

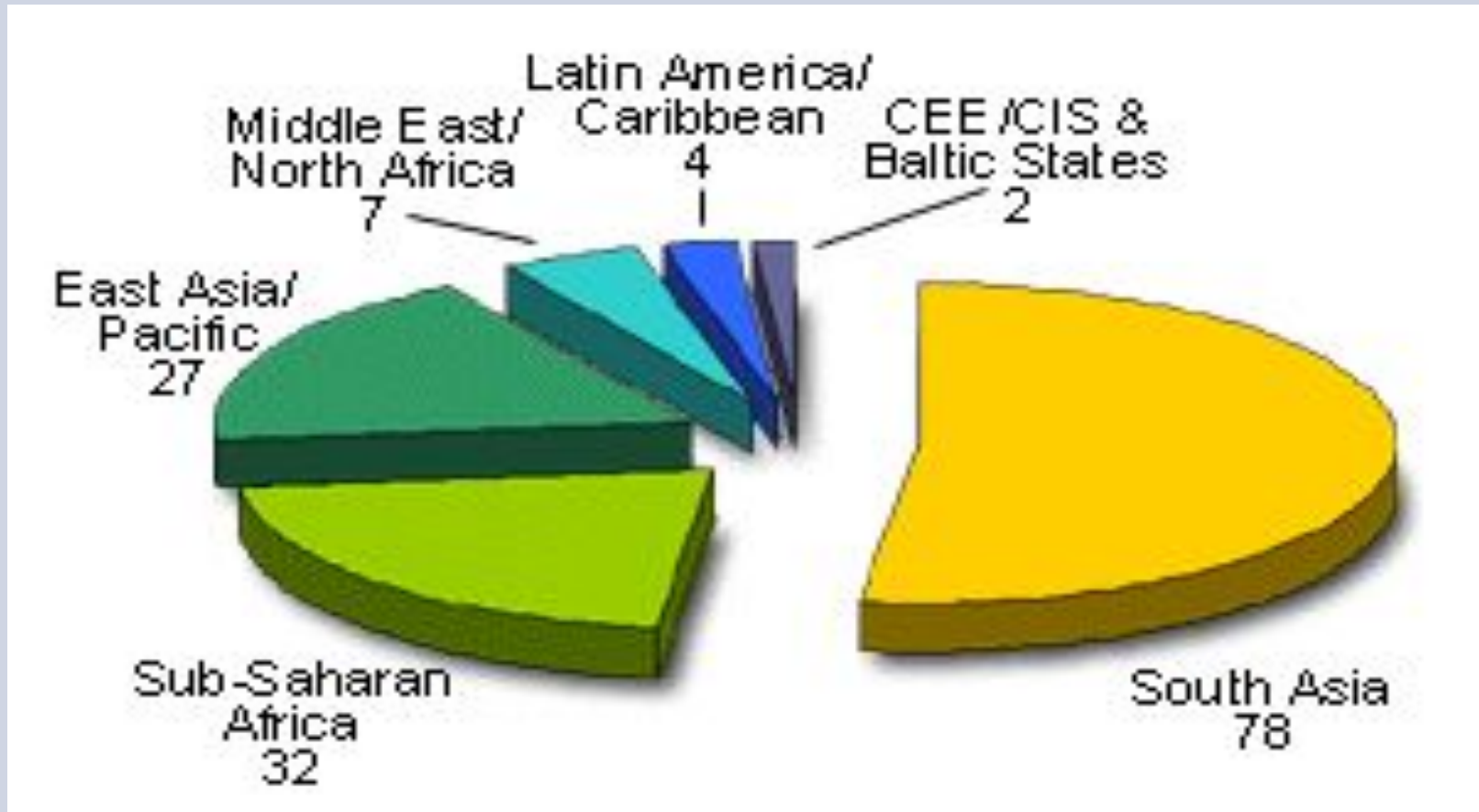
Protein-energy malnutrition in children

**(Prenatal and postnatal
hypotrophy).**

Plan of the lecture

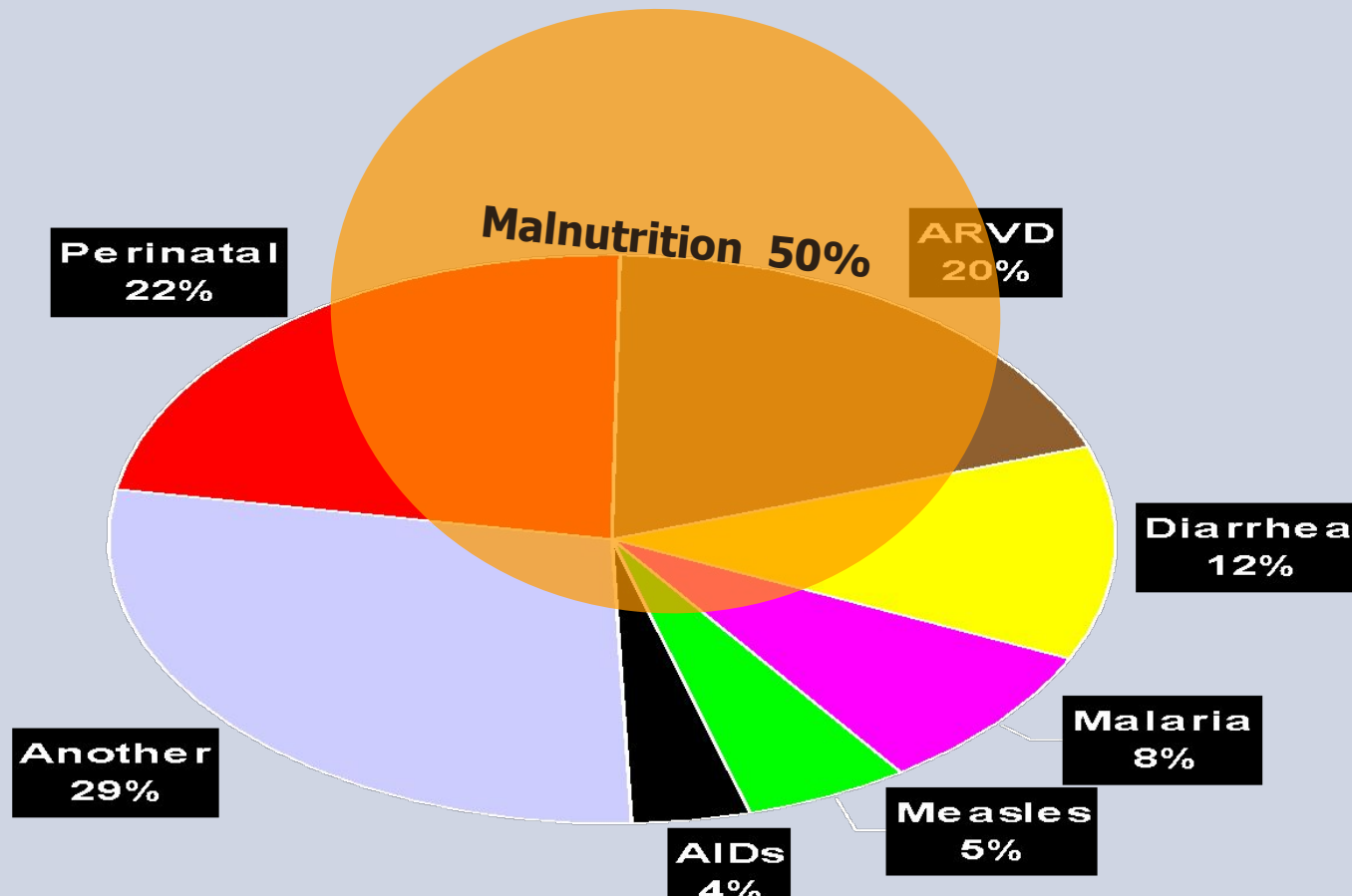
- **1. The frequency of protein-energy malnutrition in children**
- **2. Etiology**
- **3. PATHOGENESIS**
- **4. *Classification of hypotrophy***
- **5. Clinics**
- **6. *Laboratory tests***
- **7. Treatment**

