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Thiamine deficiency

and its prevention and control in major emergencies

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This review was prepared by Zita Weise Prinzo, Technical Officer, in WHO's Department of Nutrition for Health and Development.

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Thiamine Deficiency

A clinical syndrome that arises insidiously as a result of a severe, prolonged deficiency of thiamine in the diet, manifested in the initial stages by anorexia, malaise, and weakness of the legs, frequently with paraesthesia; there may be slight oedema and palpitations. The disorder may persist in this chronic state or may at any time progress to an acute condition characterized either by cardiac involvement with oedema or by peripheral neuropathy; forms intermediate between these two extremes may also occur. It is thought that the basic cause is the inhibition of a series of enzyme-catalysed cleavages of carbon-carbon bonds in which thiamine diphosphate is a coenzyme.

Synonyms: beriberi; Ceylon sickness; occidental beriberi (in part); oriental beriberi (in part); rice disease.

Note: The disorder (or spectrum of disorders) is classically associated with a diet consisting largely of polished rice (oriental beriberi), but may also arise if highly refined wheat flour forms a major part of the diet, in alcholics, and in food faddists (occidental beriberi). Owing to the confusion that has surrounded the use of 'beriberi' terms, it is recommended that they be abandoned.

Source International Nomenclature of Diseases Vol IV Metabolic, Nutritional, and Endocrine Disorders. WHO Geneva 1991 pg 277

Introduction

Scope

This is a document on thiamine deficiency, which looks at the risk factors leading to outbreaks of thiamine deficiency, describes the signs and symptoms of the deficiency disease, and discusses the strategies to prevent the deficiency in populations affected by major emergencies. A literature review of the epidemiology of thiamine deficiency, the properties and functions of the vitamin thiamine, and a discussion of food sources of this vitamin and its stability is also provided.

Background

Outbreaks of the micronutrient deficiency disease 'beriberi' have occurred frequently in refugee and displaced populations dependent on international food aid. Nutritional deficiencies do not generally occur with the consumption of a moderately varied diet However, the food rations distributed are usually not balanced in energy, protein and micronutrient content. Moreover in the initial phase of an emergency the affected populations are usually survivors of varying periods of minimal food intake and many are ill with infections Thiamine deficiency occurs where the diet consists mainly of milled white cereals, including polished rice, and wheat flour, all very poor sources of thiamine. Thiamine deficiency can develop within 2-3 months of a deficient intake and can cause disability and death. Thiamine deficiency in refugees has been seen in Thailand at the beginning of the 1980's and in the 1990's, in Guinea (1990), Djibouti (1993) and in Nepal (1993-1995).

Recent outbreaks of thiamine deficiency

In the general population

In the northern and north eastern parts of Thailand, thiamine deficiency, confirmed biochemically, was reported to be common in spite of adequate but marginal thiamine intakes, with the daily food consumption of the people being large amounts of glutinous rice, raw fermented fish and vegetables. Betel nut chewing was found to be common. From the data presented by Vimokesant and others (1982), anti-thiamine factors in the diet may have been a precipitating factor causing the thiamine deficiency in these population groups.

Thiamine deficiency has been observed in pregnant women who have increased demands for thiamine Rolfe and colleagues (1993) reported that it may be an unrecognized complication of pregnancy in urban areas in certain parts of Africa and Asia and be a cause of preventable maternal death. The potential for large outbreaks of thiamine deficiency exist in urban areas in West Africa where polished rice is the staple diet with many asymptomatic people probably having subnormal thiamine levels. In 1988, an outbreak of thiamine deficiency occurred in a rural area in The Gambia At least 140 people, mainly young men, were affected and 22 died (Tang et al, 1989). In 1990–1991 38 patients with thiamine deficiency were seen in a hospital in The Gambia and 4 patients (10.5%) died (Rolfe et al, 1993) In areas where rice is the staple, cases have been reported each year in the rainy season when food supplies are lowest and there is intense agricultural activity with increased energy expenditure There have also been reports of

outbreaks in confined populations in The Gambia, in prisons, psychiatric units, among communally-fed policemen, as well as amongst migrant workers in Ethiopia (Marsden et al, 1967, Rolfe et al, 1993).

