Vitamin K

Vitamin K is a fat soluble vitamin, which is synthesized to an active form by the gut flora and the actions of the enzyme epoxide reductase. The active form plays a role in the carboxylation of glutamate, which is an essential reaction in the activation of blood clotting factors II, VII, IX, X, protein C and protein S. Without the synthesis of these proteins, the patient has severely impaired blood clotting. This can be seen in patients with a vitamin K deficiency or who are on warfarin therapy, which is a vitamin K antagonist. Common causes of vitamin K deficiency include malabsorption, as well as gut flora depletion, which is seen in neonates and in patients with prolonged antibiotic use. Those who are vitamin K deficient will display a normal bleeding time with increased PT and PTT.

PLAY PICMONIC

Sources

Dark Green Leafy Vegetables

Dark Green Leafy Vegetables

Vitamin K1, or phylloquinone, is the type of naturally-occurring vitamin K present in green leafy vegetables. It can be found in many vegetables including kale, spinach, collards, broccoli, and swiss chards.

Synthesized by Intestinal Flora

Intestinal Flowers

Intestinal microflora is another avenue to satisfy vitamin K requirements, where certain gut bacteria synthesize a form known as vitamin K2. Patients without developed gut flora, such as newborn babies or patients on chronic antibiotics, may display difficulty obtaining adequate stores of functional vitamin K.

Mechanism

Activated by Epoxide Reductase

Epoxy-side Red duck

Vitamin K epoxide reductase, or VKOR, is the enzyme responsible for reducing vitamin K from its quinone oxidation form to hydroquinone form, which is the active form of vitamin K required as a cofactor to activate clotting factors. During the carboxylation reaction, VKOR lives up to its name by also reducing the vitamin K epoxide that formed.

Gamma Carboxylation of Glutamate

Gamma ray gun Cardboard-box-lace with Glue-tomato

Vitamin K is an essential cofactor for the carboxylation of glutamate within hepatic cells by providing energy via oxidation, which drives this essential biochemical reaction in the activation of clotting factors.

Activation of Clotting Factors II, VII, IX, X, Protein C and S

2+7=10 and 9 equation on synthesizer with (C) cat and (S) snake proteins

Through its utility as a cofactor in gamma-carboxylation, vitamin K is required in the activation of clotting factors II, VII, IX, X and protein C and protein S.

Considerations

Deficiency with Broad Spectrum Antibiotics

ABX-guy Mowing Down Intestinal Flowers

Broad spectrum antibiotics deplete normal gut flora, of which several microorganisms play an important role in the synthesis of absorbable vitamin K. Therefore, prolonged antibiotic use can result in vitamin K deficiency, with subsequent clotting deficiencies. Labs will show a normal bleeding time, but increased PT and aPTT.

Neonatal Hemorrhage with Increased PT and aPTT

Neon-baby hit by Hemorrhage-hammer with Up-arrow PT and aPTT hourglasses

Newborn infants lack gut flora colonization, and therefore are deficient of vitamin K. This predisposes them to clotting deficiencies and subsequent bleeding problems for the first weeks of life. Lab studies will show increased PT and aPTT levels, with a normal bleeding time. For this reason, all newborns are given an injection of vitamin K.

Warfarin is a Vitamin K Antagonist

War-fairy and Ant-in-a-toga Antagonizing Viking (K) King

Warfarin is considered a vitamin K antagonist and depletes the body of clotting factors by preventing vitamin K's normal function as a cofactor in activating these hepatically-synthesized coagulation factors. This is accomplished by competitive inhibition of the essential enzyme VKOR, discussed earlier, that normally reduces vitamin K to its active form. As such, warfarin binds to and precludes VKOR from reducing vitamin K to its active form, which also prevents the vitamin K-dependent activation of clotting factors II, VII, IX and X, as well as the antithrombin factors protein C and protein S. In order to reverse the effects of warfarin, vitamin K can be administered.