150 millions of children worldwide suffer on malnutrition



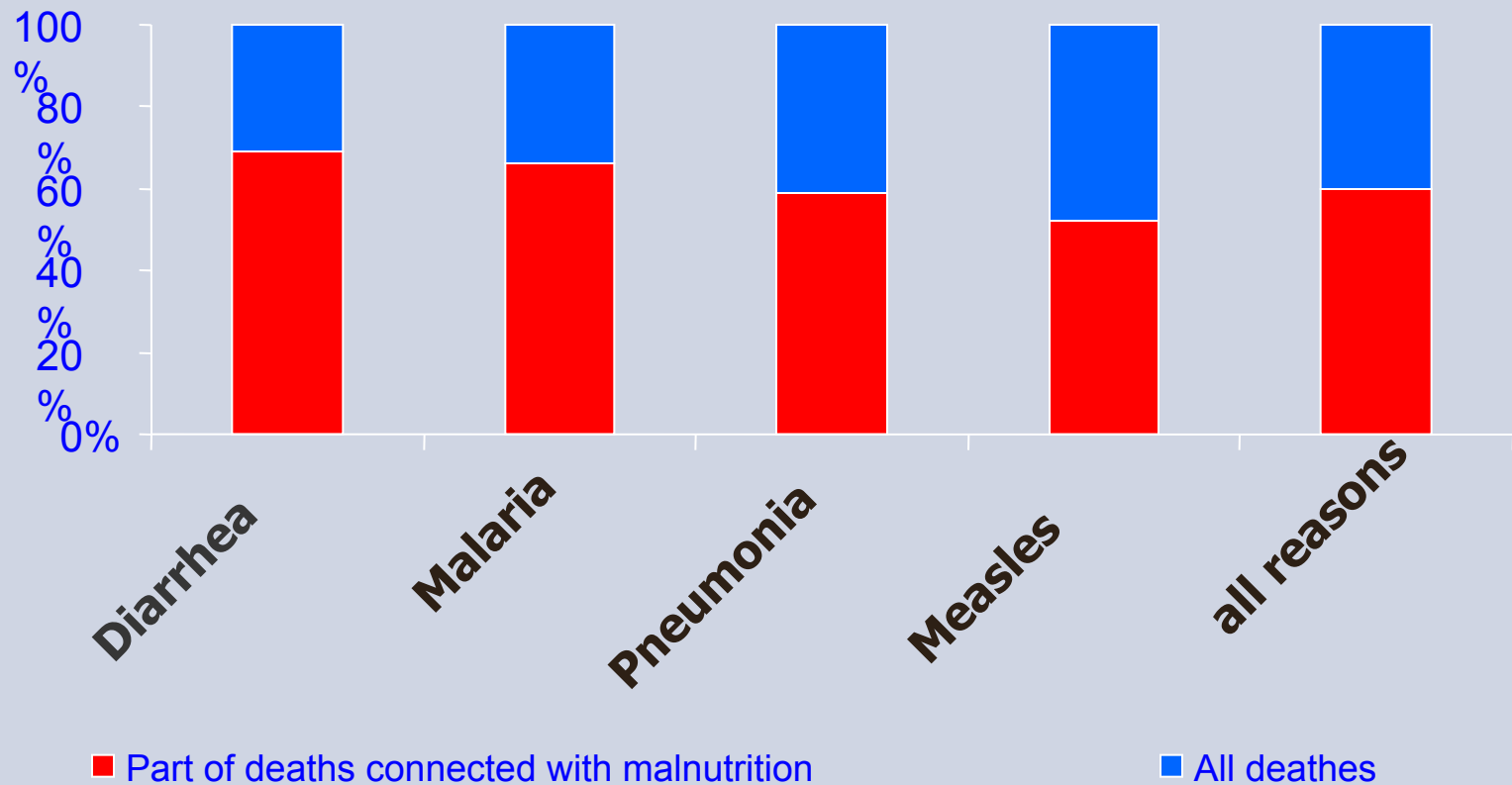
(UNICEF State of the World's Children, 2001)

The reasons of 10.8 millions deaths in toddlers and infants at the developing countries



5 diseases are reported to cause child's deaths and malnutrition covers 50% as a reasonable predisposing factor of children mortality

Contribution of malnutrition into mortality of children less than 5 years old depending on deaths reason, 2000



Sources:

- *For cause-specific mortality:* EIP/WHO.
- *For deaths associated with malnutrition:* Caulfield LE, Black RE. Malnutrition and the global burden of disease: underweight and cause-specific mortality.

ETIOLOGY

- **Prenatal factors**
- - Insufficient alimentation and diseases of mother (in early pregnancy term – gestosis; later- pathology of placenta with impairment of placenta-fetus circulation and intrauterine fetus hypoxia, job hazard, stresses, pernicious habits)
- Intrauterine infections
- **Exogene reasons:**
- **a) alimentary factors:**
- ***Quantitative underfeeding:***
- In hypogalactia ; in difficulties of breast feeding-plant, retracted nipples, «tight» mamma;
- Due to child feeding difficulties —regurgitation, vomiting, hypognatia, short frenulum of tongue etc.;
- ***Qualitative underfeeding:***
- Usage of improper formula, late semisolid feeding, deficiency of proteins, fats, vitamins, iron, trace elements in diet;

- b) **infectious factors:**
- *intrauterine generalized infections like cytomegaloviruses, rubella, syphilis, toxoplasmosis etc.,*
- Intranatal infections, toxic-septic conditions, pyelonephritis and urinary tract infection
- Gut infections ;
- c) **toxic factors**— usage of expired formula, hypervitaminosis A and D, poisonings by drugs and another substances.;
- d) **Care defects** —deficiency of attention, love, psychogenic stimulation, walks, massage, gymnastics etc.