In Europe, North America and Australia, thiamine deficiency is common among alcoholics and usually manifests itself as the Wernicke-Korsakoff syndrome but has also been reported in patients on restricted diets for obesity, those who receive total parenteral nutrition and in those who are on fad diets or whose intakes are high in carbohydrate and low in thiamine (Kawai et al, 1980; Anderson et al, 1985, Feldman, 1988) Little attention has been given to possible thiamine deficiency in infancy. Studies in Australia have revealed quite unexpected incidence of biochemical thiamine deficiency in pregnant mothers at term and in apparently healthy infants subsequent to the neonatal period Thiamine deficiency was found in infants and their mothers coming from families who had a high incidence of Sudden Infant Death Syndrome (Australian Health and Medical Research Council, 1978; Wood et al, 1980, Jeffrey et al, 1985)

In active young adults, subclinical yet biochemical thiamine deficiency may be a cardiovascular and a psychological stress factor as seen both in Japan (Anderson et al,1985) and the USA (Lonsdale et al,1980) Symptoms reported in the patients in the USA were those of neurotic dysfunction that are frequently treated by sedatives and psychological counselling. Diet history revealed increased consumption of high carbohydrate foods such as sweetened drinks and products made from refined wheat flour for long periods of time. The symptoms in the patients improved following the administration of thiamine.

Thiamine deficiency occurs sporadically in people who are socially isolated, suffer loss of appetite and self neglect In these cases 'mixed' vitamin deficiency syndromes are more common and respond better to vitamin B-complex treatment (Carney, 1971). Multiple vitamin B deficiencies including thiamine, pyridoxine and cyanocobalamin can result in polyneuropathy of varying manifestation. In Cuba in late 1992 and early 1993 there was an outbreak of a B vitamin deficiency related polyneuropathy affecting 50 000 people. It was reported to be a combination of a nutritional problem associated with possibly a toxic substance (WHO Press Release, September 1993). Thiamine deficiency is also seen in association with certain diseases. dysentery, diarrhea cancer, liver diseases, infections and hyperthyroidism

In refugee populations

Outbreaks of thiamine deficiency in refugees occurred in Cambodian refugees in Thailand in the beginning 1980's and more recently in Bhutanese refugees in Nepal in 1993–1995 A few cases were reported in Liberian refugees in Guinea (1990), in Eastern Ethiopia (1993) and in Djibouti (1993-1994). Table 1 summarises some of the recent outbreaks of thiamine deficiency among refugee populations. The outbreaks were always associated with rice-based diets lacking in variety In Djibouti, children under five and women of childbearing age were most affected (RNIS, ACC/SCN No 2, Dec.93). The outbreak was brought under control as a result of thiamine supplementation and the addition of fortified corn soy blend to the ration. Cases of infantile beriberi and thiamine deficiency in pregnant women were also reported by MSF-F (1992) among the Karen refugee population in the Mae Sod Region, Thailand.

Rations of polished rice, oil and beans have a thiamine content of approximately 0 7 mg per day

Table 1. Thiamine deficiency in refugee populations

Year	Location	Population	Prevalence (%)
1980[a,b]	Thailand (Cambodian refugees)	-----	8% in adults only
1981[c]	"	60 000	5%
1982[a]	"	----	-----
1985[d]	"	----	-----
1992[e]	Thailand (Karen refugees)	----	6% of breast-feeding women/cases of infantile beriberi
1990[c]	Guinea (Liberian refugees)	200 000	few cases
1993[f]	Eastern Ethiopia (Djibouti/Somalia border)	----	few cases
1993/94[f]	Djibouti	10 000	142 cases
Oct '93-June'94 [f,g]	Nepal (Bhutanese refugees)	85 000	12000 suspected cases
June'95	"	----	0.005/10000/day
Aug.'95	"	----	1.83/10000/day
Oct '95	"	----	0.85/10000/day

[a] Berry-Koch et al 1990, [b] Dahlberg, 1980, [c] Clugston, 1994, [d] Toole, 1992; [e] MSF/Epicentre, 1992;
[f] RNIS reports #1,2,4,7,8,13. ACC/SCN News. Oct'93-Dec.'95 , [g] SCF(UK) Nepal reports

(see Table 2). A ration should contain a minimum of 0.9 mg thiamine which does not provide for preparation and cooking losses. Blended food e.g CSB (corn soy blend) contains 0.6 mg to 0.8 mg of thiamine per 100 g. A hundred grams of CSB would need to be added to the daily ration for the RDA of thiamine to be covered providing also for preparation and cooking losses.

