Vitamins

Definition

- Are organic compounds that the body requires in small amounts for its metabolism, yet cannot make for itself, for the most part, they are not related chemically and differ in their physiological role. Their primary function is to promote a wide variety of biochemical and physiologic processes necessary for life.

Classification

- Vitamins are divided into **two groups** on the basis of **their solubility**.

1. **Water-soluble vitamins**
2. **Fat-soluble vitamins**

1. Water-soluble vitamins

are not associated with dietary lipids and fat absorption does not interfere with their own absorption. They are normally excreted in the urine in small quantities. With the exception of vit. B12, they are not stored in appreciable quantity and, there fore, these vitamins have to be supplied frequently to avoid their depletion. The water-soluble vitamins are divided into B-complex group is further separated into the energy releasing vitamins, hematopoietic group and others with miscellaneous functions.

2. Fat-soluble vitamins

A, D, E and K

Are found in foods associated with lipids. They are absorbed from the intestine with dietary fats, so conditions unfavorable to normal fat uptake also impairs their absorption. Because they are lipid soluble, significant quantities of these vitamins can be stored in the body, so they do not have to be consumed every day.

Deficiency

- **Hypovitaminosis is a deficiency disease resulting from inadequate supply of one or more vitamins in the diet. Dietary vitamin deficiencies are still common in some developing countries. The deficiencies usually coincide with a lack of basic nutrients. The vit deficiency can be classified as primary or secondary. Primary deficiency is caused by consuming an inadequate diet which can by evaluated by dietary history. In secondary type, the recommended amount may be consumed, but because of some problem (conditioning factors), such as gastrointestinal disorders, malabsorption, medication, allergies, metabolic defects, the nutrient is not efficiently absorbed and/or metabolized. The secondary deficiency can be assessed from clinical history. Regardless of the etiology, the deficiency, if prolonged, leads to a step wise loss of body reserves of the vitamin or vitamins.**
- **Who is at risk for vitamin deficiencies? Chronic deficiency of various vitamins has been associated with cancer, cardio vascular pathology, cataract, arthritis, disorders of the nervous system, and photosensitivity. The very young, the very old, the stressed.**

1. Water-soluble vitamins

Thiamin-B1

- This vitamin acts as a coenzyme in carbohydrate metabolism.
- Food sources: all foods of animal origin and plant tissues contain thiamin. In cereals the vitamin is present mainly in the germ and outer coat of the seed. Much of the vitamin is lost when cereals are milled and refined. All green vegetables, fruits, roots and meat as well as dairy product (except butter) contain significant amounts of the vitamin but none are rich sources.

Deficiency

- the classic disease resulting from vit B1 def in humans is called Beriberi. All cells require thiamin in the coenzyme form for energy metabolism. The most prominent symptoms include: the gastrointestinal disorders (anorexia, indigestion, and weight loss), neurologic disorders and cardio vascular disorders.
- The CNS dependent on glucose for energy to do its work, so without B1 neuronal activity is impaired. The failure of energy metabolism affects neurons and their functions in selected areas of the CNS. Alertness and reflex responses are diminished and general apathy and fatigue result. Depending on the extent of deficiency, lipid synthesis is impaired and damage or degeneration of the myelin sheath follows and causes increased nerve irritation and pain. If the deficiency continues paralysis results.
- Heart muscle weakness cause cardiac failure; smooth muscle of vascular system may be involved causing dilation of peripheral blood vessel and, as a result of cardiac failure, edema appears in the extremities.

Requirement

- The requirement varies with the composition of diet. Since the vit. Participates in the metabolism of energy-yielding nutrients, the requirement is based on the amount of carbohydrate in the diet. The minimum daily adult thiamin needs are 0.23-0.35 mg/1000 Calories. The elderly utilize vit-B1 less efficiently and, therefore, an allowance of at least (1mg) is recommended even their caloric intake may be below 2000 calories. The need for the vit. Increases with the amount of alcohol consumed; this accounts for the increased incidence of beriberi among chronic alcoholics. Fever and infection also increase thiamin needs.
- The foods such as fish, shellfish and a variety of vegetables have a variety of substances such as tannic acid, caffeic acid which are powerful inhibitors of thiamin. Tannic acid is most likely the substance in tea that inactivates thiamin and rapidly induce symptoms of Vit. B1 deficiency.

