1. **What is the nutrient?**

-Thiamin is a vitamin, also known as vitamin B1, which helps the body’s cell change carbohydrates into energy (carbohydrate metabolism). Thiamin is involved in many other body functions, including the nervous system and muscle function, the flow of electrolytes in and out of the nerve and muscle cells, as well as digestion (Thiamine 2013; Thiamin 2014).

2. **What is the RDA/DRI for the nutrient?**

-Thiamin is likely to be safe when taken by mouth daily in amounts considered to be RDA: in adults 19 and older, 1.2mg for males and 1.1mg for females; and in pregnant or breastfeeding women of any age, 1.4mg. In adults, thiamin is likely safe to supplement when taken by mouth daily in doses of 1-2mg. In those with a thiamin deficiency, such doses may be as high as 50mg per day. For children, the following doses of thiamin are likely safe when taken by mouth daily: 0.2mg in infants 0-6 months old; 0.3mg in infants 7-12 months old; 0.5mg in children 1-3 years old; 0.6mg in children 4-8 years old; 0.9mg in children 9-13 years old; 1.2mg in males 14-18 years old; and 1.0mg in females 14-18 years old.

-Additionally, the following doses of thiamin are considered to be possibly safe: 50-100mg taken by mouth daily for 3-6 months; 50-100mg injected into vein 3-4 times daily; and 5-200mg injected into the muscle in five divided doses over two days (Thiamine 2013).

-Eating a well-balanced diet that contains a wide variety of foods is the best way to get the daily requirement of essential vitamins (Thiamin 2014).

3. **How is the nutrient metabolized?**

-Thiamin helps to maintain a normal metabolism and helps burn carbohydrates. Thiamin, in the form of thiamin pyrophosphate, plays an essential role as a cofactor in key reactions within carbohydrate metabolism. Additionally, this vitamin is involved in the metabolism of branch-chained amino acids and may have non-coenzyme roles in excitable cells. Vitamin B1 is needed to process carbohydrates, fat, and protein. Every cell of the body requires this vitamin to form the fuel that the body runs on – ATP. Nerve cells require thiamin in order to function normally. Additionally, thiamin assists in blood formation, carbohydrate metabolism and the production of HCl – important for proper digestion. Thiamin is also responsible for enhancing appetite, learning capacity, and is needed for muscle tone of the intestines, stomach and heart. In humans, thiamin can be
synthesized within the large intestines as thiamin pyrophosphate (TPP), while the main circulating form of thiamin within the red blood cells is thiamin diphosphate (TDP). TDP is a cofactor for several enzymes – pyruvate dehydrogenase and transketolase as well as thiamin triphosphate – thought to be important in nerve conduction (Vitamin B1).

4. **What are food sources of the nutrient?**

- Thiamin is found in enriched, fortified, and whole grain products including bread, cereals, rice, pasta, and flour. Beef liver and pork, dried milk, eggs, legumes and peas, as well as nuts and seeds, are additional sources of thiamin. Dairy products, fruits and vegetables are not very high in thiamin, but when eaten in large amounts, they become a significant source (Thiamin 2014).

5. **What disease states alter the nutrient's metabolism?**

- Thiamin is one of the B vitamins that play an important role in energy metabolism and tissue building. When there is not enough thiamin in the diet, basic energy functions are disturbed, leading to problems throughout the body.

- Specific situations can increase the body’s thiamine requirements and lead to symptoms of deficiency such as over-active metabolism, prolonged fever pregnancy, and breastfeeding. Extended periods of diarrhea or chronic liver disease can result in the body’s inability to maintain normal levels of many nutrients, including thiamin. Other populations at risk of thiamin deficiency include patients with kidney failure on dialysis and those with chronic digestive problems who are unable to absorb nutrients. Alcoholics are susceptible to thiamin deficiency due to frequent substitution of alcohol for food. Excessive intake of alcohol decreases the body’s ability to absorb thiamin (Beriberi). Severe deficiency can result in congestive heart failure (wet beriberi), peripheral neuropathy (dry beriberi), Wernicke encephalopathy (medical emergency that can progress to coma and death), and Korsakoff syndrome (irreversible memory loss and dementia that can follow) (Test ID: TDP).

- A lack or deficiency of thiamin can result in weakness, fatigue, psychosis, and nerve damage. In the US, thiamin deficiency is most often seen in people who abuse alcohol (alcoholism). Excess alcohol makes it more difficult for the body to absorb thiamin from foods. Unless those with alcoholism are receiving higher-than-normal amounts of thiamin to make up for the difference, the body will not be able to absorb enough for its needs. Thus, this can lead to a disease called beriberi (Thiamin 2014). The gastrointestinal system, nervous system, cardiovascular system, as well as the musculoskeletal system, are most affected in those with beriberi (Beriberi).
6. What are the tests or procedures to assess the nutrient level in the body?

-In assessing thiamin status, whole blood thiamin testing is superior. Serum or plasma thiamin testing has poor sensitivity and specificity, and <10% of blood thiamin is contained in plasma. Transketolase determination, once considered the most reliable method of assessing thiamin status, is now considered inadequate. Because transketolase activity requires thiamin, decreased activity is presumed to be due to the decreased thiamin. This test has been considered inadequate, since the test is somewhat nonspecific, as other factors may decrease transketolase activity, is less sensitive than HPLC, has poor precision, and specimen stability concerns.

