

Vitamins and minerals

Vitamins

Vitamins are used for the prevention and treatment of specific deficiency states or when the diet is known to be inadequate. It has often been suggested but never convincingly proved, that subclinical vitamin deficiencies cause much chronic ill-health and liability to infections. This has led to enormous consumption of vitamin preparations, which have no more than placebo value. Most vitamins are comparatively non-toxic but prolonged administration of high doses of retinol (vitamin A), ergocalciferol (vitamin D₂) and pyridoxine (vitamin B₆) may have severe adverse effects.

Retinol (vitamin A) is a fat-soluble substance stored in body organs, principally the liver. Periodic high-dose supplementation is intended to protect against vitamin A deficiency which is associated with ocular defects particularly xerophthalmia (including night blindness which may progress to severe eye lesions and blindness), and an increased susceptibility to infections, particularly measles and diarrhoea. Universal vitamin A distribution involves the periodic administration of supplemental doses to all preschool-age children with priority given to age groups, 6 months to 3 years, or regions at greatest risk. All mothers in high-risk regions should also receive a high dose of vitamin A within 8 weeks of delivery. Since vitamin A is associated with a teratogenic effect it should be given in smaller doses (no more than 10 000 units/day) to women of child-bearing age. It is also used in the treatment of active xerophthalmia. Doses of vitamin A should be administered orally immediately upon diagnosis of xerophthalmia and thereafter patients with acute corneal lesions should be referred to a hospital on an emergency basis. In women of child-bearing age there is a need to balance the possible teratogenic effects of vitamin A should they be pregnant with the serious consequences of xerophthalmia. Where there are severe signs of xerophthalmia high dose treatment as for patients over 1 year should be given. When less severe symptoms are present (for example night blindness) a much lower dose is recommended. Vitamin A therapy should also be given during epidemics of measles to reduce complications.

Vitamin B is composed of widely differing substances which are, for convenience, classed as 'vitamin B complex'. **Thiamine** (vitamin B₁) is used orally for deficiency due to inadequate dietary intake. Severe deficiency may result in 'beri-beri'. Chronic dry 'beri-beri' is characterized by peripheral neuropathy, muscle wasting and weakness, and paralysis; wet 'beri-beri' is characterized by cardiac failure and oedema. Wernicke-Korsakoff syndrome (demyelination of the CNS) may develop in severe deficiency. Thiamine is given by intravenous injection in doses of up to 300 mg daily (parenteral preparations may contain several B group vitamins) as initial treatment in severe deficiency states. Potentially severe allergic reactions may occur after parenteral administration. Facilities for resuscitation should be immediately available. **Riboflavin** (vitamin B₂) deficiency may result from reduced dietary intake or reduced absorption due to liver disease, alcoholism, chronic infection or probenecid therapy. It may also occur in association with other deficiency states such as pellagra. **Pyridoxine** (vitamin B₆) deficiency is rare as the vitamin is widely distributed in foods, but deficiency may occur during isoniazid therapy and is characterized by peripheral neuritis. High doses are given in some metabolic disorders, such as hyperoxaluria and it is also used in sideroblastic anaemia.

Nicotinic acid inhibits the synthesis of cholesterol and triglyceride and is used in some hyperlipidaemias. Nicotinic acid and **nicotinamide** are used to prevent and treat nicotinic acid deficiency (pellagra). Nicotinamide is generally preferred as it does not cause vasodilation. **Hydroxocobalamin** is the form of vitamin B₁₂ used to treat vitamin B₁₂ deficiency due to dietary deficiency or malabsorption (see section 10.1).

Folic acid is essential for the synthesis of DNA and certain proteins. Deficiency of folic acid or vitamin B₁₂ is associated with megaloblastic anaemia. Folic acid should not be used in undiagnosed megaloblastic anaemia unless vitamin B₁₂ is administered concurrently, otherwise neuropathy may be precipitated (see section 10.1). Supplementation with folic acid 400 micrograms daily is recommended for women of child-bearing potential in order to reduce the risk of serious neural tube defects in their offspring (see section 10.1).

Ascorbic acid (vitamin C) is used for the prevention and treatment of scurvy. Claims that ascorbic acid is of value in the treatment of common colds are unsubstantiated.

The term **vitamin D** covers a range of compounds including **ergocalciferol** (vitamin D₂) and **colecalfiferol** (vitamin D₃). These two compounds are equipotent and either can be used to prevent and treat rickets.