Riboflavin-B2

- Is a coenzyme in the electron transport system associated with conversion of tissue oxidations into stable energy.
- Food Sources:
- B2 is widely distributed in both plants and animal tissues. The most important food source is milk. Other good sources include egg, liver and green leafy vegetables.
- Deficiency:
- B2 deficiency is not known to be a primary etiologic factor in a major human disease, although patient with beriberi and protein deficiency are generally also deficient in vit B2.

Niacin-B3

- Niacin is required by all living cells as part of the two coenzymes NAD (Nicotinamide adenine dinucleotide) and NADP(Nicotinamide adenine dinucleotide phosphate) which are essential in the metabolism of carbohydrate, fat and protein.
- Food sources:
- Niacin is present in small amounts in most foods; particularly rich sources are cereal grain (e.g. whole wheat), legumes, meat, poultry and peanuts. tea and coffee also can contribute significantly to niacin intake.
- Deficiency:
- Deficiency of niacin causes Pellagra. The disease is classically characterized by the 4 D's—Dermatitis, Diarrhea, Dementia and Death.

Cyanocobalamin-Vitamin B12

- **Food sources:**
- **Naturally occurring vit.B12 is synthesized by microorganisms, animals can not synthesized it. This vit. is Unique among the B-group is that it is not present in fruits, vegetable, and grains. Animals get their vitamin by ingesting microorganisms containing vit. B12, and/or the B12 activity of microorganisms high enough in alimentary tract for absorption and storage in tissue (especially liver). The best sources of vit. B12 include meats, seafood, eggs and milk.**
- **Deficiency: the deficiency of vit-B12 can occur because of inadequate dietary intak such as in strict vegetarians, but in most cases the deficiency is secondary to a defect in absorption which can result from disorders affecting the stomach, the intestine and the pancreas. Deficiency of vit-B12 causes a macrocytic, megaloblastic anemia, there leucopenia and thrombocytopenia. The patient appears pale, glossitis and irritated mucosa, vit-B12 deficiency can cause disorders of nervous system.**
- **Damage to the myelin sheath. This causes a wide variety of neurological symptoms, including paresthesias of the hands and feet, loss of memory and dementia.**

Vitamin C-Ascorbic Acid

- **Vitamin C has many functions, its protect, regulate, and facilitate the biologic processes of many enzyme systems, act as a reducing agent, and its major function is in the formation of collagen.**
- **Food sources: vit-C is widely distributed in the vegetables and fruits especially citrus fruits, tomatoes, lettuce, green peppers are excellent sources.**
- **Cabbage, cauliflower, spinach and other green vegetables are good sources.**
- **Although low in vit C, potatoes are consumed in such quantities that they become a good source.**
- **Deficiency: the deficiency in vit c results in Scurvy. The signs of the disease in adults include aching Joints, bones and muscle, impaired capillary integrity with subcutaneous hemorrhage, and bleeding gums. Other symptoms are mental depression, hysteria and anemia.**

2. Fat-soluble vitamins
Vitamin A

- Vitamin A was the first fat-soluble vitamin to be discovered and has been known chemically since 1927
- Chemistry:
- The term 'vitamins A' is reserved to design any substance or mixture of substances that possesses activity similar to vit. A. Retinol is the most commonly known and abundant of all naturally occurring vit.A compounds.
- Food Sources:
- Performed vit.A is available only in foods of animal origin in which the animal has converted the precursor into active vitamin. Rich sources of the vitamin include: liver, kidney, and animal fats including these found in milk, butter, egg yolk and fatty fish. [retinol—natural source of vit.A].
- Plants food are rich in carotenoids which are chemically related to vit.A. They are known as the precursors (or provitamin A) that are converted in the body by an enzyme-catalyzed reaction to active vit.A. The major dietary sources of provitamin A are the yellow and green vegetables and fruits [carrots, sweet potatoes, apricots, spinach]. The carotenes are useful nutritionally only in so for as they may be converted to retinol.[pumpkin, tomato, peach, water melon]