- 3. **Endogene reasons:**

- a) perinatal encephalopathies, bronchial and lung dysplasia;
- b) congenital and inborn malformations of gut, heart, big vessels, short bowel syndrome after resection of intestine
- c) hereditary (primary) immune-deficiency or secondary immune failure;
- d) primary and secondary malabsorption syndrome, hereditary metabolism anomalies (galactosemia, fructosemia, leucinosia, xanthomatosis, Niemann-Pick, Tay-Sachs syndrome etc.
- e) endocrine diseases (adreno-genital syndrome, hypothyroidism, hypophysis nanism etc.).

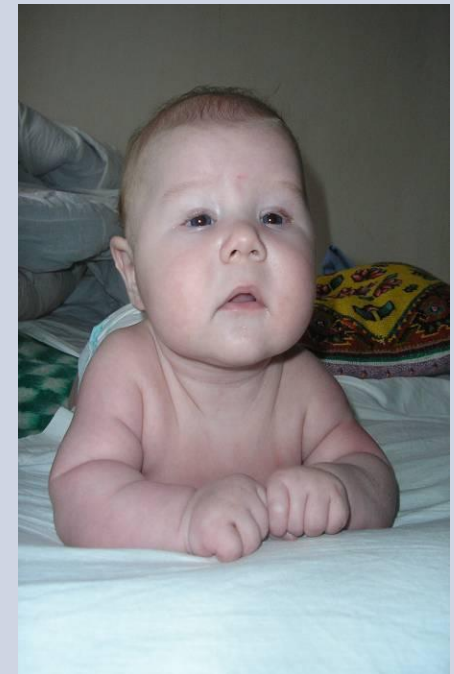
PATHOGENESIS

- **Decreased secretory function of digestive glands - abnormality of food evacuation**
- **Decreased secretory function of digestive glands –abnormality of ingredients absorption and assimilation**
- **Failure of cavitory and parietal digestion, disbacteriosis development**
- **Changes in protein metabolism and degradation of tissue proteins**
- **Hypoproteinemia, abnormal protein fractions ratio,**
- **Increased excretion of aminoacids with urine, negative protein balance**
- **Exhaustion of glycogen, fat, mineral substances storage**
- **Changes in main metabolism, development of exhaustion.**

- **Protein-energy malnutrition (prenatal, postnatal malnutrition)** –Insufficient child feeding characterised by
 - failure to thrive or retardation of weight gaining
 - progressive decreasing of subcutaneous fat layer
 - body disproportional development
 - abnormality of metabolism
 - suppression of specific and nonspecific defending mechanisms, exhaustion of organism
 - predisposing to another diseases
 - physical and neuro-psychic development retardation

Authorities of paediatrics Maslov M.S., Speransky G.N., Tur A.F. while characterizing normotrophy (eutrophy) point to:

1. Clean, pinkish smooth skin without signs of hypovitaminosis;
2. Normal subcutaneous fat layer, good tissue turgor, proper muscle tone;
3. Absence of rickets signs according to the age of child;
4. Normal as for age psycho-motor development, positive psycho-emotional status;
5. Good appetite and normal organ's functioning;
6. Good resistance to infectious diseases and rare, mild or moderate infectious diseases or processes;
7. Body weight and height, physical development indexes deviates from normal not more than 5-10%.



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Prenatal, postnatal malnutrition types (according to Worldwide disease register)

- Type E 43 – Severe protein-energy malnutrition –failure to thrive of unclear origin
- Type E 44 –Moderate and mild protein-energy malnutrition
- Type E 45 – Failure to thrive due to protein-energy malnutrition
 - alimentary
 - failure of growth (dwarfism)
 - retardation of height gaining
 - physical development retardation due to feeding insufficiency
- Type E 46 – Protein-energy malnutrition of another origin



- **Classification of hypotrophy (protein-energy malnutrition - PEM):**

- I degree PEM – weight deficiency 11 – 20 %
II degree PEM – weight deficiency 21 – 30 %
III degree – weight deficiency more than 30 %

II. Diagnostics criteria

1. Main clinic features

- Physical status evaluation (weight to age and weight to height correlation)
- Evaluate somatic and emotional condition (vivacity, attitude to contacts, morbidity etc.)
- Evaluate skin condition (paleness, dryness, rashes etc.)
- Evaluate mucous membranes condition (erosions, thrush etc.).
- Evaluate tissue turgor (decreased)
- Evaluate subcutaneous fat layer (decreased or absent):
 - in I degree PEM – decreased at abdomen
 - in II degree PEM – decreased at abdomen, trunk and limbs
 - in III degree PEM – decreased at face, abdomen trunk and limbs



CLINICS

- Main clinic symptoms are retardation or arrest of body weight gaining
- In **I degree** common condition is satisfactory, skin is pale, slight decreasing of subcutaneous fat layer and tissue turgor.



