BERIBERI—WITH SPECIAL REFERENCE TO PROPHY­LAXIS AND TREATMENT.

By Colonel William Henry Willcox, C.M.G., M.D., F.R.C.P.Lond.

Physician to Out-Patients, St. Mary's Hospital, London.

The following paper is based upon the careful clinical study of over fifty cases of beriberi seen during the latter half of the past year in the Mediterranean area.

The cases were of especial interest as regards their aetiology.

It is generally recognized that diet plays a very important part in the causation of beriberi, and some writers—e.g., Osler in the last edition of “The Principles and Practice of Medicine”—go so far as to definitely classify beriberi among such diseases as scurvy as a “deficiency disease.”

In the cases seen many of them showed some other aetiologial factor than that of diet; there was some toxic influence at work as well, such as a previous attack of dysentery, chronic diarrhoea, purpura, or jaundice.

Thus in cases in British troops from the Dardanelles area twenty-six cases of beriberi were seen. Of these twelve had recently, before the onset of symptoms, suffered from jaundice. One case suffered from paratyphoid A fever associated with slight jaundice. One suffered from a slight attack of jaundice three weeks after the onset of beriberi. Five cases had suffered from previous chronic diarrhoea or dysentery. Three cases had suffered from purpura.

In eleven cases of beriberi seen in British troops from the Mesopotamia district, one had suffered from recent jaundice previous to the attack, and one from chronic diarrhoea.

The dietetic conditions in the two series of cases previous to the onset of the disease were similar except that in the Mesopotamia series of cases, owing to difficulties unavoidable to an expedition of that nature, the dietetic factor undoubtedly played a more important part than in the Dardanelles' cases.

Clinically and pathologically there is not the slightest doubt that all the above cases were typical cases of beriberi.

In the twenty-six Dardanelles cases twenty-one suffered from
some toxic factor associated with recent jaundice, diarrhoea, paratyphoid fever, or purpura, so that it is seen that there were very few cases in which diet was the only aetiological factor.

It must be remembered, however, that the diet on campaign given in hospital for diseases like epidemic jaundice, diarrhoea, dysentery, and paratyphoid fever, while being suitable for the treatment of these diseases, is nevertheless very deficient in antiberiberi vitamins, and thus if one regards beriberi as due entirely to dietetic influences, these cases cannot be excluded as beriberi cases, since the diet associated with the treatment of the diseases in question might undoubtedly cause beriberi in a patient who, as regards his previous dietary, had only a small margin as regards his protection qua diet against beriberi.

In the Mesopotamia cases the toxic factor was quite unimportant, and calls for no consideration, since the occurrence of toxic factors would undoubtedly have been as great amongst any other disease occurring in these troops.

**SYMPTOMS.**

In the cases observed, which were almost entirely of the òedematous or wet type, the earliest symptom noticed was usually some weakness of the legs or shortness of breath on exertion, generally accompanied by malaise and anorexia.

In a few cases the òedema of the legs was the first symptom observed, but it must be remembered that the detection of a preliminary symptom is dependent on the subjective observation and intelligence of a patient, and can only be elicited by means of "leading questions." Paraesthesia of the legs occurred quite early in some cases, patients complaining of numbness, "pins and needles" and alteration in the tactile sense. The weakness of the legs was shown by inability to march or walk properly, the gait being somewhat unsteady.

Probably one of the earliest evidences of weakness of the legs would be shown by the *squatting test*, which was quite too much for any of the patients in my series to perform at the time of examination.

The *squatting test* consists in the patient bending his knees and separating them while standing so that he assumes a squatting position with the buttocks a few inches from the ground. A beriberi patient is unable to raise himself up from this position, and often attempts to do so by climbing up his knees with his
hands very much like a patient suffering from pseudo-hypertrophic muscular atrophy.