Function of vitamin A

1. Vision: the light receptors of the eye are the rod and cone cells of the retina, both contain light –sensitive pigments that require vit A for their formation and proper functioning.
2. Maintenance of epithelial cells: retinol deficiency has a deleterious effect on epithelial structure in general. Epithelial cells are found in the linings of all openings in the interior of the body as well as in glands and ducts. They also from the outer protective layer of the skin. Most epithelial cells secrete mucus, but in vitamin A deficiency there is reduction in mucus secreting cell.
3. Bone development: vitamin A is required for normal bone growth. In a deficiency, bones fail to grow in length, probably because the remodeling process that is an essential phase of bone growth is poorly controlled. The skull and spinal column do not continue to enlarge to accommodate the growing nervous system. Vitamin A is also necessary for enamel forming epithelial cells in the development of teeth antioxidant factor against cancer I.e. lung cancer.

Vitamin A requirement

1. Influencing factors a number of factors modify the needs such as:

A. The amount stored in the liver

B. The form in which it is taken (carotene or vit A), as only approximately (1/3) of beta carotene is absorbed in to intestinal wall and then only (1/2) of this is converted in to retinol. The absorption of both retinol and carotene is facilated by fats in the diet and bile salt in the duodenum.

C. Illness

D. Gastrointestinal or hepatic defects.

2. Units: the units are presently expressed as retinol equivalents (R.E). It takes in to account the variations in absorption and conversion of different precursors in to vit A. One R.E is equal to 1µg of retinol, 6 µg of β-carotene and 12 µg of other carotene precursors. Which vit.A is expressed in international Units (I.U), 1 R.E. =3.3 I.U. of retinol=10 I.U. of carotene.

3. RDA:

The requirement of vit. A is proportional to body weight the RDA for adult males is 1000 R.E; the RDA for women is lower, 800 R.E, during pregnancy , 1000 R.E. are recommended and during lactation 1200 R.E., children need 600-1000 R.E. daily, with the amount increasing from infancy to 14 years of age.

Vitamin A Deficiency

- **Primary vit.A deficiency**: - generally results from in adequate intake in the diet, a low intake of protein and fat needed for the absorption and utilization of vit. A may aggravate the problem. The liver can store quantities of vit. A sufficient for several months and therefore deficiency only becomes apparent when inadequate intake as persisted for so long that the liver stores are too depleted to supply the body's requirement.
- **Secondary vit. A deficiency** occurs due to:-

1. Poor absorption due to lack of bile or defective absorbing surface
2. Inadequate conversion of carotene because of liver disease (liver cirrhosis) or intestinal disease

Young children because of their requirement are particularly at risk of vit A deficiency, as vit A deficiency and its ocular clinical manifestation xerophthalmia is found mainly among the poor of the developing countries. Vit A deficiency is one of the seven most common causes of blindness. The WHO estimates that 250 thousand children become blind every year from vit A deficiency. Clinical features :earliest symptom is night blindness followed by degenerative changes in the retina.

Xerophthalmia Classification

- **XN Night blindness**
- **X1A Conjunctival xerosis(conjunctiva becomes dry and thick)**
- **X1B Bitot's spot–small foamy, superficial plaque on the temporal conjunctiva.**
- **X2 Corneal xerosis as the cornea becomes dry and lacks luster, later it may look bluish and milky.**
- **X3A Corneal ulceration with xerosis.**
- **X3B Keratomalacia.**
- **XF Xerophthalmia Fundus, softening of the cornea that leads to permanent scaring and deformation of the cornea, leading to blindness.**
- **XS Scare.**

Vitamin A deficiency is considered to be a public health problem if, among children aged 0.5 years, at least if;
1% have night blindness or
2% have Bitot's Spots or
0.01% have corneal dryness, ulcers or keratomalacia or
0.05% have corneal ulcers.

Vitamin A deficiency is associated with an increased risk of transmitting HIV from mother to infant in the breast milk. Severe forms of the disease are often associated with other co-existing factors that may affect both levels of and demand for, retinol binding protein. These include energy nutrient malnutrition, and infections. An association between measles and xerophthalmia has been reported. When the measles virus infects the conjunctiva and cornea, the epithelia are damaged; if there is insufficient vit.A or retinol binding protein available for epithelial regeneration. Xerophthalmia may develop. Also skin changes which include dryness and hyperkeratosis are also sign of vit. A deficiency.