Simple deficiency of vitamin D occurs in those who have an inadequate dietary intake or who fail to produce enough colecalfiferol (vitamin D₃) in their skin from the precursor 7-dehydrocholesterol in response to ultraviolet light.

Children with dark skin must continue vitamin D prophylaxis for up to 24 months because of their inability to produce enough vitamin D₃ in their skin. Dark skin with a high melanin content must be exposed to daylight longer than light skin in order to obtain the same synthesis of vitamin D₃. Vitamin D is also used in deficiency states caused by intestinal malabsorption or chronic liver disease and for the hypocalcaemia of hypoparathyroidism.

Vitamin K is necessary for the production of blood clotting factors (see section 10.2).

Ascorbic acid

Vitamin C

Tablets , ascorbic acid 50 mg

Uses:

prevention and treatment of scurvy

Dosage:

Prophylaxis of scurvy, *by mouth* , **ADULT** and **CHILD** 25–75 mg daily

Treatment of scurvy, *by mouth* , **ADULT** and **CHILD** not less than 250 mg daily in divided doses

Adverse effects:

gastrointestinal disturbances reported with large doses

Ergocalciferol

Vitamin D₂

Ergocalciferol is a representative vitamin D compound. Various vitamin D compounds can serve as alternatives

Tablets , ergocalciferol 1.25 mg (50 000 units)

Capsules , ergocalciferol 1.25 mg (50 000 units)

Oral solution , ergocalciferol 250 micrograms/ml (10 000 units/ml)

Note. If there is no plain vitamin D tablet available for the treatment of simple deficiency, calcium and ergocalciferol tablets may be used but the calcium is unnecessary

Tablets , ergocalciferol 10 micrograms (400 units), calcium lactate 300 mg, calcium phosphate 150 mg

Uses:

prevention of vitamin D deficiency; vitamin D deficiency caused by malabsorption or chronic liver disease; hypocalcaemia of hypoparathyroidism

Contraindications:

hypercalcaemia; metastatic calcification

Precautions:

ensure correct dose in infants; monitor plasma calcium at weekly intervals in patients receiving high doses or those with renal impairment; nausea and vomiting—may indicate overdose and hypercalcaemia; pregnancy and breastfeeding (Appendices 2 and 3); **interactions:** Appendix 1

Dosage:

Prevention of vitamin D deficiency, *by mouth* , **ADULT** and **CHILD** 10 micrograms (400 units) daily

Treatment of vitamin D deficiency, *by mouth* , **ADULT** 1.25 mg (50 000 units) daily for a limited period; **CHILD** 75–125 micrograms (3000–5000 units) daily

Hypocalcaemia associated with hypoparathyroidism, *by mouth* , **ADULT** 2.5 mg (100 000 units) daily; **CHILD** up to 1.5 mg (60 000 units) daily

Adverse effects:

symptoms of overdosage include anorexia, lassitude, nausea and vomiting, diarrhoea, weight loss, polyuria, sweating, headache, thirst, vertigo, and raised concentrations of calcium and phosphate in plasma and urine; tissue calcification may occur if dose of 1.25 mg continued for several months

Nicotinamide

Nicotinamide is a representative vitamin B substance. Various compounds can serve as alternatives

Tablets , nicotinamide 50 mg

Uses:

treatment of pellagra

Dosage:

Treatment of pellagra, *by mouth* , **ADULT** up to 500 mg daily in divided doses

Pyridoxine hydrochloride

Vitamin B₆

Tablets , pyridoxine hydrochloride 25 mg

Uses:

treatment of pyridoxine deficiency due to metabolic disorders; isoniazid neuropathy; sideroblastic anaemia

Precautions:

interactions: Appendix 1

Dosage:

Deficiency states, *by mouth* , **ADULT** 25–50 mg up to 3 times daily

Isoniazid neuropathy, prophylaxis, *by mouth* , **ADULT** 10 mg daily

Isoniazid neuropathy, treatment, *by mouth* , **ADULT** 50 mg 3 times daily

Sideroblastic anaemia, *by mouth* , **ADULT** 100–400 mg daily in divided doses

Adverse effects:

generally well tolerated, but chronic administration of high doses may cause peripheral neuropathies

