



What About Taurine?

By Jackie Burgess RDH

BACKGROUND

In one of my many posts reporting my success with magnesium glycinate (MgG) in eliminating breakthrough arrhythmia while on Flecanide, I mentioned my interest and use of magnesium taurate (MgT). Some discussion ensued as to our true need of supplementing with taurine – and another comment was quoted from the magnesium pages of Cold.cure.com indicating MgG tended to unbalance taurine stores if used long term.

This was of concern, since I'm an enthusiastic advocate of MgG, so I set out to prove or disprove the "unbalancing" statement. I was unable to find any documented statement that either expressly stated that fact or implied it, other than on the Coldcure site.

I corresponded with the Web author, George Eby, to learn his reference source. It seems it is his personal hypothesis based on his dramatic and very successful cure of his depression and arrhythmia – first with MgG and later refined with MgT.

His reasoning is based on rat studies (and his own experience) showing glycine suppresses hepatic taurine content, but not in other taurine-rich organs (brain, heart or kidney.) As glycine goes up, taurine goes down and bile production is impaired with intestinal absorption of magnesium, impaired to a greater extent.

He speculates that in people sensitive to this reaction, MgG would be contraindicated and MgT would be helpful. He also speculates his arrhythmias and PAC's (ectopy) are caused by too much glycine and by switching to the taurine form, they are prevented. It also corrected his bowel intolerance reaction.

My Metagenics contact, consulted with Metagenics Research at headquarters and was told that there was no foundation to the unbalancing or depleting theory. Rather, they recommended taurine along with magnesium glycinate because they potentiate each other.

I found no evidence that the amino acid, glycine, another major inhibitory neurotransmitter that calms the body, is pathogenic. (However, my search was only cursory for this initial investigation.) Glycine is extremely abundant in the body and is as common as glucose. The average daily adult intake of glycine in the US is 3 to 5 grams.

It is speculated that under some conditions, glycine might become essential in humans. Glycine has been shown to be an effective carrier for minerals that facilitate absorption in the intestinal tract. Glycine is used by the body to form collagen, a key protein in cartilage and connective tissue.

This research endeavor was fortuitous for me, because after reading extensively, I am strongly convinced we need to examine and understand taurine more closely...not only for its potential impact on afib.

My intention was to post a formally written and referenced research paper, but ran out of time so rather than delay the information, I'm summarizing the highlights and providing references at the end. I have either directly quoted or paraphrased. Everything can be substantiated from the resources. My comments are in the brackets [] since this is an informal report, I'm posing some questions for consideration.

References to magnesium's role and importance is also mentioned since this search focus was on magnesium glycinate's effect on taurine stores...and the basic hypothesis for using supplemental is to correct magnesium deficiency from which, most assuredly, all afibbers suffer.

The importance of additional magnesium in afibbers is a given, in light of the commonly recognized magnesium depleters...#1 being stress of all types, followed by too much sugar, too much calcium, antibiotics, large amounts of protein, chemotherapy, refined flour, diuretics, alcohol, sodium-softened water either municipal tap or in-home, fluoride and high fat foods along with foods high in oxalic acid.

Magnesium glycinate was patented by Metagenics to provide maximum bioavailability without the typical side effects of bowel intolerance to elevated (therapeutic) doses needed to overcome magnesium deficiency. Obviously, it does no good to consume supplemental Mg if it doesn't remain in the small intestine long enough for nutrient absorption.

The question posed by this report is.....Is it time to embrace the use of magnesium taurate rather than magnesium glycinate? Perhaps there is a need for both forms.

I'm using three capsules/tablets of each form and getting a little almost 700 mg. magnesium daily from divided doses. I'd like to think the bioavailability factor from the MgG form assists the majority of the magnesium into the cells where it belongs.

At the end of this report, I've listed resources for the MgT and plain taurine.

