Chapter 16. Beriberi and thiamine deficiency

Beriberi is a serious disease which was extremely prevalent, particularly in poor rice-eating people in Asia, around the end of the nineteenth century and the beginning of the twentieth. Beriberi, which takes different clinical forms, is caused mainly by thiamine deficiency. Classical cases of beriberi are now reported only sporadically. Because the disease was controlled in the highly endemic areas of Asia some years ago, medical practitioners and public health officials now give less attention to thiamine deficiency and are less familiar than in the past with its manifestations. However, thiamine deficiency leading to a variety of clinical signs, sometimes in conjunction with deficiencies of other vitamins, is not uncommon, but is underreported. Thiamine deficiency is prevalent in chronic alcoholics in industrialized and developing countries, with manifestations different from beriberi.

Causes and epidemiology

Experimental investigations in Japan, Indonesia and Malaysia led to medical discoveries that proved that beriberi was a deficiency disease, leading to the discovery of its actual cause (see Chapter 11). Beriberi can be said to be a disease in part caused by new technologies: it became a scourge as the milling industry expanded throughout Asia, providing poor people with highly milled polished rice deprived of its thiamine content, at a financial cost no higher than that of home-pounded rice, but at the cost of many thousands of lives. In Asian countries such as China, Indonesia, Japan, Malaysia, Myanmar, the Philippines and Thailand, beriberi used to be a major cause of morbidity and mortality in those whose diet consisted mainly of rice. In contrast, people in many parts of the Indian subcontinent were relatively protected from beriberi because they consumed mainly parboiled rice, which conserves enough thiamine. There have been authenticated cases of beriberi in wheat eaters in the Canadian province of Newfoundland and elsewhere, and also in those consuming other staple foods, but high prevalence rates have been confined to rice-eating people.

It has been suggested that an outbreak of disease in Cuba in 1993 may have been caused in part by thiamine deficiency. The manifestations included neurological signs and optic neuritis including loss of sight (see Chapter 22).

Chapter 26 provides details about the nutritional consequences of milling cereals including rice, wheat and maize.

Clinical manifestations

There are various ways of dividing beriberi into clinical types. Here it is grouped into three forms: wet beriberi, dry beriberi and infantile beriberi. These conditions have many different features, yet they appear to be caused by the same dietary deficiencies and they occur in the same endemic areas. Wet beriberi is the cardiac form and dry beriberi is the neurological form.

Early clinical features common to both wet and dry beriberi

Wet and dry beriberi usually begin in a similar mild way. The person feels unwell. The legs become tired and heavy and appear to have less power, with some swelling towards evening. There may be a little numbness and some feeling of pins and needles in the legs, as well as occasional palpitations. Activity may continue to be normal, although movement at home or at work may often be reduced, but the person seldom reports to a doctor. Examination would reveal a little loss of motor power of the legs, perhaps some alteration in gait and areas of mild anaesthesia, often over the shin. The condition would improve either with a better diet or with thiamine. If left untreated the condition might continue for months or years, but it could at any stage progress to either wet or dry beriberi. No satisfactory explanation has been given as to why one case develops one way and a second case the other.
Wet beriberi

The patient does not usually appear either particularly thin or wasted. The main feature is pitting oedema, which is nearly always present in the legs but may also be seen in the scrotum, face and trunk of the body. The patient usually complains of heart palpitations and chest pain. Other symptoms include dyspnoea (breathlessness); a rapid, sometimes irregular pulse; and distended neck veins with visible pulsations. The heart is found to be enlarged. The urine, which tends to be diminished in volume, should always be tested for albumin, either in the hospital ward or in a small dispensary. In beriberi no albumin is present, and this feature is an important help in diagnosing a case with oedema.

A patient with wet beriberi, even if he or she looks reasonably well, is in danger of very rapid physical deterioration with the development of sudden coldness of the skin, cyanosis, increased oedema, severe dyspnoea, acute circulatory failure and death.

Dry beriberi

The patient is thin, with weak, wasted muscles. Anaesthesia and pins and needles in the feet and arms may increase, and the patient gradually develops difficulty in walking, until it is not possible to walk at all. Before this stage is reached, the patient may develop a peculiar ataxic gait. Foot drop and wrist drop commonly occur.

On examination, the main features are wasting, anaesthetic patches (especially over the tibia), tenderness of the calves to pressure and difficulty in rising from the squatting position.