- In II degree of PEM altogether with body weight deficiency we can see height gaining deficit(2-4 cm)); subcutaneous fat layer disappear at trunk and limbs, skin loose its elasticity, become dry, form folds, at some places can be flacking or hyperpigmented, hair become hoarse and rare, tissue turgor decreases, muscular hypotonia appear.
- For III PEM degree beside more severe exhaustion abnormality of inner organs and systems functioning is typical.
- Eyes sink down, face looks like old one skin become wrinkled, dry, pigmented, folds can't get smoothed; mucous membranes become dry , bright, vulnerable and frequently affected by Candida developing of stomatitis



- In 3 PEM degree excitability, alertness or apathy and flaccidity usually appear; sleep is disturbed, appetite is decreased. Development of motor functions is delayed (children start to sit, stand and go later or can't perform this function). Muscles become atrophic. Heart sound become muffled, pulse is retarded, BP is decreased. Thermoregulation is disturbed, limbs usually are cold. Belly is retracted or inflated, gut atonia and meteorism is present. Anemia usually is developed
- In children with PEM resistance to infections is decreased. They fell ill more frequently, susceptible to infections, disease course frequently is more severe with development of complications.



Kwashiorkor — is a type of PEM in infants and toddlers due to feeding predominantly by plants (banana) and protein deficiency in food

Kwashiorkor typical symptoms are :

- **Neuro-psychic abnormalities (apathy, lethargy, sluggishness, tearfulness, absence of appetite, delaying in psycho-motor development)**
- **Edema develops due to hypoproteinemia at first than hyperhydrosis of inner organs occur, later edema can occur at limbs, face and produce impression of good feeding status in child;**
- **Decreased muscular tissue even with atrophia of them.;**
- **Delayed physical development (more of height than weight).**

Frequently it can be :

- **Darkening of skin with desquamation of epithelium in folds.,**
- **Lightening of hair, changes of nails.**
- **Anorexia, signs of hypovitaminosis.**

Laboratory tests

a) *obligatory*:

- common blood test
- common urine test
- stool test - coprogramme (neutral fats, mucus, undigested cellulose etc.)
- stool analysis for dizbacteriosis (once per 6 mo, under demand if containing of bifido-, lactobacillus, appearance of conditional pathogenic bacteria in titers more than $> 10^4$)

b) if necessary:

- immune test (in children with frequent morbidity)
- biochemical (electrolyte level, common protein, albumins, liver tests etc.)
- genetic

c) Instrumental examining

- ultrasound diagnostics of abdomen for screening
- fibrogastroduodenoscopy in children with constant regurgitation or vomiting syndrome

- **Treatment must be complex:**
- Eliminate etiologic factor, normalize diet, rational regimen, good care, treatment of all infection focuses, rickets, anemia and other comorbidities
- **Great attention is paid to feeding:**
- Take into account age child necessities and physiologic possibilities.
- Correct ratio of main food ingredients that will produce positive effect for normalization of metabolic, physical and psychological development.

- **Main diet approaches in PEM is triphase feeding :**

1. Period of food tolerance clarifying;
 2. Transient period;
 3. Period of intensive (optimal) feeding.
- In I PEM degree calculations and feeding correction is performed per 1 kg of normal body weight.
 - In I PEM degree quite enough to eliminate feeding defect, normalize regimen and care to reach normal body weight and child development.
 - Children with II and especially III PEM grade with intolerance to food first days of treatment day volume of food must be reduced to $\frac{3}{4}$ or $\frac{1}{2}$ of necessary day volume feeding (dependently on child condition).
 - Deficient food volume can be substituted by drinking (tea, glucose solution, fruit juices, vegetable and fruit decoction). After child condition improvement food quantity steadily increased to necessary physiologic requirement.
 - **There are necessary** more frequent feedings (7 — in I PEM grade, 8 — in II PEM grade, 10 feedings in III PEM grade);
 - Systemic control of feeding (diary with marking the quantity of consumed meals), stool, diuresis, quantity of oral and injected liquids, salt containing solutions must be taken. Once per 7 days calculations of alimentary loading by proteins, fats and carbohydrates are obligatory; twice per week coprogramme must be performed.

- In II and III PEM grade when metabolic disturbances are more expressed and therefore assimilation of food ingredients is failed individual approach is necessary.
- In II PEM grade protein and carbohydrate quantity in daily diet is calculated per 1 kg of required weight, fats quantity is calculated per 1 kg of existed weight, later to the simple average of required and existed weight.
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- In III PEM grade necessary protein and carbohydrate quantity is calculated per 1 kg of approximately required weight (existed weight + 20% of its value).
- Fats quantity is calculated only per existed weight as tolerance to fats is suppressed in these children.