REFERENCES

My resource references are listed at the end, but the majority of my findings came from two sources: the book, "The Healing Nutrients Within" (originally published in 1987 and revised in 2003) by Eric R. Braverman, MD, who is an integrative physician and Director of the Place for Achieving Total Health in NYC and a paper published by one of Dr. Braverman's co-authors, Richard Smayda, D.O., Director of Primary Care Medicine at Cape Cod Hospital, Brewster, MA. Taurine metabolism is Dr. Smayda's area of expertise. There several other references as well.

Taurine was dubbed The Miracle Substance back in 1993, by the late Donald J. Carrow, MD who was one of the early pioneers in alternative medicine. After this research, I agree.

Now, to Taurine (T)— the miracle substance —while you read the properties or attributes of taurine, keep thinkingdo I have enough (T) to perform all these important functions? And remember as well, the reason we are boosting the magnesium glycinate intake is to replenish magnesium stores that have become depleted and therefore, have allowed conditions such as afib to flourish

I hypothesize that the synergy between MgG and T are responsible for calming heart cells and eliminating afib...based on my own success. You may conclude that taking magnesium and taurine in a complexed form in addition to MgG (or in place of) makes a good deal of sense.

The following (T) highlights are not presented in order of importance. Some of the BB readers will recognize the excerpt from an exceptionally fine article written by Patrick Chambers, MD, known on the board as PC...entitled: Magnesium and Potassium in LAF. Everyone with afib should call up that article, print it out, and go over it paragraph by paragraph to understand the story PC lays out for us. Don't miss it if you haven't read it.

TAURINE PROPERTIES - (A FEW OF MANY)

- Is a lesser-known essential amino acid and is the most abundant source of sulfur available from an amino-containing compound in the body.
- Is found in every cell and in great quantity throughout the body.
- Regulates the most basic of cell functions – genetic transcription.
- The body can make its own from amino acids, methionine and cysteine in the presence of Vitamin B6, but prefers to obtain it directly from food sources.
- The body normally makes all it needs, but under certain conditions, such as disease, injury or physical exertion and high periods of stress (both physical and mental), the supply may not meet the demand. Deficiencies have been documented in vegans and diabetics.
- Cellular depletion of (T) has been linked to developmental defects, retinal damage, immunodeficiency, impaired cellular growth and the development of cardiomyopathy.
- Is most concentrated in, and plays a major role in the central nervous system (CNS), heart, white blood cells, muscle and retina.
- Is inhibitory and suppresses the release of excitatory neurotransmitters like norepinephrine and acetylcholine.
- Most important function is to facilitate the passage of sodium, potassium (possibly calcium and magnesium) ions in and out of cells and to electrically stabilize cell membranes.....or said another way:
- Is necessary for the proper functioning of the sodium/potassium ATPase pump which regulates the ion balance between cells and the extracellular fluid that surrounds them.
- Is found in high concentrations in white blood cells. Enhances the immune system by stimulating the release of macrophages and increasing neutrophil activity.
- Critical in preterm and newborns for growth and development
- Relieves angina, normalizes blood pressure, corrects cardiac arrhythmia.
- Normalizes blood sugar levels in diabetics.
- Decreases carbohydrate cravings and aids in the release of insulin.
- Alleviates liver disturbances due to poor fat metabolism.
- Is vital to adrenal gland, liver and gallbladder function.
- Improves nerve impulse transmission and eye physiology.
- Regenerates damaged retinal cells.

- Is depleted by MSG
- Prevents glutamate excitotoxicity through regulation of calcium and mitochondrial energy metabolism.
- Lowers elevated blood pressure
- Retards cholesterol-induced atherogenesis
- Lowers cholesterol, triglycerides, suppresses VLDL , elevates HDL
- Stabilizes platelets, preserves erythrocytes
- Increases cholesterol excretion in the bile (rat studies)
- Is useful in some cases of mitral valve prolapse, cardiomyopathy, congestive heart failure and epilepsy
- Can neutralize toxic effects of known internally-produced substances and xenobiotics (environmental agents) and can act as a direct or indirect detoxifying agent since it has both acid and alkaline activity.
- Is a weak chelator and a powerful antioxidant. As an antioxidant, can block the damaging effect of both ionizing (gamma x-ray) and non-ionizing (electricity) particles as well as block lipid peroxidation ...which may have implications in the aging process and degenerative disease processes.
- The effects of taurine are greatly enhanced by cations such as magnesium and zinc.

