Choline
Nutritional therapy

DESCRIPTION
Choline is an essential nutrient usually grouped within the B-complex vitamins. It is also referred to as a half-vitamin, because choline can be produced by the body in very small amounts, although this level of production is insufficient in most people. Consequently, dietary intake is essential in many cases.

Choline is found in all natural fats and is ubiquitous in (primarily animal) food products. The richest sources are eggs, liver and other offal, soya and fatty meat. Nevertheless, deficiencies are not uncommon. One reason for this is (for example) that a great many people dispense with consumption of foods rich in natural fats when dieting. Moreover, the use of alcohol and the consumption of sugary foods have an adverse effect on choline levels. In addition, pregnant women have a markedly higher need for choline.

Choline and its metabolites are also essential in the case of food providing methyl groups, even in limited quantities. As such, vegetarians and vegans (for example) represent a high risk group. Finally, many people have genetic polymorphisms, resulting in an increased choline requirement. All in all only a fraction of people are getting their recommended daily quantity of choline. And this impacts on their health.

EFFECT
In chemical terms, choline is an ammonium salt on which three methyl groups can be distinguished. These methyl groups play an important role in methionine metabolism.

Choline is present in all tissues as an essential component of phospholipids. The body does not store it in any single specific tissue, but it occurs in relatively high concentrations in essential organs such as the brain, liver and kidneys. The placenta of pregnant women is another site where a lot of choline is stored. Here it is most commonly found in the form of phosphatidylcholine and sphingomyelin, substances that are important for proper foetal development.

Choline and its metabolites play a primary role in the following physiological processes:

- **Structural integrity and signalling function of cell membranes**: Choline constitutes part of phosphatidylcholine, an important structural component of the biological membrane. It is a precursor of ceramide, which plays a role in the transmission of nerve impulses through the cell membrane. Furthermore, phosphatidylcholine is essential for the transportation of fat and cholesterol in the form of VLDL (Very Low Density Lipoprotein) from the liver. The body uses choline to produce lecithin, an emulsifier that has a fat-regulating effect and inhibits cholesterol from clogging up the blood vessels.

- **Cholinergic neurotransmission**: Choline is a precursor of the neurotransmitter acetylcholine. It accelerates the production and release of acetylcholine in the nerve cells. In the peripheral nervous system, acetylcholine activates the muscles, and it is also the most important neurotransmitter within the parasympathetic nervous system, the system that sees to it that the body is capable of resting and repairing. It encourages digestion as well as the production of glycogen, in which excess glucose from the blood is stored. Furthermore, acetylcholine fulfils an important function in learning, short-term memory, arousal and the reward system in the brain.

- **Source of methyl groups**: Choline is an important source of methyl groups, predominantly in the form of its metabolite betaine.

Together with folate and cobalamin, it is an important coenzyme for the re-methylation of homocysteine to methionine in the methionine cycle. Toxic in high concentrations, homocysteine is a metabolic product of the amino acid methionine. A raised homocysteine level is bad for the heart and blood vessels, the brain, joints and bones. It is also associated with strokes. In addition, methylation is crucial for switching genes on and off, for the transmission of messages between cells and the regeneration of nerves.

INDICATIONS

**Asthma**
There is good scientific evidence that choline, when combined with regular asthma medication, reduces the severity and duration of asthma symptoms more than is possible using medication alone. This has potential to lower the amount of the relevant asthma medication being prescribed. In this regard, higher adjuvant doses of choline should have more effect than lower ones. **Perinatal**
It is extremely important for pregnant women to take in sufficient quantities of choline. The American Food & Drug Administration (FDA) even mandates that choline be added to baby food not made from cows' milk. The reason for this is that, as is the case with folic acid deficiency, inadequate intake of choline during pregnancy considerably increases the chances of neural tube defects and (for example) a groove in the upper lip (cleft lip). Furthermore, a choline deficiency can have an adverse effect on the memory of the baby after the birth, and has the potential to cause heart defects. Administering extra choline around and during pregnancy can have significant long-term effects on newborns' memory, learning ability and concentration.