Diet of children with PEM must be of full value

- **Infants must be supplied by breast milk (if mother has hypogalactia provide high adopted formula or cultured milk adopted treating formula)**
- **Correction of diet by protein components is rational to provide by natural products like curds, egg yolk, meat pure) or by special tinned and new dry dietetic products as Enpit (Protein containing enpit, nonfat enpit).**
- **Carbohydrate correction is performed by sugar syrup, fruit juices and fruit pure.**
- **Fat containing in diet is recommended to increase after complete adoption of child to all another ingredients by adding butter and oils or fat enpit**
- **Semisolid food to children with PEM must be induced very carefully only after stable weight gaining and absence of intercurrent diseases. As a rule first complementary feeding is performed by inducing milk porridge; 1-1,5 weeks later another complementary food is proposed – vegetable pure.**
- **All types of complementary food are induced steadily i.e. start with low quantity and steadily increase the volume (approximately in 7-10 days) for the proper volume.**

Efficacy criteria of dietetic treatment are:

emotional status improvement, appetite normalizing, skin condition improvement, turgor normalizing, per day weight gaining 25—30 g, normalization of Chulitsky index (nutritional state index), restoration of psych-motor development, improvement of digestion (after coprogramm)

- **Outpatient care**

- Treatment of I grade PEM take something around 1 mo , II grade PEM – 2-3 mo, severe PEM -4-5 mo.
- Doctor must observe patient with antropometric measurement once per 2 weeks, get different specialists , perform blood tests, coprogramm.
Outpatient care is stopped 6-8 weeks after full normalization of physical and psycho-motor development according to child age.
Specialists consultations:
Paediatrician – 1-st mo. 5 times (obligatory weight control and another anthropometry indexes once er mo ; neurologist, surgeon, orthopedist in need.

- **Prognosis**

depends on possibility to eliminate reason of malnutrition, comorbidities, complications, patient's age, type of feeding, surroundings and care of child etc. In alimentary and infectious-alimentary malnutrition usually prognosis is good. I grade PEM don't influence significantly to further child development.

- **Profilaxis** must include rational feeding, organizing of the rational regimen, outdoor walking, thorough care, physical development and hardening.

Treatment

- In II and III PEM grade treatment is performed in hospital:
 - parenteral nutrition (solutions of aminoacids, fat emulsions)
- To stimulate trophic processes one can prescribe trimetabol, carnitin, anilac.
- In all grades of malnutrition vitamin complex must be prescribed in age dosages.
- In the stage of metabolic adaptation enzyme therapy will be useful.
- In severe malnutrition resistant for treatment hormones are indicated.

Hypovitaminosis

- **Ascorbic acid (vit C) insufficiency.**
- **Clinics.** As another types of hypovitaminosis can start gradually. The earliest symptoms are nonspecific: weakness, fatigability, bad appetite; later bleeding of gums, hemorrhages at skin and mucous membranes can appear. More severe affection of vessel's wall can occur with profuse hemorrhages into muscles, joints, ligaments. It can be accompanied by muscle weakness, pains in joints. Movement become limited and painful. Gingivitis as a rule is developed, gums become edematous and teeth become impaired or come out.
- **Diagnosis.** Is based on typical clinic manifestation and decreasing of vit C in urine and blood.
- **Treatment.** Ascorbic acid is used in dosage of 100 - 300 mg/day in injections or per os (1—2 ml of 5 % solution).
- To prevent hypovitaminosis diet must contain proper quantity of vegetables like potato, cabbage, and fruits, berries, greens, lemons, oranges, hips. Vit C can be preserved in vegetables and fruits after freezing. But vit C is unstable in heating and in open air it can be oxygenized and destroyed. So its necessary to store and preserve products that contain this vitamin.
- Day necessity of vit C depends on age and is 20 mg for infants, 40-50 mg for children of 1-6 years old, 60-80 mg for schoolchildren.

- **Thiamin deficiency** (vitamin B1).
- **CLINICS.** Disease is manifested by changes in muscles and nervous tissue. Fatigability, weakness, muscle weakness, nausea, constipations, decreasing of appetite. Later symptoms of nervous system affection join to clinics: convulsions in extremities, paresis can occur.
- **Diagnostics.** Is based on clinics and specific biochemical reactions: excretion of thiamin with urine, defining of thiamin or pyruvic acid in plasma..
- **Treatment.** Medications of vit B1 are used in dosage 0,005—0,015 g/day per os or in injections (0,5 ml of 2,5 % solution of thiamin chloride or 0,5 ml 3 % solution of thiamin bromide once per day. Treatment course usually needs to prescribe 10—30 injections.
- Main sources of vit B1 are cereals, wheat and rye bread, yeasts, beans, liver, kidneys, egg yolk.
- Day necessity in vit B1 is 0,5 mg for infants, 0,8—1,2 mg for children of 1 to 6 years old, 1,7— 1,9 mg for schoolchildren.