[Since 80% of the population is magnesium deficient, we can assume, taurine's job performance is also deficient.]

TAURINE'S CONNECTION TO HEART FUNCTION & ARRHYTHMIA

- Taurine is a powerful cell membrane stabilizer
- A deficiency of vitamin B6 suppresses the activity of taurine.
- Taurine, along with Vitamin B6, acts as a natural diuretic for salt and water retention.
- Taurine increases in the heart during chronic stress as part of the adaptive response.
- Following ischemia, taurine levels drop to as low as 1/3 of normal.
- Low levels of taurine are observed in patients following heart attacks and is frequently recommended as a supplement for promoting "heart health"
- Taurine appears to offer potential in the treatment of arrhythmia and reducing blood pressure at relatively high doses....(2 – 6 grams a day) and has been used in studies of heart function at levels up to 6 grams a day.
- Taurine works hand-in-hand with magnesium in controlling calcium in the heart. Heart tissue contains over 100 times more taurine than is found in the blood, making it a critical nutrient for the heart since it affects the heart muscle's ability to contract.
- Protects the heart from oxidative stress.

It is relevant to read PC's report – but go specifically to the Magnesium section and note some of

these passages. If I pulled out all the important portions, I'd have to copy the whole report. PC provides a logical connection between magnesium's function, magnesium deficiency, the detrimental role of excess calcium, and stress hormones....and the importance of keeping magnesium and potassium in the cells.

-Revisiting this from PC's report.....

"If there is insufficient Mg for adequate ATP, then the primarily extracellular cations sodium (Na) and calcium (Ca) tend to leak into the cells and the primarily intracellular cations potassium (K) and Mg tend to leak out.

However, membrane leakiness in magnesium deficiency depends less on ATP related activity and more on the membrane stabilizing effects of magnesium phospholipid complexes(12).

This leakiness disrupts proper gradients and cellular function. In addition Mg is an antioxidant and Mg deficiency allows accelerated free radical damage to cell membranes (lipid peroxidation), further compromising cellular cation (positive ion) homeostasis(3,24,32,60,61).

[Jackie asks: Might we not also conclude that the ion-stabilizing property of taurine is also involved here and if K is allowed to leak out, taurine is more a factor of arrhythmia than perhaps even the magnesium?]

Again – PC's report--- go to this report and review these key points...

...starting with " Unfortunately, the deleterious effects of aldosterone (watch for reference #41 and continue through references 80, 81).

Be sure you note he was addressing taurine long ago. The connection is certainly plausible. Taurine is the powerful membrane stabilizer. We need K and Mg in the cells to avoid afib along with appropriate calcium and sodium regulation.

"A CONTEMPORARY REVIEW OF THERAPEUTIC BENEFITS OF THE AMINO ACID TAURINE"

by Richard Smayda, D.O. (An excerpt from the "Heart" Subtitle)

"During ischemia, hypoxia, and heart failure, the heart is subjected to a series of adverse changes. Taurine level is depleted in the failing heart. Taurine acts with a number of electrophysiological actions on cardiac cells by modulating the ion channels.

Calcium homeostasis is critical to stable myocardial contractile function. Taurine prolongs the action potential duration of calcium at high intracellular levels and shortens it at low levels.

Changes in the intracellular taurine pool modulate calcium transport, and regardless of whether calcium is elevated or depressed, taurine exerts a cardioprotective action. Through the sodium-calcium transport exchanger in cardiomyocytes (heart cells), taurine permits the entry of sodium which favors a co-transport of calcium. It also modulates the activity of calcium channels to promote sodium influx. Within the area of the sarcoplasmic reticulum, changes in the intracellular taurine concentration modulate calcium transport by promoting calcium release and inhibiting an enzyme that triggers loss of calcium.