The disease is usually chronic, but at any stage improvement may occur if a better diet is consumed or if treatment is begun. Otherwise, the patient becomes bedridden and frequently dies of chronic infections such as dysentery, tuberculosis or bedsores.

Infantile beriberi

Beriberi is the only serious deficiency disease that commonly occurs in otherwise normal infants under six months of age who receive adequate quantities of breastmilk. It results from inadequate thiamine in the milk of mothers who are deficient in this vitamin, though the mother often has no overt signs of beriberi.

Infantile beriberi usually occurs at two to six months of age. In the acute form, the infant develops dyspnoea and cyanosis and soon dies of cardiac failure. In the more chronic variety, the classical sign is aphonia: the child goes through the motions of crying but, like a well-rehearsed mime, emits no sound or at most the thinnest of whines. The infant becomes wasted and thin, develops vomiting and diarrhoea and, as the disease advances, becomes marasmic because of deficiency of energy and nutrients. Oedema is occasionally seen, and convulsions have been described in the terminal stages.

Diagnosis and laboratory tests

The diagnosis of wet, dry and infantile beriberi is difficult when only the early manifestations are present. Evidence of a diet deficient in thiamine in an endemic area and of an improvement on a good diet both help to establish the diagnosis.

Wet beriberi must be distinguished from oedema resulting from kidney disease or congestive cardiac failure. In both of these conditions there is albuminuria. A wrong diagnosis of dry beriberi may sometimes be made in a case of neuritic leprosy that has no obvious skin lesions. In neuritic leprosy the affected nerves, especially the ulnar and peroneal nerves, are palpably thickened and cordlike, whereas in beriberi there is no enlargement. It is often extremely difficult to differentiate infective and toxic neuropathies from dry beriberi, but a full investigation into the patient's history is essential.
In acute infantile beriberi the course of the disease is so rapid that diagnosis is very difficult. In the more chronic form, loss of voice is one of the characteristic signs of the disease. In either form the mother should be examined for signs of thiamine deficiency.

In nutrition status surveys thiamine levels in urine are sometimes used to determine the thiamine status of the community. If 24-hour urine specimens are used or thiamine levels are related to urinary creatinine levels, urine testing can provide evidence of thiamine status. However, for the individual subject urinary thiamine reflects amounts of dietary thiamine consumed in the last 48 hours, and levels may be low without the person's thiamine status being low.

Another method has been to test for elevated blood pyruvate levels following a dose of glucose. The most sensitive test to date is measurement of erythrocyte transketolase activity levels. This test is made more sensitive with the addition of thiamine pyrophosphate (TPP). These tests are usually only available in well-equipped laboratories.

In wet beriberi and infantile beriberi the response to medicinal thiamine is usually dramatic. Non-response is a good indication that the condition is not beriberi.

**Treatment**

### Wet beriberi

In wet beriberi the following treatment is recommended:

- absolute bed rest;
- thiamine by intramuscular injection (or intravenously), 50 to 100 mg daily until improvement is shown;
- after injections are discontinued, 10 mg daily by mouth;
- a full nutritious diet rich in foods known to contain thiamine (perhaps supplemented with the vitamin B complex) but low in carbohydrate.

Severe wet beriberi is a most gratifying disease to treat, for the response is in most cases rapid and dramatic. Diuresis and lessening of dyspnoea is observed, and after a few days oedema disappears.

### Dry beriberi

Treatment of dry beriberi consists of the following:

- rest in bed;
- 10 mg thiamine daily by mouth;
- a full nutritious diet rich in thiamine and supplemented with the vitamin B complex;
- physiotherapy or splinting of joints, depending on the individual case.

Response to treatment tends to be rather slow, but deterioration of the condition is arrested.
Infantile beriberi

Treatment of infantile beriberi is as follows:

- intramuscular or intravenous injection of 25 mg thiamine when the disease is first seen (can be repeated);
- 10 mg thiamine twice daily by mouth to the mother if the child is being breastfed, and/or 5 mg to the child;
- provision of thiamine-rich foods or supplements (such as yeast-based products) to the child if the mother is unavailable or the child is not being breastfed.