- **Riboflavin deficiency** (vitamin B2).
- **CLINICS** Decreasing of weight, retardation in growth, weakness, prompt fatigability, decreased immune indexes. Frequently mucous membranes changes of eyes – blepharitis, conjunctivitis; mucous membranes changes of mouth – angular stomatitis or fissurae, gingivitis can occur. Skin disorders like seborrheic dermatitis with impairment of skin regeneration can be seen. Nervous system disorders can be present.
- **Diagnosics**. Decreasing of riboflavin excretion with urine, depletion of vit B2 in serum.
- **Treatment**. Riboflavin is prescribed in tablets in dosage 0,002—0,01 g dependently on age and in injections 1 % solution 1 ml once/day for 3—5 days, than 2—3 times per week. Average necessity for course is 15—20 injections.
- Vitamin B2 is present in products of animal origin: meat, liver, eggs. Most of all it present in yeasts , milk and milk products- cheese, curds. It's also present in beans.
- Daily necessity of Vit B2 is 0,6 mg for infants, 1,1 - 1,6 mg –for preschools, 2,3—2,5 mg – for schoolchildren.

- **Nicotinic acid deficiency** (vitamin PP, niacin, vitamin B₃).
- **Clinics** presents abnormalities of gut. Inflammatory changes of mucous membranes in mouth, tongue, accompanied by bright red shining color are typical features of vit B₃ deficiency. Diarrhea is the next symptom and it can be persistent. Skin rashes appear like erythema, desquamation, pigmentation (pellagra).
- **Diagnostics**. Is based on clinics and decreased excretion of Ni-methyl-nicotinamide in urine.
- **Treatment** Nicotinic acid is prescribed in daily dosage 0,005 -0,05 g BID or TID 10—15 days; nicotinamide —0,01—0,05 g BID or TID 15—20 days long.
- Nicotinic acid is present in meat, milk, kidneys, liver, yeasts, bread, potato, buckwheat.
- **Daily necessity** depends on age: 6 mg for infants, 9—13 mg for preschools, 18—20 mg for schoolchildren. In physical loadings necessity in vit B₃ increases.

- **Pyridoxine deficiency (vitamin B6).**
- **Clinics** Vitamin B6 influences for nervous system activity and hematopoiesis. In deficiency conditions irritability, excitability, seizures can occur. In some children deficiency of vit B6 can induce flaccidity, apathy, suppressed appetite. There are frequent skin changes like dry seborrheic dermatitis. Hemopoiesis is impaired with decreasing of leukocytes in blood, hypochromic microcytic anemia.
- **Diagnostics** based on clinics and decreased excretion of 4-pyridoxy-new acid, increased level of xanturemic acid after triptophan loading.
- **Treatment** Pyridoxine per os in dosage 0,01 -0,1 g/daily.
- Viat B6 is present in meat, liver, fish, egg yolk, vegetables, fruits, yeasts..
- Daily necessity depends on age: 0,5 mg for infants, 1,0—1,4 mg for preschools, 1,9—2,2 mg for schoolchildren. Necessity of vitamin increases in diseases, stresses, inheritance.

- **Biotin deficiency (vitamin N).**
- **Clinics.** In the case of vit N deficiency or insufficient synthesis of it in intestine severe dermatitis, alopecia, affection of nails can develop . Frequently suppressing of appetite, fatigability, weakness, muscle pains hyper- and parestesia.
- **Treatment** Dosage of biotin dependant on age; for infants and toddlers recommended daily dosage is 5— 10 mcg.
- Biotin is present in liver, milk, yolk, soya, peas, cauliflower, mushrooms.
- Daily necessity approximately 2— 3 mcg/kg .

Cyancobalamine deficiency (vitamin B12).

- **Clinics** Impairment of hemopoiesis with hyperchromic, macrocytic, megaloblastic anemia and leukopenia. Impairment of gastric secretory function and symptoms of nervous system affection. Vit B12 insufficiency can occur due to deficiency of it in food (exogenous one) or impaired synthesis and absorption of it in gut (endogenous).
- **Diagnostics** Early diagnostics is based on defining its quantity in blood and increased excretion of methylmalone acid with urine.
- **Treatment** . Vit B12 is prescribed in daily dosage 30 - 100 mcg IM for 30—40 days.
- Vitamin B12 is present in milk, cheese, meat, liver, yolk.
- Daily necessity for infants is 0,3 mcg, preschools— 0,9 mcg..