Table 2. Thiamine content of a rice-based ration

	Quantity (g) per day	Thiamine content (mg)
Rice, polished	400	0.4
Vegetable oil	30	--
Beans	40	0.25

Source: Toole, 1994

In Nepal, the first symptoms of thiamine deficiency appeared in the adult refugee population after the majority had been residing in the camp for 12 - 24 months. All reported cases of suspected thiamine deficiency appeared to be thiamine deficiency with peripheral neuropathy (dry beriberi). From October 1993 to June 1994, 12000 suspected thiamine deficiency cases had been reported of whom 10700 were mild and 1300 were severe cases. Mild cases were defined as those who reported to the refugee health centres with tingling and/or burning sensation and numbness. Severe cases were defined as those who reported to the health centres with weakness of limbs, ataxia, oedema, breathlessness and cardiac problems. Over 80% of the severe cases completely recovered with vitamin B complex administration and the rest responded to the treatment only partially. Those who did not improve had other medical problems as well, for example, cirrhosis of liver

Usually thiamine deficiency develops within 12 weeks of a deficient intake. However, in the above mentioned refugee population, fresh vegetables and lentils had been provided consistently and symptoms of a deficiency appeared at a later stage than expected if the diet were totally lacking in thiamine.

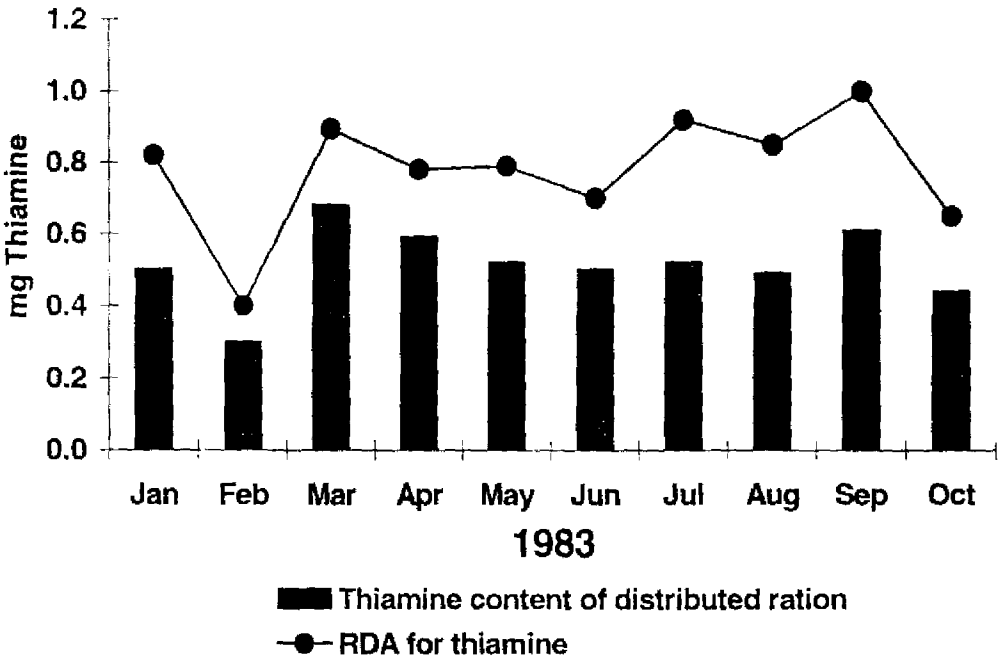
The thiamine content of the general ration that was distributed at the time is outlined in Table 3. Figure 1 shows the thiamine content of the ration in relation to the RDA for thiamine based on the energy content of the ration distributed. As shown, the thiamine content of the rations distributed were always lower than the minimum required.

