Trace Mineral Analysis and Psychoneuroimmunology

Richard Malter, Ph.D.[1]

Abstract

The primary mechanism by which psychological factors predispose one towards a disease process is by means of the stress response and its effect on nutrient minerals at the cell and tissue levels. The stress response involves a general systems response relating psychological, neurological, endocrine, and immune system phenomena. These phenomena are reflected in certain types of nutrient mineral patterns involving levels of specific minerals and ratios between pairs of minerals.

A secondary mechanism affecting this complex general systems response involves the accumulation of toxic metals from the environment in the body's cells and tissues. This accumulation of toxic metals at a cell and tissue level displaces and interferes with regulating nutrient minerals. By interfering with cellular energy production and with neuroendocrine and immune system functions, the individual's psychological coping mechanisms are also undermined. Vulnerability to stress is increased.

A data base is suggested for observing critical relationships between essential nutrient minerals as well as commonly found toxic metals. Trace Mineral Analysis (TMA) provides this essential data base. TMA generates and presents data in a manner which allows us to observe more clearly the dynamics of nutrient minerals and toxic metals at a cellular level. The dynamic relationships between these regulating nutrient minerals help to more comprehensively account for some of the phenomena described in PNI research and clinical practice. This approach allows us to see more clearly how psychological factors triggering the stress response relate to shifts in nutrient mineral levels and ratios at the cellular level. TMA data also allow us to observe the relationship between chronic psychological factors and patterns of nutrient minerals and toxic metals.

Given the nature of the complex phenomena reflected in TMA data and the fact that these phenomena are highly dynamic, observing each individual's pattern fluctuations over time is essential to maximize our understanding of these dynamic bio-psychological phenomena. TMA data also will be useful in helping us to better understand current health problems and to anticipate future health trends. By applying TMA concepts and data, health policy involving societal and environmental factors can be more intelligently developed. Prevention or reversing adverse trends can also reduce health care costs.

1. Clinical Director, Maker Institute for Natural Development, 650 E. Higgins Road, Suite 5E, Schaumburg, Illinois 60173.

It is commonly recognized that a significant conceptual split between mind and body occurred in the 17th Century with the dualistic thinking of Des Cartes (Capra, 1977). The Cartesian dualism of mind and body has had profound effects on scientific thinking and clinical health practices concerning physical and psychological dysfunctions. This dualism has tended to limit conceptions of psychological and physical interactions reflecting general systems phenomena. It also encouraged greater and greater reliance on analytic and reductionist thinking in health research and clinical practice. It was inevitable that this trend would result in the extreme degree of specialization which characterizes much of medical and psychological practice today. The absurdity of this trend is reflected in the fact that, today, many physicians are unable to recognize in their patients the general underlying problems of diminished cellular energy production which is so commonly experienced by many people today.

Even when research has reflected a more general systems approach as in the work of Dr. Hans Selye (Asterita, 1985), many of his discoveries pertaining to the general stress response have been abstracted by medical specialties and incorporated into medical/psychiatric practice as isolated discrete physio-

logical and/or psychological conditions. By this means, the relationship between a particular problem and its position in a more general system is often lost. A good example of this practice has to do with psychotropic medications. MAO inhibitors were relied on as antidepressants without considering that excessive MAO accumulations were strongly related to excessive accumulations of copper in the tissues (Mason, 1979; Pfeiffer & Mailloux, 1987). Excessive copper accumulations tend to be strongly associated with slower metabolic patterns related to adrenal insufficiency and hypothyroid tendencies. Problems with other biogenic amines in psychiatrically treated disorders also tend to be related to the same endocrine tendencies as excessive MAO accumulations. However, the typical psychiatric approach is to treat such conditions from the "chin up", i.e. to assume that brain chemistry is completely separate from other biochemical phenomena of the body's neuro-endocrine systems.

The emerging new field of psycho-neuroimmunology (PNI) represents a major trend in the direction of restoring the inherent connection of mind and body to scientific and clinical health related research and clinical practice. As a result, in research which has recently been categorized under the general term of psychoneuroimmunology (PNI), there is increased recognition of what seems to be a truism, namely, that the mind is connected to the body and that each affects the other in profound ways. More specifically, PNI research indicates that there are substantial data linking psychological and physiological reactions and conditions.