- **Rutin deficiency (vitamin P).**
 - **Clinics** Vit P deficiency can cause fragility of vessels predominantly capillaries with appearance of hemorrhagic rash in mucous membranes and skin.
 - **Treatment**. Oral prescribing of vit P depending on age.
 - Vitamin P is present in the same products as Vit C. Black current , lemon, hips, salad parsley are rich in Vit P.
 - Daily necessity of VitP is 15 mg for infants, 25-30 mg for preschools and schoolchildren.
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- **Panhotenic acid deficiency (vitamin BS).**
 - **Clinics** Fatiguability , weakness, neuropsychic abnormalities, dermatosis , gastro-intestinal disturbances
 - **Treatment** Panhotenat Calcium is used in dosage 0,2—0,4 g daily.
 - Panhotenic acid is present in plants: cereals, beans, mushrooms, potato, in dry yeasts, meat, eggs, fish. Biotransformation of it is possible only if folic acid and biotin is present in proper quantity
 - Daily necessity is supplied by proper diet. Approximate necessary quantity is 10 mg.

Folic acid deficiency (vitamin Bc).

- **Clinics** appears predominantly after antibiotic and sulfonamides treatment, due to malabsorption syndrome and several liver diseases. Main symptoms concerns to impairment of hemopoiesis (macrocytic hypochromic anemia, leucopenia, thrombocytopenia). Symptoms of gut, skin, mucous membranes leisons can be present.
- **Treament** Folic acid treatment dosage for adults is 0,005 mg BID, children are proposed lower dosage dependently on age for 20—30 days.
- Folic acid is present in liver, kidney, egg yolk, cheese, potato, tomato, carrot, beans, wheat, mushrooms, spinach, parsley, dill and in yeasts. Daily necessity of vit Fc for infants is 40 mcg, for toddlers — 100mcg.

Retinol deficiency (vitamin A).

- CLINICS** Signs of organism resistance depression, growth retardation, skin and mucous membranes dryness, vision depletion, developing of night blindness – hemeralopia, xerophthalmia, cornea opacity. In vit A deficiency follicular hyperkeratosis formation is quite frequent. Not rare affection of gut and respiratory tract.
- **Diagnostics** Early diagnostics is based on clinics and decreasing of vit A and carotene in blood, impairment of night adaptation.
 - **Treatment** Vit A is prescribed 5000— 20 000 IU/day.
 - Vitamin A is present in a lot of animal products: liver especially in cod liver, kidney, egg yolk, butter, cheese, fish. In plants vit A exist in form of pigment carotene that can be metabolized in organism into vit A. Such plants as red carrot, red pepper, green onion, salad, tomato, apricots, ash-berry, sea-buckthorn
 - Child needs in some quantity of vit A. As deficiency and excess of vit A can produce damage in organism. Physiological necessity is 425—500 mcg during the first 6 mo of life, during 6-12 mo old term child needs 300 mcg, toddlers' necessity is 250 mcg per day.

- **Tocopherol deficiency (vitamin E).**
- **CLINICS** There can be observed fragility of capillaries, muscular dystrophy, liver affection. Sexual hormones production is impaired.
- **Treatment** dosage of tocopherol acetatis is 10-100 mg/day and dependent on age.
- Vitamin E is present in salad, spinach, cabbage, wheat, corn, barley, meat, liver, eggs, milk, oils.
- Daily necessity is not defined exactly. Approximately it's 10-30 mg for adult person.
- **Vitamin K deficiency .**
- **CLINICS** develops due to decreasing of prothrombin and proconvertin and characterized by inclination for bleeding. Vit K deficiency can developed after antibiotic and sulphonamides consuming, especially in infants and toddlers. Deficiency of vit K can also be the co-morbidity in some liver and gut diseases.
- **Treatment** Vicasol is prescribed for vitK supplying. Dosage for infants is 0,002—0,005 g, toddlers-0,006- 0,008g, preschools - 0,01g, schoolchildren — 0,015 g. Medication is prescribed for 3— 4 days, after the interval of 4 days course is repeated once more.
- Vitamin K is present in plants: spinach, cabbage, pumpkin. In animal products its quantity is higher in liver.
- Daily necessity of vit K is covered by rational diet and its synthesis in intestine.

Questions

- To indicate etiologic and pathophysiologic factors at chronic disorders of nutrition and protein energy malnutrition in children
- To classify, analyze typical clinic of the chronic disorders of nutrition and protein energy malnutrition in children.
- To make list of the examination and to analyze data of the laboratory and instrumental examination at chronic disorders of nutrition and protein energy malnutrition in children.
- To prescribe treatment, rehabilitation, prophylaxis of the chronic disorders of nutrition and protein energy malnutrition in children.
- To diagnose and to give the first medical aim in chronic disorders of nutrition and protein energy malnutrition in children.
- To perform differential diagnostic of chronic disorders of nutrition and protein energy malnutrition failure in children
- To make prognosis chronic disorders of nutrition and protein energy malnutrition.