This test should be remembered by regimental officers as a simple way of picking out early beriberi cases from amongst a body of troops who may be likely to be affected with the disease. One patient said that he first noticed that something was wrong because he could not step up on to the firing ledge of his trench. For a few days he was lifted up there by his comrades, and supported while he did his allotted task. He soon became too weak to walk and then became a hospital patient.

Dyspepsia was an early symptom in most of my cases; it was not of a severe type and consisted of epigastric discomfort and flatulence. There was commonly definite tenderness on palpation over the duodenum.

Swelling of the legs and feet was a marked symptom in many of the cases, and in some the oedema extended on to the thighs, scrotum and abdomen. In severe cases there may be oedema over the sternum.

In some cases the oedema was slight. It must be remembered that one important factor in causing the oedema is the standing position. In mild cases, after resting in bed and appropriate treatment, the oedema quickly clears up.

Nervous Symptoms (Paræsthesia has been noted above).

Anæsthesia and analgesia occurred in all the cases; there was inability to distinguish on the feet and legs the difference between a pin-prick and finger-touch when the eyes were closed; the extent of this anæsthesia varied in different cases. In some cases the feet only were affected; in others the feet and legs; and in some cases the anæsthesia of the feet and legs was complete. In a few cases the upper extremities were affected. All cases showed definite weakness of the legs, and marked wasting occurred in all. The extensor muscles were affected more than the flexors, so that foot and ankle drop were present in cases showing severe nervous symptoms. There was not opportunity to test the electrical reactions of the affected muscles.

Tenderness of the calves on pressure was present in all the cases. In some cases cramp in the calves occurred.

Gait.—This was unsteady in type and there was a tendency for the toes to drop and render walking difficult; the gait was
somewhat high-stepping in type in some cases. The gait had not the stamping character characteristic of tabes dorsalis.

Some cases—e.g., two out of the twenty-six Dardanelles cases—showed definite circumoral anaesthesia.

Laryngeal paresis occurred in two of the twenty-six Dardanelles cases, and in two of the eleven Mesopotamia cases there was loss of voice for some days.

Pharyngeal paresis, shown by difficulty in swallowing, especially marked for liquids, occurred in one of the Mesopotamia cases and in one of the Dardanelles cases.

Reflexes.—The knee-jerks may be increased in the first few days. They are soon, however, diminished, and become quite lost, even with reinforcement by pulling the hands apart, the fingers being opposed.

An interesting symptom often present in beriberi cases is that the knee-jerk disappears before the Achilles jerk, and when both reflexes are lost the Achilles jerk is recovered before the knee-jerk when the patient improves. This sign occurred in several of the cases of each series. It was first pointed out to me by Lieut.-Col. de Crespigny of No. 3 Australian Hospital. I do not believe that it has been previously published.

Late signs in some of the cases showing severe multiple neuritis may be contractures of the muscles, e.g., those of the calf causing a condition of talipes equinus; these are not common.

CARDIO-VASCULAR SYMPTOMS.

The pulse is usually quickened, especially on exertion. In severe cases it may be feeble and irregular. Palpitation is a common symptom. The cardiac dulness is increased, both on the right and left sides. The heart shows signs of myocardial degeneration. The impulse is feeble, and the first sound of the heart is short and poor in quality. Often a systolic murmur replaces the first sound of the heart more or less completely. There may be a definite galloping rhythm in severe cases. Mild cases may show reduplication of the second sound of the heart.

In the twenty-six Dardanelles cases, twelve showed signs of marked cardiac involvement. In four of the cases the cardiac symptoms were of a very severe type, there being marked dilatation, irregularity and galloping rhythm.

Pyrexia is absent in beriberi cases, unless they are associated with intercurrent affections.
William Henry Willcox

Vomiting occurred in a few cases; it is a bad sign and many of the cases terminate fatally.  

Loss of weight was marked in most of the cases.

