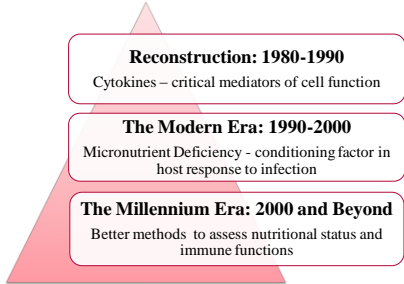


Keusch, American Society for Nutritional Sciences, 2003



10/11/2011

# History of Nutrition: Malnutrition, Infection, and Immunity cont.



Keusch, American Society for Nutritional Sciences, 2003



10/11/2011

# Malnutrition



## Malnutrition

**Malnutrition** is the **condition** that results from taking an **unbalanced diet** in which certain nutrients are **lacking**, in **excess** (too high an intake), or in the **wrong proportions**.

- (1) A state of poor nutrition; can result from insufficient or excessive or unbalanced diet or from inability to absorb foods

10/11/2011

7

## Malnutrition Definition

**Malnutrition** is the condition that develops when **the body does not get the** right amount of the **vitamins, minerals, and other nutrients** it needs to maintain healthy tissues and organ function.

The Free Dictionary by Farlex

10/11/2011

8

## Under nutrition

- **Too few essential nutrients**
- **Using or excreting nutrients** more rapidly than they can be replaced.
- **Nutrient loss:** diarrhea, excessive sweating, heavy bleeding (hemorrhage), or kidney failure
- **Nutrient intake:** restricted by age-related illnesses and conditions, excessive dieting, food allergies, severe injury, serious illness, a lengthy hospitalization, or substance abuse

10/11/2011

9

## Protein-Energy Malnutrition

- **Protein**
  - Amino acids are needed for cell structure, metabolic function
  - Amino acids are essential for brain growth in premature infants
- **Energy**
  - Protein, Carbohydrate and Fat all contribute to Calories (joules)

10/11/2011

10

## The Role of Micronutrients in Malnutrition

- **Micronutrients**
  - Vitamin A, D, E and K
  - B-complex
    - thiamin [B<sub>1</sub>], riboflavin [B<sub>2</sub>], niacin, folate, pyridoxine [B<sub>6</sub>], cyanocobalamin [B<sub>12</sub>]
  - Vitamin C
  - Iron and zinc
  - Iodine, calcium, and others

Katona, Clinical Practice, 2008

10/11/2011

11

## Over nutrition

- Results from **eating too much**, eating too many of the wrong things, **not exercising enough**, or taking too many vitamins or other dietary replacements.

10/11/2011

12

### Symptoms of Malnutrition

- People who are **malnourished** may be skinny or bloated.
- **Other symptoms** of malnutrition include:
  - Anemia
  - Diarrhea
  - Disorientation
  - Night blindness
  - Irritability, anxiety, and attention deficits
  - Malnourished children may be short for their age, thin, listless, and have weakened immune systems



10/11/2011

13

### Normal Growth: Weight

Birth Weight		7.7#(3.5kg)
6 months	Doubles	15.4# (7kg)
12 months	Triples	23.1# (10.5kg)
2 years	Quadruples	28# (13kg)
2 year to teens	~5.0#/year	
Adolescence	~10#/year	



10/11/2011

14

### Growth Velocity/Rate of Gain:

Age	Weight	Length
Premature	15g/kg/d<2kg	.9cm/wk
0-3mo	25-35g/d	2.6-3.5cm/mo
3-6mo	15-21g/d	1.6-2.5cm/mo
6-12mo	10-13g/d	1.2-1.7cm/mo
1-3yr	4-10g/d	0.7-1.1cm/mo
4-6yr	5-8g/d	0.5-0.8 cm/mo
7-10yr	5-12g/d	0.4-0.6cm//mo

Weight Velocity in Infants and Children. Danner, E. et al. NCP 2009 24; 76-79.  
Reference data on gains in weight and length during the first two years of life. Guo, S et al. J Ped 1991; 355-62.

15

### Changes In Body Composition

	Infant	Adolescent	Adult
Brain, Heart, Liver, Kidney	29% body weight	8% body weight	5-6% body weight
Muscle	30%	42%	44%



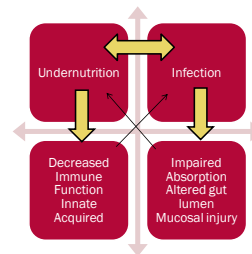
10/11/2011

16

### Nutrition and Perinatal Infection



### Interaction Between Malnutrition and Infection



Katona, Clinical Practice, 2008




10/11/2011

18

## Protective Mechanisms against Infection

- Intact skin Epithelial surfaces of the lung, gastrointestinal system, genitourinary tract, etc
- Cell-mediated protection by T cells and natural killer cells
- Cytokine action
- Metalloprotease action
- Complement
- Various acute phase reactants

Goldenberg, American Society for Nutritional Sciences, 2003  Riley Hospital for Children  
Indiana University Health

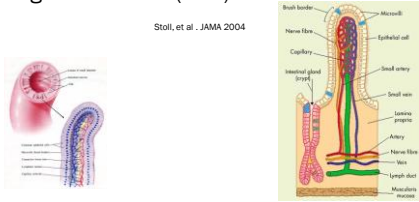
## Preterm Infants

- **Neonatal Immunodeficiency**
  - Sterile environment to an environment with antigenic challenges
  - Functional immaturity of the immune system
  - Development of the gut-associated lymphoid tissues
- **Neonatal Compromises to the innate immune systems**
  - Competent proteins are low
  - Impaired chemotactic, phagocytic and microbicidal capabilities
  - Impaired macrophage activation by cytokines and Toll-like receptor ligands