**Cholesterol**
When there is insufficient phosphatidylcholine in the liver, fat and cholesterol are not carried away, as a result of which they accumulate in the liver. Choline deficiency can therefore lead to fatty liver disease and liver damage. In the case of methotrexate-induced non-alcoholic fatty liver disease, this can even be reversed by administering choline. Methotrexate is an immunosuppressive and anti-inflammatory used in (for example) rheumatism, multiple sclerosis, Crohn's disease and asthma.
As a ‘biotransformer’, the liver is the most important methylation organ. Research carried out by choline expert Professor Zeisel shows that methyl group donors such as choline have an important effect on the methylation of genes that can cause fatty liver and fibrosis of the liver. Whether these conditions will emerge is partly down to the switching on or off of the genes responsible. Consequently, this epigenetic mechanism of choline plays an intrinsic role in preventing fatty liver and fibrosis of the liver.

**Brain atrophy and Alzheimer’s**

It is presumed that sufficiently high concentrations of choline protect the brain from age-related cognitive deterioration and certain forms of dementia, including Alzheimer’s. One possible reason is that sufficiently high doses of choline have the capacity to preserve neurons, brain volume and neuronal transmissions. In a double-blind study, early-stage dementia patients (Alzheimer’s type) were treated with 25 g/day of phosphatidylcholine for six months. Modest improvements were observed on a variety of memory tests compared to those taking the placebo.

It may be the case that the retention of neurological pathways related to memory play a role in preventing negative changes in the physical form of the brain that lead to Alzheimer’s. Various studies demonstrate that pharmacological quantities of choline can be clinically effective in elderly people with cognitive problems, poor memory and early-stage Alzheimer’s. Research also shows that this group perform better in terms of memory (visual and verbal) when they take in higher quantities of choline.

White matter hyperintensities (WMHs) occur in 90% of all people with vascular dementia and Alzheimer’s. Vascular dementia is characterized by areas of the brain dying due to disturbed blood supply. Research has shown that people with a higher degree of WMHs have significantly poorer cognitive function and increased brain atrophy. Studies have demonstrated an inverse relationship between choline intake and the volume of WMHs: the more choline ingested, the smaller the volume of WMHs.

**Cardiovascular diseases**

An increase in inflammatory markers in the blood serum is one of the most important risk factors for developing atherosclerosis and cardiovascular diseases. Epidemiological research reveals a connection between long-term intake of choline and a reduced risk of dying from cardiovascular diseases. The underlying reason is that choline reduces inflammation and other risk factors for cardiovascular diseases.

**Tardive dyskinesia**

Tardive dyskinesia primarily occurs in patients undergoing long-term treatment with antipsychotics. It is a movement disorder involving involuntary movements of some parts of the body as the tongue, lips and torso. It is caused by disturbed neurotransmission at the level of the cholinergic interneurons in the striatum, an area in the cerebrum. The most well-known function of the striatum is its role in planning and modulating movement. High doses of choline (several grams) are used to raise choline levels in the brain to above normal, which fosters production of acetylcholine in the nerve endings. This reduces the symptoms of dyskinesia. Consequently, choline (as well as other vitamins and antioxidants) is increasingly being used as adjuvant therapy these days in treatment with antipsychotics for such things as psychosis and schizophrenia.

**Bipolar disorder**

There is some evidence to suggest that patients with bipolar disorder and rapidly fluctuating moods may benefit from administering choline.

**CONTRA-INDICATIONS**

Choline is considered safe and is generally well tolerated. Use of choline should be avoided in individuals who are oversensitive or allergic to choline, lecithin, phosphatidylcholine or products containing these substances.

**SIDE EFFECTS**

In people who have the rare metabolic disorder trimethylaminuria, the use of choline can cause a strong fishy body odour.

**INTERACTIONS**

Caution is advised when taking choline with medication to reduce blood pressure.

**DOSE**

The regular recommended daily intake of choline has been set at 425 mg/day for women aged 18 and over, 450 mg/day for pregnant women and 550 mg/day for women who are breastfeeding. For men aged 18 and over the regular recommended daily intake is between 400 and 3500 mg/day. Dosages of choline between 500 mg and 20 g have been used 1-3 times a day to treat asthma, brain damage and schizophrenia. Dosages between 15 mg and 8.5 g have been used over a 24-week period to improve memory and physical endurance, as well as to prevent liver disease.

**SYNERGISM**

Thanks to its stimulatory effect on brain function, choline constitutes a good synergistic combination with DHA and other omega-3 fatty acids. In terms of homocysteine metabolism, choline works well together with vitamins B6, B12 and folic acid. S-adenosyl methionine (SAMe) is another good option here.

**REFERENCES**

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