Seasonal Pattern:

Xerophthalmia prevalence is greatest during the hot, dry months when green leafy vegetables are least prevalent and the incidence of infectious diseases are high.

Treatment

- **Immediately on diagnosis (60 mg) retinol (200,000 I.U) should be given orally, or if there is vomiting or severe diarrhea (55 mg) retinol by I.M injection. The corneal lesions clear up within 48-72 hours.**
- **The vitamin preparation in a dose of 8-10 mg/day should be given for a month. Patients with ocular complication should be referred to the ophthalmologist.**

Prevention

- **The control of vitamin A deficiency can only be achieved through an improvement in the population's dietary intake of retinol or beta carotene, this may require a change in food habits. Pregnant woman should be advised to eat dark green leafy vegetables. This helps to build up stores of retinol in the fetal liver and should be educated about the importance of given such vegetables to their babies.**
- **A more specific short term measure is the oral administration of single high dose capsule containing 200.000 I.U of vit. A to--at risk children.**
- **In Iraq, we provide a single dose of vit. A (50.000) I.U to young children at the age of 9 months with the measles vaccine, at the age of 18 months another dose of vit.A (100.000) I.U, and another prophylactic dose at the first year of primary school, also a single dose of (200.000) I.U usually provided to lactating mothers after delivery.**

Vitamin D

Vit D is required for normal metabolism of calcium and phosphorus and for bone formation. It enhances the absorption of these minerals from the gut, their mobilization from bone and the reabsorption of phosphorus by the kidney.

All forms of vit D are soluble in fat but not in water.

Dietary Sources of vit. D

Few natural food sources of vit.D exist. The main food sources are milk, butter, cheese, egg yolk and fish liver oils. In general foods are low sources of vit.D, as human milk contain 2-100 I.U/L, cow milk 3-50 I.U/L, egg yolk 100-500 I.U/100gram, 20% of egg is egg yolk, therefore 7 eggs are needed to compensate for this quantity.

Therefore the main source is the skin synthesis; smoke prevented the Ultra Violet Radiation in crowded urban areas.

Vitamin D Requirement

- Influencing factors: difficulties exist in setting requirements for vit.D. Variables arise from many sources:-

1. A limited number of food sources available.
2. Lack of knowledge of precise body needs.
3. Differing degrees of skin synthesis by irradiation.
4. Need; vary between winter and summer.
5. A persons way of living and working determines the degree of sunlight exposure. Elderly people who do not go out of doors may need supplementary vit.D. Growth demands in children and in pregnancy and lactation necessitate increase in take.

- In general RDA standard is 400 I.U (10µg).

Vitamin D Deficiency

- Vitamin D deficiency causes Rickets in the growing child and Osteomalacia in adult.
- **Aetiology of vitamin Deficiency:**

  These disorders resulted from various aetiological factors which all results in deficient calcium and phosphorous metabolism.

1. Deficient diet intake of vitamin D.
2. Inadequate exposure to sunlight.
3. Malabsorption diseases such as celiac syndrome, colitis and crohn disease.
4. Anticonvulsant drug therapy which transform vit.D into inactive form, or it effect the transfer of vit. D into an active form.
5. Congenital defect of some enzymes.
6. Defective tubular reabsorption which lead to loss of phosphorous and to less degree calcium.
7. Chronic renal insufficiency which is called Osteodystrophy.

Treatment

- **Oral administration of vitamin D in doses of 1500-5000 I.U daily brings about rapid improvement in vast majority of cases. The dose may be given orally or as I.M injection. After complete healing of the lesion, vit. D should be given in dose of 400 I.U daily for preventing recurrence. Children should be encourage to get exposure to sun in moderate amounts.**

Prevention

- **Supplementation of the infant food with vit.D is required, as fortified milk or baby food with 100 I.U/L, but there is the danger of vit.D intoxication can occurred from excessively fortified food, or vit.D can be given by drops for daily supplement of 400 I.U, and it is shown that it is better absorbed than fortify milk.**

Thank you