Until the present time, PNI research has utilized concepts and techniques from medicine, psychology, and stress research. However, medicine and psychology have tended to focus on pathological conditions which are reduced to highly specific entities. These clinical entities are usually conceived as existing separately from other aspects of the individual' s psychophysiological functioning. On the other hand, underlying most of the research which falls under the rubric of "stress" is an implicit or explicit recognition that whatever phenomenon is being investigated is part of a larger integrated system.

As PNI researchers collect more and more data, it will be useful to develop new models and data bases which will better help us to study and understand the complex interactions of general systems which include both psychological and physiological phenomena. One important development that has been lacking is a source of data which may be related to both psychological and physiological functions. The latter would include neurology, endocrinology, and immunology. With such a data base, it would be possible to see more clearly how psychological phenomena affect physiological or neuroimmunological functions. The converse would also be true. The development of such a data base then would reflect correlates of both psychological and physiological phenomena in one unified system.

Trace Mineral Analysis

The purpose of this paper is to show that Trace Mineral Analysis (TMA) provides a data base for a much better understanding of psychoneuroimmunological phenomena within one unified system. TMA is a technique of collecting a tissue sample (most commonly hair) and analyzing the mineral content. There are two types of minerals which are sampled and measured. These are

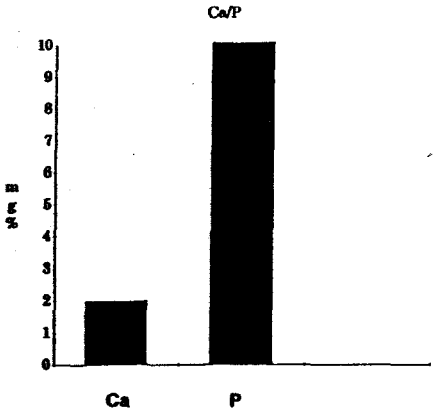
(a) nutrient minerals such as calcium, magnesium, sodium, potassium, and phosphorus and
(b) toxic metals such as lead, cadmium, mercury, aluminum, and copper.

What is most significant for the field of psychoneuroimmunology is that the nutrient minerals which are sampled and measured in TMA are the same minerals which are known to play a role in regulating the psychophysiological functions of the stress response (Asterita, 1985). Since these minerals are involved in the regulation of the psychophysiological functions of the stress response, they are also likely to play a critical role in regulating psychoneuroimmunological phenomena.

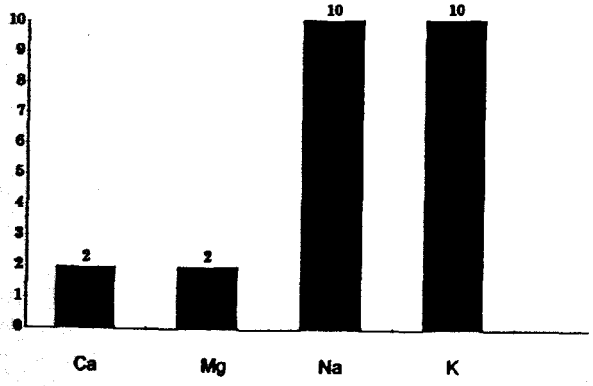
The stress response is part of an inherently dynamic system of processes which has both psychological and physiological components. TMA is essentially a cross-sectional sampling of minerals involved in regulating this dynamic system of processes which change over time. When a series of cross-sectional samples of minerals from one individual are taken over time, it becomes possible to see more clearly some important trends which can be interpreted in

reference to psychophysiological functions as well as psychoneuroimmunological processes.