Types of Beriberi

Other than the oedematous type described above are:—

1. The Acute Pernicious Type.—In this type sudden death, without previous complaint of illness, may occur and the post-mortem examination show signs of beriberi. Usually anorexia, nausea, vomiting, epigastric discomfort and tenderness occur first, and these are quickly followed by marked cardiac symptoms. Dropsy usually occurs, and also some signs of neuritis such as anaesthesia, hyperaesthesia, paresis, or paralysis. The patient dies of severe cardiac symptoms within a few days.

2. The Dry or Atrophic Form of Beriberi.—This is similar in its symptoms to the oedematous type, except that dropsy is absent. Marked wasting is a prominent feature. One of the Dardanelles cases was of this type.

3. The Rudimentary Form.—In this type the symptoms are slight. The patient complains of malaise, dyspepsia with paraesthesia and anaesthesia of the lower extremities, and some loss of power. The symptoms rapidly clear up under appropriate treatment.

Post-mortem Signs.

Three of the Dardanelles cases died. Careful post-mortem examinations were made on two of them.

The following were the special post-mortem signs found in these two cases:—

Very marked oedema of the lower extremities, and to a slight extent on the trunk and upper extremities.

The stomach showed marked redness of the mucous membrane, which was most marked in the pyloric half, where the colour was deep crimson.

The duodenum showed intense crimson congestion of the mucosa, most marked in the upper part.

The jejenum and ileum showed marked congestion, some petechiae being present in the ileum.

The large intestine showed congestion.

Numerous small hæmorrhagic patches about half an inch in diameter were present in the wall of the ascending colon.

The mesenteric glands showed slight enlargement.
The heart showed marked dilatation of the right and left cavities. No valvular disease was present.
The lungs showed œdema and congestion of bases.
The kidneys were congested and showed some œdema.
The liver was congested and showed slight nutmeg change.
The popliteal nerves were removed for subsequent examination for degenerative changes.

Etiology.

The etiology of beriberi is one of the most interesting problems in medicine. A great deal of original work has been done on this disease during the last twenty years, and the important work recently done by Funk, Fraser, Stanton, Eykman and Cooper have definitely established the important fact that beriberi is essentially a deficiency disease.

Gowland Hopkins in his recent studies of the important part played by vitamines in metabolism has confirmed the conclusions of the above-mentioned investigators.

Modern research on metabolism has shown that a diet of pure protein, fats, and carbohydrates, with due admixtures of salts and water, is not sufficient to maintain health, though the quantities given may be theoretically correct.

A growing animal fed on the above dietary will cease to grow and will develop some deficiency disease, such as polynneuritis (beriberi) or scurvy. Some other addition is necessary in the dietary if the animal is to maintain health and thrive. Many natural foods contain the necessary additional substances, and these additional substances need only be present in most minute amount in order to make a diet which was formerly deficient quite ample for growth and health. The necessary additional substances are known by the name of vitamines.

The vitamine for preventing beriberi, or polynneuritis in animals, is different from that which prevents scurvy.

The anti-beriberi vitamine is a nitrogenous substance. It is not a protein. It does not contain phosphorus. It is soluble in water and alcohol or dilute acids. It is destroyed on heating to 130° C., but not at a temperature of 100° C., nor by dilute acids, though sterilization of foods undoubtedly destroys the vitamine.

Tinned foods, owing to the heat employed in their sterilization, are almost entirely deficient in anti-beriberi vitamine. The anti-beriberi vitamine is more stable than the anti-scurvy vitamine. Thus the latter is destroyed by heating to temperatures below
100° C., e.g., about 70° C. Also the drying of fresh vegetables, or even the keeping of them for long periods, destroys the anti-scorbutic vitamine.