In these regards, taurine has an essential function in ensuring stable calcium levels, which thereby promotes proper contractile function of the heart tissue. Likewise, potassium is also an important ion in heart cells. Taurine directly modulates the potassium ion current by increasing the current's action potential duration.

In ischemia, arrhythmia may be induced. Irregular heartbeat patterns are caused by abnormal

extracellular calcium concentration in heart cells. With both low and high calcium, the number of beating cells, the beating rate, and the number of arrhythmic cells are adversely affected. In a research study, the addition of taurine attenuated this response of myocytes to varying calcium concentrations. Taurine's effect was quite specific, as analogs (including glycine) were not effective substitutes (20). The incidence of premature beats and tachycardia of the ventricles is notably decreased by taurine treatment.

Taurine is valuable in its role to protect the heart from oxidative stress and post-ischemic injury. It reduces lipo-peroxidation (free radical damage). In patients undergoing coronary artery bypasses who were pretreated with taurine, heart cell mitochondria (the cellular powerhouses) were subjected to far less extensive damage.

The ability to scavenge free radicals is a potent cardioprotective role. When taurine is administered to people recovering from ischemia, the rate of the heart's action is notably different than non-treated counterparts.

Both the quantity of lactate (a marker of ischemic challenge) and quantity of glutathione (a marker of oxidative stress) are attenuated with taurine. ATP levels (denoting cellular energy production) are also suppressed in ischemia. Through the modulation of lactate, glutathione, and ATP, taurine influences the ability and extent of recovery (21-22).

Thrombosis, the formation of a clot (thrombus) in the cardiovascular system, may result in myocardial infarction (heart attack). In this condition, serum endothelin concentration is markedly higher within the first several hours of onset.

When taurine is administered with urokinase, a plasminogen activator (an enzyme that hydrolyzes arginine and lysine), serum endothelin levels decreased after eight hours post-infarction and stayed suppressed for several days. This suggests that taurine can beneficially affect serum endothelin levels and thus be a valuable adjunct to thrombolytic treatment (23).

Angiotensin is a hormone that the kidneys secrete to cause changes in blood pressure, either directly or by altering the sodium content of the blood. It is suspected that incorrect instructions from the angiotensin system are involved in producing hypertension.

Researchers notice that in spontaneously hypertensive rats, minute amounts of angiotensin II cause increase in mean arterial pressure and heart rate, accompanied by increased release of glutamate (24). These changes were partially blocked by using an antagonist of glutamate -- taurine, glycine, or GABA. This research suggests that amino acid neurotransmitters may mediate, as well as contribute to, the cardiovascular effects of angiotensin.

Angiotensin II increases the rate of protein synthesis in heart cells. It also promotes a rise in intracellular calcium. In a particular type of heart cell (non-myocyte), angiotensin II promotes hyperplastic and hypertrophic growth, resulting in an increase in bulk.

Taurine reduces the responsiveness of heart cells to these actions of angiotensin II, largely by altering calcium ion flux across cell membranes. It thereby may benefit cases of heart failure by suppressing undesirable cellular activities.

Angiotensin also activates the sodium-calcium transport exchanger, over which taurine exerts control. Taurine depletion causes an impairment of myocardial relaxation; angiotensin counters this effect. Taurine deficit adversely affects heart contractile ability and ion transport, effects that are ameliorated by angiotensin II.

Taurine lowers arterial pressure by promoting diuresis and vasodilation (opening of the vessels). A depletion of taurine in the heart leads to a decrease of plasma atrial natriuretic peptide (ANP) in the vascular system, causing additional alteration of arterial pressure. ANP secretion caused by increased blood sodium levels is depressed by taurine depletion, leading to a state of diuretic imbalance: excess

salt in the absence of taurine leads to an increase of arterial pressure.

Taurine makes up nearly 50% of the free amino acids in the heart cells. It has a dramatic effect on the success of recovery from life-threatening cardiac conditions. Researchers conducted a six-week comparative study of oral supplementation of taurine versus Coenzyme Q-10 in patients with congestive heart failure attributed to cardiomyopathy (including ischemia) and exhibiting a grossly compromised ejection fraction (the ability of the heart to pump blood) (25).