Prevention

People should be encouraged to consume a varied diet containing adequate quantities of vitamin B. If highly milled white rice is the staple diet, part of the rice should be replaced by a lightly milled cereal such as millet, and the diet should be supplemented with foods rich in thiamine such as nuts, groundnuts, beans, peas and other pulses, whole-grain cereals or cereal brans and yeast-based products.

The sale of thiamine-deficient rice and other cereals should be prevented by:

- encouraging the consumption of lightly milled rice and other cereals;
- legislation or other inducement to ensure that all rice put up for sale is lightly milled, parboiled or enriched;
- legislation to ensure vitamin enrichment of cereals made deficient by milling.

Instruction should be given in the most satisfactory ways of preparing and cooking foods to minimize thiamine loss.

Thiamine should be administered in natural food, yeast products, rice polishings or as tablets to certain vulnerable groups in the community.

Nutrition education should be implemented to stress the cause of the disease and to indicate the foods that should be consumed and the ways of minimizing vitamin loss during food preparation.

It is important to strive for early diagnosis of cases of thiamine deficiency and appropriate measures of treatment and prevention.

Thiamine deficiency in alcoholics

Although classical beriberi is uncommon in industrialized countries, thiamine deficiency is by no means a rarity. It is prevalent in the alcoholic population in countries both North and South. Alcoholism is an increasingly prevalent condition, and several clinical features previously believed to be due to chronic alcoholic intoxication are now known to be the result of nutritional deficiencies. The most common of these conditions is probably alcoholic polyneuropathy, which has similarities to neuritic beriberi and is believed to result mainly from thiamine deficiency.
Alcoholics who get much of their energy from alcoholic drinks often consume insufficient food and do not get adequate amounts of thiamine and other micronutrients. They may develop a peripheral neuritis, which can influence both the motor and the sensory systems, often affecting the legs more than the arms. The various manifestations include muscle wasting, abnormal reflexes, pain and paraesthesia. These symptoms often respond to treatment with thiamine or B-complex vitamins taken orally.

Another condition resulting from thiamine deficiency in alcoholics is Wernicke-Korsakoff syndrome. Wernicke's disease is characterized by eye signs such as nystagmus (rapid involuntary oscillation of the eyeball), diplopia (double vision arising from inequal action of the eye muscles), paralysis of the external rectus (one of the muscles of the eyeball) and sometimes ophthalmoplegia (paralysis of the muscles of the eye). It is also characterized by ataxia (loss of coordination of body movements) and mental changes. Korsakoff’s psychosis involves a loss of memory of the immediate past and often elaborate confabulation which tends to conceal the amnesia. It is now generally agreed that any distinction between Wernicke's disease and Korsakoff's psychosis in the alcoholic patient may be artificial; Korsakoff's psychosis may be regarded as the psychotic component of Wernicke's disease. This view is supported by the fact that many patients who appear with ocular palsy, ataxia and confusion, and who survive, later show loss of memory and other signs of Korsakoff's psychosis. Similarly, psychiatric patients with Korsakoff's psychosis often show the stigmata of Wernicke's disease even years after the illness. Pathological evidence also indicates the unity of the two conditions.

That Wernicke-Korsakoff syndrome is caused by thiamine deficiency and not by chronic alcohol intoxication is shown by the fact that the condition responds to thiamine alone, even if the patient continues to consume alcohol. Of overriding importance in this syndrome is the rapid occurrence of irreversible brain damage; early recognition and treatment are therefore vital. A patient at all suspected of having the syndrome should immediately receive 5 to 10 mg of thiamine by injection, even before a definitive diagnosis is made.

**Prevention**

The prevention of Wernicke-Korsakoff syndrome calls for considerable public health ingenuity. Several possible measures have been suggested:

- the "immunization" of alcoholics with large doses of thiamine at regular intervals (the development of a suitable depot carrier to reduce the frequency of these injections would be very helpful);
- the fortification of alcoholic beverages with thiamine;
- a provision by public health authorities that thiamine-impregnated snacks be made available on bar counters.

The cost of any of these measures would almost certainly be less than the present enormous expenditure on institutional care of those who have suffered from Wernicke-Korsakoff syndrome.

**Other thiamine deficiency states**

An optic or retrobulbar neuritis, also known as nutritional amblyopia, that occurred in prison camps during the Second World War was probably caused at least in part by thiamine deficiency not associated with alcoholism. This occurrence may be similar to the serious outbreak of neuropathy disease in Cuba in 1993.