Rice has long been associated with the causation of beriberi, and modern research has completely cleared up the former obscurity as regards its relationship. The rice grain consists of a husk or pericarp, beneath which is a subpericarpial layer or aleurone layer, and the main central part of the grain or endosperm consists chiefly of starchy matter. The anti-beriberi vitamine is present in the subpericarpial or aleurone layer. Machine-polished rice consists solely of the starchy endosperm, the pericarp and subpericarpial or aleurone layer being completely removed. This rice, which is the ordinary white rice of commerce, is devoid of anti-beriberi vitamine and birds fed on it rapidly develop polyneuritis, which will prove fatal.

Human beings fed on this rice will develop beriberi if it is the main article of diet, and if the other articles of diet are deficient in anti-beriberi vitamines.

Rice from which the husk is removed by steaming or treatment with hot water (parboiled rice) and subsequent rubbing in a mortar or by hand, will not cause beriberi. The reason is that some of the subpericarpial layer, or aleurone layer, is left adherent to the grain and this contains the anti-beriberi vitamine which is so essential to the dietary.

Numbers of experiments on animals and observations on human beings who have contracted beriberi from rice have completely proved the above view.

In animals in whom polyneuritis or beriberi has been caused by feeding on polished rice, the symptoms quickly clear up if for the polished rice the native unhusked rice, i.e., the rice from which the husk has been removed by previous treatment with steam or hot water, is substituted. Instead of this the addition to the polished rice of an extract of the husks of rice will have the same beneficial effect.

The Katjang idjoe bean also contains anti-beriberi vitamine and its addition in amount of \( \frac{1}{3} \) pound a day to a polished rice diet will prevent beriberi in natives.

Yeast is a substance which is, perhaps, the richest in anti-beriberi vitamine. Egg-yolk, brain, liver, kidneys, sweetbread, oatmeal, haricot beans, peas, are all fairly rich in this vitamine. Milk and fresh meat contain only small amounts.

In the cases of beriberi in this series the dietetic conditions were compatible with the development of beriberi.
Beriberi—with special reference to Prophylaxis

In the Dardanelles series the presence of a toxic factor such as jaundice, diarrhoea, or paratyphoid, necessitated a special diet, which, though suitable to the diseases in question, was almost devoid of anti-beriberi vitamin, and so an additional dietetic factor was added to a borderland case, thus causing the development of beriberi.

Other causes of beriberi which have been stated by various authorities are the following:
1. Arsenical poisoning.
2. Copper poisoning.
3. Poisoning by potassium oxalate.
4. Food poisoning, e.g., raw fish containing parasites, decomposed fish, or decomposed rice.
5. Bacterial infections, e.g., a specific coccus, the Kakke coccus of Okata and Kokubo, two Japanese surgeons. Other organisms have also been described by different observers.
6. That it is due to animal parasites, e.g., Ankylostomum duodenale, or Trichocephalus dispar.
7. That it is due to a fungus, e.g., Captain Archibald in one case has isolated a spore-bearing fungus from the intestine, liver, and spleen.
8. That it is a disease of locality, the infection being spread from the soil.
9. That it is due to a deficiency of organic phosphorus in the dietary.

The subpericarpial or aleurone layer of rice is richer in organic phosphorus than the endosperm, and as a consequence it was found that rice poor in phosphorus was more likely to cause beriberi.

The investigations into the nature of the anti-beriberi vitamin by Funk and Cooper showed that it contained no phosphorus, and that the addition of organic phosphorus compounds did not per se have any curative or prophylactic effects in animals suffering from polyneuritis caused by a diet deficient in anti-beriberi vitamins.

It cannot be said that any of the above have been definitely established as causes of the disease.

Certain is it that the "deficiency theory" has been proved to be the most important factor. It is possible that infective causes such as microbic or fungoid may also play a part.

Predisposing causes are undoubtedly bad sanitary conditions, an insufficient and poor quality diet, previous debilitating diseases, such as dysentery, jaundice, etc.