The results were surprising: the taurine-treated group exhibited significant treatment effect on systolic left ventricular function, with no observable effect in the Co Q-10 group. Additionally, its role in blood pressure, caused by its interaction with substances that modulate diuresis, attests to taurine deficiency as a major factor in the hypertensive state.

When treated with taurine, an increase in survival rate and reduction of elevated calcium content in aortic and myocardial tissue is found in mice, which suggests that taurine's regulation of calcium flux may prevent the progression of arteriosclerosis (26).

Additionally, taurine's modulation of calcium yields a stabilizing action on systemic arterial pressure and prevents arrhythmia or ectopy in the hypertensive heart."

[Please be sure to read Dr. Smayda's full report – see references for web page.]

TAURINE AND TONICITY (or Osmolarity)

Also important: read Dr. Smayda's section on tonicity and taurine's role. He says, "Cell volume affects the most basic processes of cell function, and as such, it exerts an important role in the onset, severity, and outcome of disease."

SIGNS OF TAURINE DEFICIENCY

Epilepsy, anxiety, hyperactivity and impaired brain function. Taurine deficiency symptoms are the same symptoms of MSG reaction – particularly a racing heart.

MAGNESIUM TAURATE

Elson M. Haas, MD writes, "I have found that magnesium taurate, an unusual form of magnesium in which magnesium is chemically combined with the amino acid derivative taurine is particularly well-utilized and beneficial. This is because some of the same effects that one hopes to get from magnesium, such as the calming effect on the nervous system, and the strengthening effect on heart muscle, is also gotten with taurine. So, the two are synergistic together. I use it in all form of cardiac and nervous system disorders."

TAURINE DOSAGE

Robert Crayhon, author of "The Carnitine Miracle" (p 174) when talking about Carnitine as a valuable nutrient in the control of arrhythmia, says:..... "but the most valuable nutrients are taurine, magnesium, and fish oils, which together have successfully eliminated every case of arrhythmias that I have seen in my practice. (Limiting sugars and caffeine and getting adequate protein is also important.)"

He suggests:

Taurine 1,000 - 3,000 mg
Magnesium 500 - 1,000 mg
EPA/DHA 1,000 mg
Carnitine 1,000 - 4,000 mg
Vitamin C 1,000 mg
Vitamin E 400 IUs
Selenium 200 mcg

Dr. Braverman says taurine is a well-absorbed amino acid with a low rate of side effects. Only patients with a tendency to increased stomach acidity have difficulty. Taking taurine with food, milk or milk of magnesia will alleviate the problem. Taurine should never be taken with aspirin. Although rare, taurine excess may cause depression.

500 mg. of taurine daily will elevate plasma taurine to one and one half times normal, which may be therapeutic in some diseases.

Those seeking natural remedies for blood pressure, diabetes, arteriosclerosis, atherosclerosis, neuropathy and anxiety can easily use 1 to 5 grams daily without significant documented risk. Doses up to 20 grams have been used IV.

FOOD SOURCES OF TAURINE

It is interesting that Dr. Braverman says (T) is not available in significant quantities in foods (mainly organ meats) and since we now think these can be toxic, are not recommended. He says food stores alone will not be sufficient in deficiency states and supplementation is necessary.

An estimated minimum requirement for the sulfur-containing group of amino acids is 13 mg/kg/day or 910 mg of these amino acids daily for the average 150 lb adult male. Some reports estimate requirements to be as high as 1400 mg/day.

On the other hand (and perhaps with newer research data).....Dr. Smyada lists a variety of foods containing taurine which include cheese, cottage cheese, granola, wild game, oatmeal, whole milk, chocolate, yogurt eggs and more... see article for complete list and values. Most notable is cottage cheese – low in calcium and very high (1700 mg) in taurine.