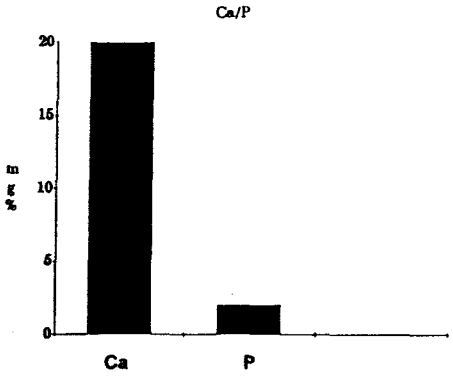
According to Dr. David Watts, Research Director of TEI, Inc., TMA patterns are highly correlated with neuroendocrine functions. More specifically, he has identified certain trace mineral ratios which tend to be associated with dominance of the sympathetic or para-sympathetic nervous system. The major TMA ratio for this assessment is the calcium to phosphorus ratio. The ideal level he uses for calcium in a tissue mineral analysis is 42 milligrams percent (mg%) and the ideal level for phosphorus is 16 mg%. Therefore, the ideal TMA ratio of calcium/phosphorus (Ca/ P) is 2.63/1. As this ratio increases above 2.63/1, there is a tendency for the person to experience dominance of the para-sympathetic nervous system. As this ratio drops below 2.63/1, there is a tendency for the person to experience dominance of the sympathetic nervous system. This is also referred to as a Fast Oxidizer pattern.



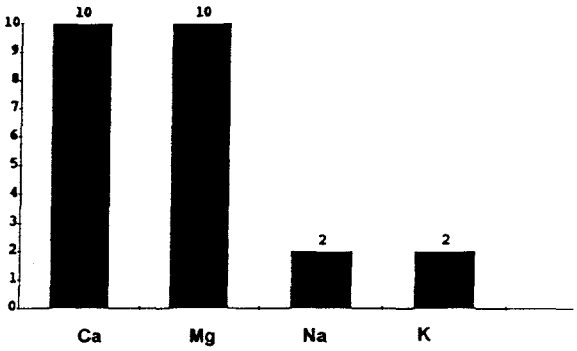
Another commonly seen mineral pattern of the Fast Oxidizer is as follows:



The Slow Oxidizer is indicated by the following relationship between Ca/P:



Another commonly seen pattern reflecting a Slow Oxidizer is as follows:



The Ca/P ratio also tends to reflect endocrine gland activity, especially that of the anterior and posterior pituitary. As the CA/P ratio increases above 2.63/1, there is a tendency for the person to experience dominance of the posterior pituitary. As the Ca/P ratio drops below 2.63/1, there is a tendency for the person to be anterior pituitary dominant. A Ca/P ratio greater than 2.63/1 tends to also be associated with slower metabolic activity while a Ca/P ratio less than 2.63/1 tends to be associated with faster metabolic activity.

Ca/P < 2.63/1	**Ca/P > 2.63/1**
Fast Oxidation	Slow Oxidation
Anterior Pituitary dominant	Posterior Pituitary dominant

Secondary TMA ratios which are useful in reflecting activity of the adrenal and thyroid glands are sodium to magnesium (adrenal) and calcium to potassium (thyroid). The ideal TMA sodium level is 24 mg% and the ideal magnesium level is 6 mg%. Therefore, he ideal TMA Na/Mg ratio is 4/1. As the Na/Mg ratio increases above 4/1, the person tends to experience hyperactivity of the adrenal glands. As the Na/Mg ratio drops below 4/1, there is a slowing down of adrenal activity. An extremely low ratio of Na/Mg tends to be associated with significant adrenal insufficiency or even adrenal “burnout”.

The ideal TMA potassium level is 10 mg%. Therefore, the ideal TMA Ca/K ratio is 4.2/1. As this ratio increases above 4.2/1, the person tends to experience hypothyroid symptoms. As this ratio decreases below 4.2/1, the person tends to experience over-activity of the thyroid gland.

The integration of these latter two ratios (Na/Mg and Ca/K) with the Ca/P ratio allows the researcher or the clinician to more precisely assess the dynamics of the neuroendocrine systems as they interrelate to one another in the regulation of the psychophysiological functions. For example, the magnitude of the Ca/ P ratio tends to indicate the degree of dominance of the sympathetic or para-sympathetic nervous system. This ratio also tends to indicate the degree of fast or slow metabolism. When the magnitude of the Na/Mg ratio is compared with the magnitude of the Ca/K, it becomes possible to assess whether the person is adrenal dominant or thyroid dominant within the neurological categories of sympathetic or para-sympathetic dominance. That is, a sympathetic dominant person may be either adrenal dominant or thyroid dominant. A para-sympathetic dominant person may also be either adrenal dominant or thyroid dominant. Thus, by using TMA data, it is possible to assess whether an individual or group of individuals have a certain type of dominance of neurological and endocrine functioning.