Geographical Distribution.—Beriberi is usually regarded as a
tropical disease, since it occurs in Japan, China, Malay, the
Philippines, India, etc. Outbreaks have, however, occurred in
America, and in asylums in England and Ireland. It is undoubtedly
rather the dietetic conditions associated with a particular place
than the place itself which is the important factor.

**Differential Diagnosis.**

**Scurvy.**—This is often present in association with beriberi,
especially in cases such as those occurring on board ship, or on
campaign, where there is difficulty in the supply of fresh food. In
the Dardanelles series of beriberi cases, three showed scorbutic
symptoms, e.g., purpura, though they could not be said to have
scurvy.

In scurvy important diagnostic signs are: The purple swollen
gums with tendency to bleed; purpuric patches on the skin;
anæmia; haemorrhage into the hard palate; tenderness and swelli-
g of bones due to subperiosteal haemorrhage. This condition is
most often evident in the tibiae, and then there is a good deal of
firm œdema of the skin around the affected bone. Indeed swelling
of the legs may be very marked, but there is great local tenderness
over the tibiae, and not in the calves.

The above signs clearly distinguish scurvy from beriberi. In
scurvy also multiple neuritis is absent.

The effect of treatment often serves to distinguish the two
diseases. Thus, while scurvy rapidly clears up if special anti-
scorbutic substances, such as raw potato, lemons, and fresh veget-
ables (uncooked), are given, beriberi requires a special dietary of a
different nature, as described below.

**Multiple neuritis** from other causes, such as alcohol, diphtheria,
arsenical poisoning, etc., must be carefully distinguished from beri-
beri. The history of the case and other evidences of the action of
the toxic agent, e.g., cirrhosis of liver from alcohol, pigmenta-
tion and rashes and presence of arsenic in the urine or hair in arsenical
neuritis, will usually enable a differentiation from beriberi to be
possible.

**Diseases of the spinal cord,** such as tabes dorsalis, myelitis,
scleroses of various kinds, may be mistaken for the neuritis of
beriberi. A careful examination for such symptoms as lack of
bladder control, extensor plantar reflex, or ankle clonus, distinguishes
myelitis and sclerotic conditions of the cord from beriberi.

In tabes, the Argyll-Robertson pupil, the marked ataxy, the
absence of muscular wasting or tenderness of the calves, are signs
distinctive from beriberi.
Dropsy from other causes, such as:

Renal disease, where the presence of albumin and casts in the urine and absence of neuritis are points of distinction.

Cardiac disease, where the history of the case, e.g., previous rheumatism or syphilis, or other cause of valvular disease, the long duration of the cardiac symptoms without signs of multiple neuritis, and the physical signs of actual valvular disease make the distinction from beriberi easy.

Epidemic dropsy is characterized by pyrexia, anaemia and absence of multiple neuritis, which serve to distinguish it from beriberi.

TREATMENT.

Absolute rest in bed is essential in the early stages and in all cases showing cardiac symptoms.

DIET.

In an acute case, where gastric symptoms are marked, the diet will necessarily be light and mainly liquid.

Yeast should be given. Two ounces of dried yeast, such as is supplied on campaign under the name of export yeast, should be given daily. This is conveniently given by pouring on the yeast a little boiling milk, stirring up into a thin cream, and then adding more warm milk and sugar, so that a palatable food results.

In place of export yeast, cakes of dried yeast mixed with a little starch are often available. These are supplied under the name of "Royal Yeast Cakes," which are like small biscuits weighing about half an ounce each. Six of these should be given daily. The following was found a convenient and palatable method of preparing the yeast cakes for consumption. One or two yeast cakes were placed in a basin, boiling milk was poured on them, and the cakes broken up and rubbed round with a spoon into a thin cream. Then warm milk and sugar were added, and the mixture was then ready for taking.

If neither of the above forms of yeast are available on campaign, yeast can always be obtained from the Army bakeries, where yeast brews are constantly kept going. The yeast obtained here will be mixed with the liquid of the brew. About half a pint of this should be taken daily. It may be sweetened with sugar and flavoured with lemon rind or essence of lemon. It is quite palatable.