Jones et al. *Pediatr Allergy Immunol* 2010; 21:564-576  Riley Hospital for Children  
Indiana University Health

## Bacterial Translocation in the Premature Infant

- Late-onset neonatal sepsis (LOS)
- Necrotizing enterocolitis (NEC)



Stoll, et al. *JAMA* 2004

 Riley Hospital for Children  
Indiana University Health

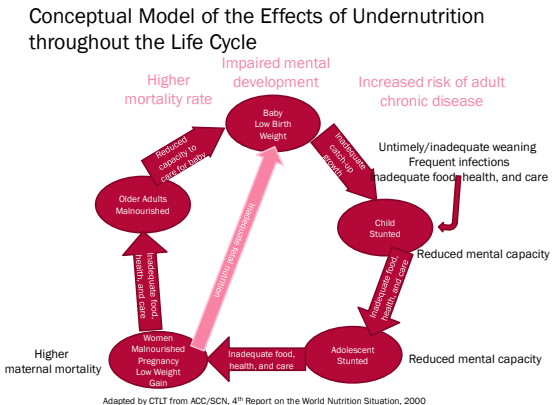
## Preventing Bacterial Translocation (BT)

- Amniotic Fluid – Intrauterine during the third trimester of pregnancy
- Human Milk - Continues to enhance intestinal development after birth
- Lactoferrin
- Probiotic Bacteria
- Prebiotics

Sherman, *Clin Perinatol*, 2010  Riley Hospital for Children  
Indiana University Health

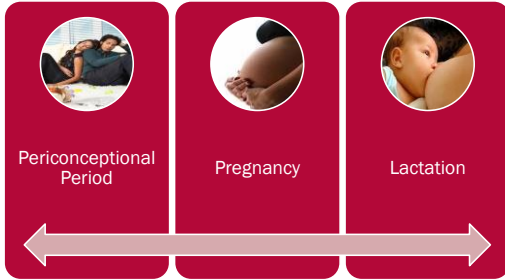
## Micronutrients Deficiency

 Riley Hospital for Children  
Indiana University Health



Adapted by CTL from ACC/SCN, 4<sup>th</sup> Report on the World Nutrition Situation, 2000

### Multiple Micronutrients in Pregnancy and Lactation



Allen, Am J Clin Nutr, 2005



10/11/2011

25

### Micronutrients Status Iron Deficiency

- Associated with impairment of neutrophil and Natural Killer (NK) cell-mediated killing and T-cell proliferative responses
  - Supplementation of iron and folic acid for children <3 years in area of intense malaria transmission increased risks of infectious morbidity and mortality
  - Routine iron supplementation in populations with anaemia demonstrated positive effects on cognition performance and other long-term outcomes

Jones and colleagues, Pediatric Allergy and Immunology, 2010 Riley Hospital for Children Indiana University Health

10/11/2011

26

### World Health Organization (WHO) Iron Guidelines

Restrict iron supplementation in Malnourished Children until:

1. Provide a broad-spectrum antibiotics
2. Appetite is starting to return
3. Then, provide iron supplementation

Jones and colleagues, Pediatric Allergy and Immunology, 2010 Riley Hospital for Children Indiana University Health

10/11/2011

27

### Micronutrients Status Zinc Deficiency

Associated with lymphopenia and impaired immune response

WHO recommends zinc supplementation as part of routine diarrhoea management

- Zinc Deficiency

Jones and colleagues, Pediatric Allergy and Immunology, 2010 Riley Hospital for Children Indiana University Health

10/11/2011

28

### Micronutrients Status Vitamin A & D

Maintaining integrity of mucosal surfaces and deficient states are associated with increased rates of invasive respiratory, gastrointestinal and ocular infections

- Vitamin A

Promotion of Th2 and regulatory T-cell signaling as well as increasing the antimycobacterial properties of monocytes and macrophages

- Vitamin D

Jones and colleagues, Pediatric Allergy and Immunology, 2010 Riley Hospital for Children Indiana University Health

10/11/2011

29

### Micronutrients Status

- Selenium
- Copper
- Manganese
- Vitamin C


Jones and colleagues, Pediatric Allergy and Immunology, 2010 Riley Hospital for Children Indiana University Health

10/11/2011

30

## Role of Long-chain Polyunsaturated Fatty Acids

- Lipid Malnutrition
  - Dietary lipids have immunomodulatory effects
  - Immunoactive properties of the n-3 Polyunsaturated fatty acids (PUFA)

Jones and colleagues, Pediatric Allergy and Immunology, 2010  Riley Hospital for Children  
Indiana University Health

10/11/2011

21

## Maternal Cereal Consumption

- Low-income pregnant women (n=596) in Pittsburgh, PA
- 31% of the women regularly consumed cereal and demonstrated:
  - Higher intakes of folate, iron, zinc, calcium, fiber, and vitamins A, C, D, and E (all  $P < 0.01$ )
  - 65% to 90% reductions in risk of nutrient inadequacies compared with non-consumption (all  $P < 0.01$ )

Parrott and colleagues, NIH Public Access, 2010

 Riley Hospital for Children  
Indiana University Health

10/11/2011

22

## Summary

- Nutrition is important through out the life cycle
- The benefits of breastfeeding are clear
- Nutritional research to date suggest that there will not be a simple or single nutritional intervention that dramatically reverses the association between malnutrition and infection
- Further work is needed in prenatal and infant malnutrition as determinants of global mortality

 Riley Hospital for Children  
Indiana University Health

10/11/2011

23