This approach allows the researcher or clinician to identify certain neuroendocrine functions which lead to meaningful sub-classifications that can be related to the psycho-physiology of the stress response. By utilizing TMA data which can be related to neuroendocrine functions, important distinctions between individuals can ascertained. These neuroendocrine distinctions may help to add power to research designs and the analysis of psychophysiological data. Psychoneuroimmunological research would likely be further enhanced by the approach described here.

There are additional TMA ratios which may be significant for psychoneuroimmunological research and clinical applications. One ratio is Ca/Mg. The ideal TMA Ca/Mg ratio is 7/1. This ratio tends to reflect and be associated with glucose metabolism among other functions. As the Ca/Mg ratio deviates from its ideal of 7/1, it can reflect problems with the regulation of blood sugar. The magnitude by which Ca/Mg deviates from 7/1 tends to be associated with the degree and nature of the glucose metabolism problems. A small deviation in the Ca/Mg ratio tends to be associated with hypoglycemia. A larger deviation in the Ca/Mg ratio tends to be associated with dysinsulinism or diabetes.

Since calcium and magnesium are known to play a role in neuromuscular functions, this ratio also tends to be reflective of neuromuscular problems and muscle tone. Problems with muscle spasticity or hypertonicity and/or fibrillations may be reflected by the Ca/Mg ratio.

Dr. Watts has further refined the assessment of the Ca/Mg ratio by introducing the concepts of absolute vs. relative deficiencies of a mineral. As an example, a sympathetic dominant individual tends to have an absolute deficiency of tissue magnesium relative to the ideal TMA level of magnesium. However, both a sympathetic and a para-sympathetic dominant person may have a relative deficiency of magnesium as seen in an elevated TMA Ca/Mg ratio. In a para-sympathetic dominant person, a relative magnesium deficiency may be present even though such an individual may have a tissue magnesium level above the normal or ideal level.

Theoretical Considerations

Since complex relationships are involved in relating psychological, neuroendocrine, and immunological phenomena, a general systems frame of reference seems to offer the best way to account for the interrelationships. The field of Biofeedback has developed in the manner it has because its researchers and practitioners have successfully incorporated the work of Dr. Hans Selye and his followers (Asterita, 1985), The same general systems frame of reference which has been so effectively applied in the field of Biofeedback can also be utilized in the field of PNI. The major difference is that PNI needs a frame of reference which will account for psychological influences on cellular metabolic processes which relate to the functioning of the immune system. The latter in turn depends on efficient cellular energy production. The glycolysis and Krebs cycles are critical in cellular energy production; nutrient minerals play key roles in these cycles. Therefore, a reliable source

of mineral data will likely be related to cellular energy production.

Two separate, but interrelated mechanisms are proposed here to better account for most PNI phenomena. One mechanism involves the basic stress response commonly referred to as the alarm stage or the "fight or flight" response. The other mechanism involves the body's accumulation of toxic metals from the environment. These toxic metal accumulations tend to compete with and to displace nutrient minerals from sites within cells and tissues. The psychological reaction to perceived threat triggers the complex psychophysiological response described as the alarm stage of stress. The basic neuroendocrine reactions in this response involve the adrenal glands and their increased secretion of aldosterone which raises sodium levels in the cells and tissues (Asterita, 1985). An increased sodium level in the tissues is strongly associated with anger and fear. These are the emotions of the "fight or flight" response. Related to the increase in sodium levels is the loss of magnesium and zinc from cells and tissues. The loss of magnesium and zinc from the tissues allows for a greater increase in sodium and a more intense alarm reaction to stress. Therefore, chronic stress will be associated with chronic loss of magnesium and zinc from cells and tissues.