SOURCES FOR SUPPLEMENTAL MAGNESIUM TAURATE & TAURINE

CardioVascular Research Ltd. offers a scientifically designed amino acid-mineral complex which insures maximal bioavailability of magnesium. Magnesium Taurate is a fully reacted complex and not simply a blend of two materials. (from the label). Magnesium taurate 125 mg. 60 capsules.

Douglas Labs Magnesium Taurate, 400 mg (120 tablets) (Mfr: Douglas Laboratories) (Professional quality product) Four tablets contain: 400 mg Magnesium (from 5000 mg magnesium taurate complex-fully reacted) <http://www.gaines.com/store/Douglas/DLB83071info.html>

NEEDS dial -800.634.1380 and ask the price of Douglas Labs product....since they don't publish it online <http://www.needs.com/> - Nutritional information and shopping site for the health conscious and environmentally sensitive person

TAURINE POWDER, Source Naturals, 3.53 oz (100 grams) for \$7.00 1/4 teaspoon = 675 mg. Pure powder (crystals) no fillers. <http://www.iherb.com>

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Richard Smayda, D.O. – 31 pages, 112 references. <http://www.mgwater.com/taurine.shtml#why>

Magnesium and Potassium in LAF, Patrick Chambers, MD
<http://www.afibbers.org/conference/PCMagnesium.pdf>

Elson M. Haas M.D.

(Excerpted from Staying Healthy with Nutrition:
The Complete Guide to Diet and Nutritional Medicine)

The Importance of Magnesium to Human Nutrition

© Michael Schachter M.D., F.A.C.A.M.

<http://www.healthy.net/asp/templates/article.asp?PageType=Article&ID=541>

Magnesium: the Stress Reliever

<http://www.healthy.net/asp/templates/column.asp?PageType=column&ID=74>

<http://www.coldcure.com>

<http://MSGtruth.org>

Functions of Magnesium <http://www.health-marketplace.com/P-Cardiovascular-Disease-9.htm>

Here's to Your Health, Donald J. Carrow, MD, October 1993, Taurine, The Miracle Substance

Taurine: <http://www.supplementwatch.com/supatoz/supplement.asp?supplementId=274>

Taurine Research Summary <http://www.diabetestea.com/p31shortoyster.html>

Disclaimer: I am not a physician and am providing this information only as reference material to increase awareness. I have no affiliation with any of the web sites, products, or references listed. JB
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Taurine, an anti-excitatory amino acid, serves as a central nervous system (CNS) sedative to help alleviate the hyperactivity associated with ADHD. It is most effective at 3,000 mg per day in divided doses between meals

Taurine is the most important and abundant free amino acid in the heart. It modulates the activity of cyclic AMP, which activates important enzymes that contribute to the heart's contractibility. It also plays a role in calcium's function of nerve transmission in the heart. Taurine plays a vital role in the adaptive response of the heart to stress. 5

5 Pfeiffer, Carl and Eric Braverman, The Healing Nutrients Within New Caanan Cn. Keats, 1987 pp. 121-124

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Sub-optimal taurine status may promote platelet hyperaggregability in vegetarians

Mark F McCarty

Received 20 September 2002; accepted 11 November 2002.

Abstract

Although vegan diets typically have a very favorable effect on a range of vascular risk factors, several independent groups have reported that the platelets of vegetarians are more sensitive to pro-aggregatory agonists than are those of omnivores. In light of clear and convincing evidence that platelet function has an important impact on risk for thromboembolic events, it is important to clarify the basis of platelet hyperaggregability in vegetarians. A dietary deficit of long-chain ω -3 fatty acids is not likely to explain this phenomenon, since most omnivore diets do not include enough of these fats to discernibly influence platelet function. A more plausible possibility is that relatively poor taurine status – a function of the facts that plants are devoid of taurine and the human capacity for taurine synthesis is limited – is responsible. Plasma taurine levels are lower, and urinary taurine excretion is substantially lower, in vegetarians than in omnivores. Platelets are rich in taurine, which functions physiologically to dampen the calcium influx evoked by aggregating agonists – thereby down-regulating platelet aggregation. Supplemental intakes of taurine as low as 400 mg daily have been reported to markedly decrease the sensitivity of platelets to aggregating agonists ex vivo. Although the

average daily intake of taurine from omnivore diets may be only about 150 mg, it is credible to speculate that a supplemental intake of this magnitude could normalize the platelet function of vegetarians in the long term; in any case, this thesis is readily testable clinically. Taurine is just one of a number of nutrients found almost solely in animal products – “carninutrients” – which are rational candidates for supplementation in vegans.