Retinol

Vitamin A

Sugar-coated tablets (Coated tablets), retinol (as palmitate) 10 000 units

Capsules , retinol (as palmitate) 200 000 units

Oral solution (oily), retinol (as palmitate) 100 000 units/ml

Water-miscible injection (Solution for injection), retinol (as palmitate) 50 000 units/ml, 2-ml ampoule

Uses:

prevention and treatment of vitamin A deficiency; prevention of complications of measles

Precautions:

pregnancy (teratogenic; see notes above and Appendix 2); breastfeeding (Appendix 3)

Dosage:

Prevention of vitamin A deficiency (universal or targeted distribution programmes), *by mouth* , **INFANT** under 6 months, 50 000 units, 6–12 months, 100 000 units every 4–6 months, preferably at measles vaccination; **CHILD** over 1 year (preschool), 200 000 units every 4–6 months; **ADULT** , 200 000 units every 6 months; **ADULT** pregnant woman, maximum of 10 000 units daily *or* maximum 25 000 units weekly; **ADULT** mothers, 200 000 units at delivery or within 6 weeks

Treatment of xerophthalmia, *by mouth* , **INFANT** under 6 months, 50 000 units on diagnosis, repeated next day and then after 2 weeks; 6–12 months, 100 000 units immediately on diagnosis, repeated next day and then after 2 weeks; **CHILD** over 1 year and **ADULT** (except woman of child-bearing age) 200 000 units on diagnosis, repeated next day and then after 2 weeks; **ADULT** (woman of child-bearing age, see notes above), severe signs of xerophthalmia, as for other adults; less severe cases (for example, night blindness), 5000–10 000 units daily for at least 4 weeks *or* up to 25 000 units weekly

Note. Oral vitamin A preparations are preferred for the prevention and treatment of vitamin A deficiency. However, in situations where patients have severe anorexia or vomiting or are suffering from malabsorption, a water-miscible injection preparation may be administered intramuscularly

Adverse effects:

no serious or irreversible adverse effects in recommended doses; high intake may cause birth defects; transient increased intracranial pressure in adults or a tense and bulging fontanelle in infants (with high dosage); massive overdose can cause rough skin, dry hair, enlarged liver, raised erythrocyte sedimentation rate, raised serum calcium and raised serum alkaline phosphatase concentrations

Riboflavin

Vitamin B₂

Tablets , riboflavin 5 mg

Uses:

vitamin B₂ deficiency

Dosage:

Treatment of vitamin B₂ deficiency, *by mouth* , **ADULT** and **child** up to 30 mg daily in divided doses

Prophylaxis of vitamin B₂ deficiency, *by mouth* , **ADULT** and **child** 1–2 mg daily

Thiamine hydrochloride

Vitamin B₁

Tablets , thiamine hydrochloride 50 mg

Uses:

prevention and treatment of vitamin B₁ deficiency

Precautions:

parenteral administration (see notes above); breastfeeding (Appendix 3)

Dosage:

Mild chronic thiamine deficiency, *by mouth* , **ADULT** 10–25 mg daily

Minerals

Calcium gluconate . Calcium supplements are usually only required where dietary calcium intake is deficient. This dietary requirement varies with age and is relatively greater in childhood, pregnancy and lactation due to an increased demand, and in old age, due to impaired absorption. In osteoporosis, a calcium intake which is double the

recommended daily amount reduces the rate of bone loss. In hypocalcaemic tetany calcium gluconate must be given parenterally but plasma calcium must be monitored. Calcium gluconate is also used in cardiac resuscitation.

Iodine is among the body's essential trace elements. The recommended intake of iodine is 150 micrograms daily (200 micrograms daily in pregnant and breastfeeding women); in children the recommended intake of iodine is 50 micrograms daily for infants under 1 year, 90 micrograms daily for children aged 2–6 years, and 120 micrograms daily for children aged 7–12 years. Deficiency causes endemic goitre and results in endemic cretinism (characterized by deaf-mutism, intellectual deficit, spasticity and sometimes hypothyroidism), impaired mental function in children and adults and an increased incidence of still-births and perinatal and infant mortality. Iodine and iodides may suppress neonatal thyroid function and in general iodine compounds should be avoided in pregnancy. Where it is essential to prevent neonatal goitre and cretinism, iodine should not be withheld from pregnant women. Control of iodine deficiency largely depends upon salt iodization with potassium iodide or potassium iodate and through dietary diversification. In areas where iodine deficiency disorders are moderate to severe, **iodized oil** given either before or at any stage of pregnancy is found to be beneficial.