Pea soup is a useful article of diet, the pea powder containing anti-beriberi vitamins.
William Henry Willcox

*Three or four raw eggs* should be given daily, beaten up with milk, or taken in any other way.

The above dietary is rich in anti-beriberi vitamins, but a valuable addition to it will be fresh lemon juice, e.g., the juice of two or three lemons per day. This will contain anti-scorbutic vitamins, which are often needed by beriberi cases, owing to the close association etiologically between beriberi and scurvy.

When the patient can take solid food in addition to the yeast, which is very essential throughout the disease, the following articles of diet may be given. They are arranged in order as regards their value from the quantity of essential vitamine present; those highest in the list being richest in vitamine.

Yeast (already mentioned): eggs, either raw or lightly cooked; brain, liver, sweetbread, kidneys, heart muscle, peas, haricot beans, Katjang idjoe beans, lentils, porridge, brown bread, milk (fresh if possible); fish or meat, ordinary bread or biscuits, lemon-juice or lime-juice should also be given.

*Extracts of yeast* are on the market. These taste exactly like extract of meat, and when mixed with warm water form a drink like ordinary meat extract or bovril.

Yeast extracts may be given with advantage in beriberi cases, both acute and chronic.

The relationship of rice to beriberi has been fully dealt with, and rice is best avoided in the treatment of beriberi cases.

Fresh vegetables, fruit and, generally speaking, an ample dietary should be given in beriberi cases where there is no gastric disturbance.

The symptoms of beriberi call for special treatment, thus:

*The cardiac symptoms* will require treatment by means of cardiac tonics, e.g., digitalis, strychnine, strophanthus, etc.

In severe cases strychnine and digitalin may be given hypodermically; and oxygen. Oxygen passed through absolute alcohol is valuable.

The multiple neuritis calls for treatment on the usual lines. Light massage, electric treatment by the galvanic current, etc., are valuable.

**Prophylaxis.**

*Diet* is most important. On campaign it is often difficult to avoid some deficiency in those articles of diet which are especially rich in anti-beriberi vitamins. Haricot-beans, pea-powder given in pea-soup, and porridge, are valuable and convenient articles of
an army dietary in the field. Fresh vegetables are also important.

If beriberi is prevalent, undoubtedly some preparation of yeast should form a constituent of the dietary of men exposed to danger from this disease. Dried yeast, or yeast cakes may be given, or else the yeast extract taken with hot water should be issued.

It is very important that beriberi cases should be recognized as early as possible, and this can immediately be done by the application of the "squatting test," described above.

Cases showing the early symptoms of beriberi should at once be put upon special treatment, since in the early stages the disease is easily and quickly cured.

General sanitary measures and attention to personal hygiene are of importance in the prevention of beriberi.

My especial thanks are due to Major Martin, R.A.M.C., of No. 3 Australian General Hospital, for valuable help and advice given in connexion with the beriberi cases. Much of the recent original work on beriberi was done under Major Martin's supervision at the Lister Institute, London, and the details given in this paper as regards diet are largely due to the valuable advice given by him.

I am also indebted to Lieut.-Colonel Stawell, R.A.M.C, and Lieut.-Colonel de Crespigny, R.A.M.C., of No. 3 Australian General Hospital, for their valuable co-operation and help in the clinical investigation of the cases.

My thanks are due to Colonel F. I. Brown, Senior Medical Officer, of H.M.H.S. "Mauretania," who very kindly placed at my disposal the cases of beriberi on his ship.
Beriberi—with Special Reference to Prophylaxis and Treatment

William Henry Willcox

J R Army Med Corps 1916 27: 191-202
doi: 10.1136/jramc-27-02-04

Updated information and services can be found at:
http://jramc.bmj.com/content/27/2/191.citation

These include:

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/