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Use and Abuse of Vitamins

Thirteen substances are accepted as vitamins by the International Union of Nutritional Sciences and other international scientific organisations. They are organic substances found in food, not made in the body, and required in small quantities – usually as a cofactor for enzymes.

There are 4 fat-soluble, A, D, E and K, and nine water-soluble, thiamin (vitamin B_1), riboflavin (vitamin B_2), nicotinic acid (vitamin B_3), pyridoxine (vitamin B_6, pyridoxal and pyridoxamine), folacin (folic acid or folates), cyanocobalamin, hydroxocobalamin (vitamin B_{12}), biotin, pantothenic acid and ascorbic acid (vitamin C). For all this definition, it must be said that vitamin D can be made in the skin, vitamin K can be derived in part from gut bacteria, and biotin can also be made by bacteria in the large bowel, from which it can be absorbed.

It is important to realise the only vitamin source which can be regarded as natural is food. Food provides a physicochemical and chemical environment for presenting vitamins, which cannot easily be simulated pharmaceutically, to the gastrointestinal tract. This is not to say that vitamins cannot be synthesised and chemically identical to those in food. But bioavailability is likely to be more appropriate from food and stability can be more of a problem removed from the food environment.

The nutritional physiology of vitamins and their therapeutic use need to be distinguished. A nutrient deficiency, however, can be dealt with therapeutically by using food and/or a nutrient supplement. In some cases, it is also possible to exploit pharmacological rather than physiological actions of vitamins. The use of nicotinic acid in the management of hyperlipidaemia is one of the few proven examples of this and the amounts required cannot be obtained from food; the source is a pharmaceutical preparation and the effects pharmacological [1]. Other suggested pharmacological effects of nicotinic acid like those on psychosis have not stood up to rigorous therapeutic trial [2,3]. In the rare circumstances of inherited disorders of metabolism, a physiological effect may be achieved by use of a pharmacological dose of a nutrient to overcome a metabolic block.

In order to counsel patients more effectively about vitamin intake from food, a working knowledge of good fast sources of various vitamins is required [4].

The 2 prerequisites for avoiding vitamin deficiency are that one be as physically active as possible so that enough food can be eaten, and that a wide variety of foods be eaten, preferably of high nutrient density. When these conditions are not fulfilled, deficiency can be seen.

Recommended dietary intakes (RDIs) of vitamins are not always understood for what they are. They cover the nutrient requirements for at least 99% of healthy individuals and a variety of circumstances, and already exceed nutrient requirements. They do not, however, allow for factors such as illness or inter-

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action with certain drugs. But for short periods of illness, body storage of vitamins and the early resumption of a normal eating pattern will mean no vitamin deficiency emerges. When a recommended dietary intake for a nutrient has not yet been formulated, a 'safe and adequate' range can generally be advised [5,6].

If consumed in sufficient quantities over a sufficiently long time, all chemicals will assume toxicological properties; that the chemical in question is an essential nutrient does not mean it will not manifest toxicity. The safety margin for different vitamins, however, does vary. A summary of vitamin toxicity is provided in table I.

Florid vitamin deficiency states are rarely seen in developed countries. The functional problem may be evident more frequently; there is not necessarily a high level of specificity for the clinical features, or even functional abnormality. As in other areas of clinical medicine, diagnostic certainty comes through collating various pieces of evidence and not being dependent on any one. Deficiency may occur on moving abruptly from a higher to a lower dosage of some vitamins, for example ascorbic acid [1]. Vitamin deficiency is unlikely with current enteral nutrition formulations unless there is some other factor to alter nutrient absorption or utilisation.