Sodium fluoride. Availability of adequate fluoride confers significant resistance to dental caries. It is now considered that the topical action of fluoride on enamel and plaque is more important than the systemic effect. Where the natural fluoride content of the drinking water is significantly less than 1 mg per litre, artificial fluoridation is the most economical method of supplementing fluoride intake. Daily administration of fluoride tablets or drops is a suitable alternative, but systemic fluoride supplements should not be prescribed without reference to the fluoride content of the local water supply; they are not advisable when the water contains more than 700 micrograms per litre. In addition, infants need not receive fluoride supplements until the age of 6 months. Dentifrices which incorporate sodium fluoride are a convenient source of fluoride. Individuals who are either particularly caries prone or medically compromised may be given additional protection by the use of fluoride rinses or by application of fluoride gels. Rinses may be used daily or weekly; daily use of a less concentrated rinse is more effective than weekly use of a more concentrated one. High-strength gels must be applied on a regular basis under professional supervision; extreme caution is necessary to prevent the child from swallowing any excess.

For the use of **iron** preparations in the treatment of anaemia see section 10.1.

Calcium gluconate

Calcium gluconate is a complementary drug

Injection (Solution for injection), calcium gluconate (monohydrate) 100 mg (Ca^{2+} 220 micromol)/ml, 10-ml ampoule

Uses:

hypocalcaemic tetany

Contraindications:

conditions associated with hypercalcaemia and hypercalciuria (for example some forms of malignant disease)

Precautions:

monitor plasma calcium concentration; **interactions:** Appendix 1

Dosage:

Hypocalcaemic tetany, *by slow intravenous injection* , **ADULT** 1 g (2.2 mmol) followed *by continuous intravenous infusion* of about 4 g (8.8 mmol) daily

Dilution and administration. According to manufacturer's directions

Adverse effects:

mild gastrointestinal disturbances; bradycardia, arrhythmia; irritation at injection site

Iodine

Oily injection (Solution for injection), iodine (as iodized oil) 480 mg/ml. 0.5-ml ampoule, 1-ml ampoule

Note. Iodized oil may also be given by mouth

Uses:

prevention and treatment of iodine deficiency

Contraindications:

breastfeeding (Appendix 3)

Precautions:

over 45 years old or with nodular goitre (especially susceptible to hyperthyroidism when given iodine supplements—iodized oil may not be appropriate); may interfere with thyroid-function tests; pregnancy (see notes above and Appendix 2)

Dosage:

Endemic moderate to severe iodine deficiency, *by intramuscular injection* , **ADULT** women of child-bearing age, including any stage of pregnancy, 480 mg once each year; *by mouth* , **ADULT** during pregnancy and one year postpartum, 300–480 mg once a year *or* 100–300 mg every 6 months; women of child-bearing age, 400–960 mg once a year *or* 200–480 mg every 6 months

Iodine deficiency, *by intramuscular injection* , **INFANT** up to 1 year, 190 mg; **CHILD** and **ADULT** 380 mg (aged over 45 years or with nodular goitre, 76 mg but see also Precautions) (provides up to 3 years protection)

Iodine deficiency, *by mouth* , **ADULT** (except during pregnancy) and **CHILD** above 6 years, 400 mg once a year; **ADULT** during pregnancy, single dose of 200 mg; **INFANT** under 1 year, single dose of 100 mg; **CHILD** 1–5 years, 200 mg once a year

Adverse effects:

hypersensitivity reactions; goitre and hypothyroidism; hyperthyroidism

Sodium fluoride

Sodium fluoride is a representative fluoride. Various fluorides can serve as alternatives

Mouth wash , sodium fluoride 0.05%, 0.2%

Uses:

prevention of dental caries

Contraindications:

not for areas where drinking water is fluoridated or where fluorine content is naturally high

Dosage:

Prevention of dental caries, *as oral rinse* , **CHILD** over 6 years, 10 ml 0.05% solution daily *or* 10 ml 0.2% solution weekly

Note. Fluoridated toothpastes are also a convenient source of fluoride for prophylaxis of dental caries

Adverse effects:

in recommended doses toxicity unlikely; occasional white flecks on teeth at recommended doses; rarely yellowish-brown discoloration if recommended doses are exceeded