-Thiamin diphosphate is the active form of thiamin and most appropriately measured in assessing thiamin status. Thiamin diphosphate is present within the circulating blood of animal cells (erythrocytes), but is unable to be detected in the plasma or serum due to very low levels. HPLC analysis of thiamin diphosphate in whole blood or erythrocytes is the most sensitive, specific, and precise method of determining the nutritional status of thiamin and is a reliable indicator of total body stores. This test specifically targets and shows how much vitamin B1 is present; thus, being a reliable indicator of vitamin B1 status (Test ID: TDP).

7. What is the drug–nutrient interactions?

-Thiamin is known to cause low blood pressure; thus, in patients who are taking drugs to lower blood pressure, the intake of thiamin should be done with caution. Caution is advised when using medications that lower blood sugar, such that those who take drugs for diabetes by mouth or insulin should be monitored closely. Additionally, thiamin may interact with agents that affect the immune system, agents that enhance athletic performance, agents that promote urination, agents that treat HIV, agents that widen blood vessels, agents used for heart disorders, alcohol, Alzheimer’s agents, antacids, antibiotics, anticancer agents, barbiturates, birth control taken by mouth, dextrose, dichloroacetate, flumazenil, heart rate-regulating agents, ifosfamide, metformin, naloxone, nervous system agents, neuromuscular blocking agents, pain relievers, phenytoin, thyroid, hormone, tobacco, and weight loss agents (Thiamine 2013).

-In regards to nutrient interactions, caution is advised when using herbs and supplements to lower blood sugar and blood pressure. Thiamine may interact with Alzheimer’s herbs and supplements, antacids, antibacterials, anticancer herbs and supplements, benfotiamine, betel nuts, birth control taken by mouth, heart rate-regulating herbs and supplements, herbs and supplements that affect the immune system, herbs and supplements that enhance athletic performance, herbs and supplements that promote urination, herbs and supplements that widen blood vessels, herbs and supplements used for heart disorders, horsetail, nervous system herbs and supplements, neuromuscular herbs and supplements, pain relievers,
polyphenols, sedatives, thyroid herbs and supplements, tobacco, vitamins, and weight loss herbs and supplements (Thiamine 2013).

8. **How is the nutrient measured?**

- The most widely used test of thiamin status is measurement of the activity of the dependent enzyme transketolase in red blood cells and its increase when additional thiamin is added. With these two measurements, an activation coefficient can be obtained – showing the normal range for erythrocyte transketolase activity (<1.25). Other tests of thiamine include red cell thiamin pyrophosphate, RBCTPP and the normal range is 165-286nmol/l (Acute Thiamine Deficiency).

- Such tests listed above may not identify all of those with or at risk of deficiency; thus, in an emergency, thiamin may be administered based on a clinician’s judgment. Additionally, the National Diet and Nutrient Surveys assessed thiamin status by measurement of both intake as well as red cell transketolase activation coefficient. Inadequate intake is classified as below the Lower Reference Nutrient Intake - <1.25, and biochemical deficiency is considered to be a transketolase activation coefficient greater than 1.25 (Acute Thiamine Deficiency).

9. **What is the Upper Tolerable Limits?**

- The upper tolerable limit of thiamin is unknown. According to the DRIs for upper intake levels of thiamin, such values cannot be determined due to lack of adverse effects in all age groups and populations and concerns with regard to lack of ability to handle excess amounts. It is recommended for most, unless directed by a physician, to consume thiamin primarily from food sources in order to prevent high levels of intake (Mitchell, M. K., 2008).

10. **What are the physical signs of deficiency?**

- Signs and symptoms of mild-to-moderate thiamin deficiency are nonspecific and may include poor sleep, malaise, weight loss and confusion (Test ID: TDP). Additionally, there are two major types of thiamin deficiency: wet beriberi - affecting the cardiovascular system, and dry beriberi and Wernike-Korsakoff syndrome – affecting the nervous system (Beriberi 2014). The physical signs of each thiamin deficiency are further explained below:

- Physical signs associated with wet beriberi include, awakening at night with shortness of breath, increased heart rate, shortness of breath with activity, and swelling of the lower legs (Beriberi 2014).

- Physical signs associated with dry beriberi include, difficulty walking, loss of feeling in hands and feet, loss of muscle function or paralysis of the lower legs,
mental confusion/speech difficulties pain, strange eye movements (nystagmus), tingling, as well as vomiting (Beriberi 2014).

11. What are physical signs of toxicity?

- Thiamin is a water-soluble vitamin; therefore, it is least likely to reach toxic levels. There is little danger of thiamin when taken by mouth; although, when taken intravenously, it has been reported to cause anaphylactic shock in some. Symptoms of thiamin overdose may include a feeling of warmth, weakness, sweating, nausea, restlessness, difficulty breathing, tightness of throat, blush colored skin, and death (Vitamin B1).
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