Table I.
Vitamin toxicity

Vitamin	Adverse effects	Daily intake above which adverse effects are seen
Fat-soluble		
A	Neurological; alopecia; bone dysmorphogenicity	200-1000 μg/kg bodyweight 700-800iu (210-240 μg/kg/day)
D	Hypercalcaemia and its effects	Possible at 10,000iu (240μg) daily over several months, but 50,000-500,000iu daily for several years may be necessary for toxicity to develop. But because of the expression, in countries where intakes have been in the region of 3000-4000iu (75-100μg) with fortification, of dysmorphogenicity it would seem prudent to keep intakes as near to 400 iu(10μg)/day as possible. Problems have been seen in infants at 90-100 μg/day.
	Possible hypercholesterolaemia Developmental abnormalities	
E	Interference with absorption of A and K Minor gastrointestinal side effects (nausea, flatulence, diarrhoea)	300-600mg
K	Long term effects uncertain. In infants, haemolytic anaemia. Increased analgesia in interaction with opioids and salicylates	5-10 mg/day in infants may lead to haemolytic anaemia
Water-soluble		
Thiamin (vitamin B_1)	Hypersensitivity reactions, parenterally	Very low level of toxicity
Riboflavin (vitamin B_2)	Not described	Very low level of toxicity. Limited water-solubility, therefore urinary excretion limited
Nicotinic acid	Nicotinamide has little adverse effect compared with nicotinic acid. Vascular dilatation (flush) experienced at any dose which leads to a fluctuation in blood levels. Slow introduction of pharmacological amounts can avoid changes in hepatic enzymes. Variable hyperuricaemia should be checked.	50-100mg
Pyridoxine (vitamin B_6)	Sensory neuropathy; phocomelia (possible); withdrawal depression (clinical observation requiring formal study)	> 500mg
Folacin	Exacerbation of cyanocobalamin deficiency	Preferable to keep dosage within 2 or 3 orders of recommended dietary intake
	Secondary zinc deficiency	
Cyanocobalamin (vitamin B_{12})	None recognised	Not established
Biotin	None recognised in humans. In experimental animals, interference with reproductive function	Not established
Pantothenic acid	Diarrhoea	10,000-20,000mg
Ascorbic acid	Diarrhoea; oxaluria; uricosuria; withdrawal scurvy; iron storage disease; increased toxicity of other metals, hypoglycaemic effects; gastrointestinal reflux; possible increase in requirement for vitamin B_6; associated excessive sodium intake; dental erosions; haemolysis in G-6-PD deficiency; mutagenic breakdown products; interaction with warfarin; gastrointestinal obstruction	Adverse effects seen at levels of > 500-1000mg

Specific nutrient supplementation may be required at minimal energy increment. Low energy, essential nutrient complete formulations may be useful in these circumstances, as may vitamin supplements which cover all of the 13 vitamins in the range of the recommended dietary intakes.

As far as total parenteral nutrition is concerned, vitamin deficiencies are occasionally seen and may include A, E, folacin and biotin.

It is possible to reassure many patients about their concern that they might have vitamin deficiency. Issues to take into account include discussion about vitamin retention in foods, and ways to improve it, encouragement to be as physically active as possible so that more food can be eaten, emphasis on nutrient dense rather than energy dense foods, encouragement to eat a wide variety of foods, caution about alcohol abuse, avoidance of cigarette smoking, which at the very least decreases interest in food, and attention to nutrition support, food wherever possible, at times of protracted illness.

It is worth knowing the groups vulnerable to vitamin deficiency in developed countries. They include socioeconomically disadvantaged, institutionalised persons, persons on medication, infants (especially premature), the elderly, alcohol abusers, women in the childbearing years, food faddists and those with low levels of physical activity. One risk factor is not usually enough to lead to a vitamin deficiency, but a combination makes it more likely. An example would be an elderly person, in an institution, who is also on medication.

Nutrient supplements should only be used when a food solution cannot be found. Nutrient selective situations which may require single nutrient supplementation include inherited disorders of metabolism, drug-nutrient interactions and specific nutrient malabsorption. In advanced nutrient deficiency, it can be worthwhile replenishing body stores with the single nutrient which is the principal problem. Concern that folacin supplements may precipitate vitamin B_{12} deficiency, at the levels found in food, would be unreasonable; therefore concern at levels of folacin equivalent to the recommended dietary intake must also be unreasonable. Thus, where a vitamin supplement is used in the face of a general food problem, the full range of vitamins at the recommended dietary intake should be used.

This cautious approach to nutrient supplementation is in great contrast to the widespread community phenomenon whereby at least 1 in 5 adult Australians regularly consumes supplements (7,8).

Under active research at the moment are situations in which supplementation in the range found in food might be preventive. These include the use of beta-carotene to reduce the risk of certain neoplastic diseases like lung and colorectal cancer, and the use of folic acid periconception to reduce the risk of neural tube defects. At the moment, we must await the outcome of prospective studies.

There is great interest among athletes in the use of nutrient supplements, again an area which must be regarded as one of considerable overuse.

However, it must be acknowledged that there is difficulty in assessing the benefit of nutrient supplements in achieving small increments in function required by athletes and in the small numbers who actually achieve these levels of performance, making experimental design difficult.

This is the time for a return to more rational use of nutrient supplements. Replenishment of deficiency states must be distinguished from the occasional pharmacological properties of vitamins and must in all ways ensure the avoidance of vitamin toxicology.

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