An extensive nutrition survey was carried out to investigate the outbreak of thiamine deficiency in Bhutanese refugees in Nepal (SCF Nepal, J. Robertson, Jan. 9, 1994). About half of the refugees exchanged or sold some ration on a regular basis. Most did not like the red lentils in the ration and exchanged or sold it for meat or eggs, milk or curd, and vegetables, as well as for non-food items. The custom of extensive washing of rice prior to cooking reduced the little thiamine present in rice. Tea was the main drink consumed by both children and adults. Tannin in tea has been reported to inhibit thiamine absorption. There were no obvious toxins that could have been linked to the widespread polyneuropathy seen. There were no reported cases of thiamine deficiency in children, however, a number of school children had visual impairment. Most improved after being given vitamin B complex injections.

Table 3. Thiamine content of general ration distributed in Nepal in 1993

	Quantity (g/ person/day)	Thiamine content (mg)
Rice, polished	430	0.43
Lentils (red)	60	0.38
Oil	25	---
Sugar	20	---
Salt	5	---
Vegetables/Condiments	100	varying

Figure 1. Thiamine content of general ration in relation to RDA for thiamine based on energy content of the ration distributed



Note The RDA for thiamine based on the energy intake is 0.4 mg/ 1000 kcal

The decline in thiamine deficiency seemed to be the combined effect of including parboiled rice (thiamine content higher than polished rice), 40 g of *unilitho* (blended food with a thiamine content of 0.1 mg per 100 g), a different variety of lentils and the continuation of vegetables (Clugston, 1994). A vigorous nutrition education programme had also been started (see annex for nutrition messages used which also contributed to the improvements seen).

Risk factors

The great outbreaks of thiamine deficiency in South-East Asia at the beginning of this century followed the large scale production of milled rice and its large scale distribution. The availability of milled rice as a cheap and popular food in urban areas was also a factor of importance for the occurrence of thiamine deficiency in those areas. The requirement of thiamine is increased when carbohydrates are taken in large amounts and is raised during periods of increased metabolism, for example, fever, muscular activity, hyperthyroidism and also during pregnancy and lactation. A diet based on polished rice is high in carbohydrates which augments the thiamine requirement and is compounded by a low thiamine content.

The overt risk factors reported by Rolfe and others (1993) in The Gambia were pregnancy, alcohol consumption, fevers, chronic disability, exercise, diabetes and dysentery. Polished rice consumption accounted for 44% of the total daily calorie consumption. In the rainy season there

was increased energy expenditure due to intense agricultural activity which raised thiamine requirements and depleted the body's already limited store of thiamine. Thiamine is water soluble and heat-labile and most of the vitamin is lost when the rice is washed and when the cooking water is discarded. Anti-thiamine factors, such as mycotoxins and thiaminases are often found in stored food especially during the humid rainy season.

MSF/Epicentre (1992) conducted a study of the food habits of breast-feeding women among the Karen refugee population with suspect clinical thiamine deficiency. Women with signs of thiamine deficiency were less likely to purchase foodstuffs in the camp stores and were less likely to consume raw vegetables at mealtimes than women without signs. The general ration distributed to the refugees was sufficient in calories (2048 kcal) with 89% coming from carbohydrates, 8% from proteins and 3% from fat. The thiamine content of the ration was 0.55 mg daily which was clearly below the requirement of 0.4 mg/1000 kcal. The staple, polished rice, was washed before boiling, sometimes up to three times, and the large quantity of water in which the rice was cooked was discarded thus depleting the rice of the small quantities of thiamine present. The breast-feeding women with signs of thiamine deficiency were also more likely to be subject to dietary taboos further limiting their intakes of thiamine. In addition, most women chewed betel nut, which is known to contain thiaminase, usually immediately after a meal. Another source of thiaminase was the raw fermented fish paste which was the main ingredient of the sauce eaten along with the rice.