(Jackie) There is a difference between thyroid disease and low-functioning thyroid that responds to thyroid hormone replacement versus one that is hyper or the euthyroid sick syndrome.

I take this report to mean that taurine is essential for thyroid function.

My personal experience is that I am/was hypothyroid and take thyroid support supplements plus a small amount of Armour Thyroid hormone (30 mg daily).... and I also take taurine in the range of at least 3 grams a day, often closer to 4 because it's also in other supplements that I use regularly.

My thyroid function has been consistent for many years and I've never had any reason to doubt that taurine is only helpful; not the reverse..

Euthyroid sick syndrome is low serum levels of thyroid hormones in clinically euthyroid patients with nonthyroidal systemic illness. Diagnosis is by excluding hypothyroidism. Treatment is of the underlying illness; thyroid hormone replacement is not indicated

<http://www.merck.com/mmpe/sec12/ch152/ch152c.html>

http://www.integrativepsychiatry.net/amino_acid_supplements.html

http://www.integrativepsychiatry.net/brain_calm_douglas_labs.html

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<http://www.ncbi.nlm.nih.gov/pubmed/11140356>

Amino Acids. 2000;19(3-4):509-26. Links

Taurine and neural cell damage.

Saransaari P, Oja SS.

Brain Research Center, Medical School, University of Tampere, Finland. blpisa@uta.fi

The inhibitory amino acid taurine is an osmoregulator and neuromodulator, also exerting neuroprotective actions in neural tissue. We review now the involvement of taurine in neuron-damaging conditions, including hypoxia, hypoglycemia, ischemia, oxidative stress, and the presence of free radicals, metabolic poisons and an excess of ammonia. The brain concentration of taurine is increased in several models of ischemic injury in vivo. Cell-damaging conditions which perturb the oxidative metabolism needed for active transport across cell membranes generally reduce taurine uptake in vitro, immature brain tissue being more tolerant to the lack of oxygen. In ischemia nonsaturable diffusion increases considerably. Both basal and K⁺-stimulated release of taurine in the hippocampus in vitro is markedly enhanced under cell-damaging conditions, ischemia, free radicals and metabolic poisons being the most potent. Hypoxia, hypoglycemia, ischemia, free radicals and oxidative stress also increase the initial basal release of taurine in cerebellar granule neurons, while the release is only moderately enhanced in hypoxia and ischemia in cerebral cortical astrocytes. The taurine release induced by ischemia is for the most part Ca²⁺-independent, a Ca²⁺-dependent mechanism being discernible only in hippocampal slices from developing mice. Moreover, a considerable portion of hippocampal taurine release in ischemia is mediated by the reversal of Na⁺-dependent transporters. The enhanced release in adults may comprise a swelling-induced component through Cl⁻ channels, which is not discernible in developing mice. Excitotoxic concentrations of glutamate also potentiate taurine release in mouse hippocampal slices. The ability of ionotropic

glutamate receptor agonists to evoke taurine release varies under different cell-damaging conditions, the N-methyl-D-aspartate-evoked release being clearly receptor-mediated in ischemia. Neurotoxic ammonia has been shown to provoke taurine release from different brain preparations, indicating that the ammonia-induced release may modify neuronal excitability in hyperammonic conditions. Taurine released simultaneously with an excess of excitatory amino acids in the hippocampus under ischemic and other neuron-damaging conditions may constitute an important protective mechanism against excitotoxicity, counteracting the harmful effects which lead to neuronal death. The release of taurine may prevent excitation from reaching neurotoxic levels.

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