Psychological Implications

TMA research tends to indicate some important relationships between nutrient minerals and psychological functions. For example, calcium and magnesium may play a role in a person's psychological and emotional functioning as well as in physiological functioning. Tissue reserves of calcium and magnesium appear to provide a block or filter for external and internal stimuli. Very low TMA levels of calcium and magnesium in the Fast Oxidizer tend to be associated with hyperactivity and agitated "nervous" energy. Such individuals tend to have weak psychological defenses. They tend to feel bombarded by too much stimulation or too many demands placed on them. They also tend to have difficulty blocking or controlling their impulses. They can be extremely aggressive and highly volatile. Emotions and feelings appear to be right on the surface with very little natural protection. There tends to be an underlying feeling of vulnerability. When tissue calcium and magnesium levels are low, there also tends to be a high anxiety level.

Rather than constantly feeling the high level of anxiety and vulnerability, the Fast Oxidizer tends to combat these feelings by constant activity and/or aggressiveness. For a Fast Oxidizer to admit to his/her vulnerability is very frightening. Hyperactivity and/or aggressiveness are very natural defenses for the Fast Oxidizer because this metabolic type tends to have very strong adrenal glands and a high tissue level of sodium. A high TMA sodium level is associated with the "fight or flight" response which is Selye's first (alarm) stage of stress.

Addictions are commonly used by Fast Oxidizers as distractions or as techniques to artificially numb or deaden feelings which are too exposed and vulnerable. One of the mineral effects of addicting substances such as alcohol or stimulant drugs is that they lower magnesium levels relative to calcium. This process helps to create a calcium "shell" which serves as a psychological block or defense.

Magnesium is also lowered by the stress response. The more intense the stress put on the individual, the higher sodium will tend to rise in the tissues in response to aldosterone secretion by the adrenal glands. As aldosterone and sodium levels rise, magnesium is lost from the cells and tissues. In this manner, over time, a chronic high calcium to low magnesium ratio will be established in the tissues. This may be the primary mechanism by which prolonged chronic stress eventually induces severe hypoglycemia or diabetes. This may also be the biochemical mechanism which predisposes such an individual to addictive cravings for sugar and/or alcohol.

In contrast to the low tissue levels of calcium and magnesium in the Fast Oxidizer, the Slow Oxidizer has elevated tissue levels of calcium and magnesium. A person's sense of awareness may be affected by tissue levels of calcium and magnesium. The higher levels of calcium and magnesium in the Slow Oxidizer tend to be associated with emotional blocking and deadening of feelings. The excess calcium and magnesium provide a natural barrier between outside stimuli and the inner emotions. The high levels of

calcium and magnesium tend to provide a protective shell at the cost of emotional blocking and deadening of feelings. This allows a person to more easily cope with stress or abusive situations because awareness is blocked and feelings are deadened.

A high tissue level of calcium tends to block natural cellular functioning, especially that involved in energy production. Lowered cellular energy production tends to be associated with emotional blocking, numbing of feelings, depression, low self-esteem, pessimism, and feelings of inferiority. The more need there is for emotional blocking and deadening of feelings, the more the TMA calcium will tend to exceed magnesium. As the Ca/ Mg ratio increases, blood sugar problems will increase along with neuromuscular problems such as spasms.

In alcoholic or other dysfunctional families, there seems to be a strong tendency for a child to develop a calcium "shell" as a natural self-protective mechanism which helps to constantly deaden feelings of vulnerability and anxiety. In chronically unpredictable and threatening situations, these feelings would become intolerable without the aid of the calcium shell. However, this calcium shell can become a chronic entrenched mineral pattern affecting glucose metabolism and neuromuscular functions. By adversely affecting glucose metabolism, the high Ca/Mg ratio also tends to predispose the individual to a higher risk of alcoholism or other addictions. Thus, TMA profiles allow us to observe and explain how psychological stress within a dysfunctional family can affect critical mineral patterns which then increase the person's risk to repeat the addictive and dysfunctional behavior. Over an extended period of time from childhood to adolescence, a high Ca/Mg ratio may become chronic and entrenched.

Psychologically, a chronic high Ca/Mg ratio tends to be associated with denial or covering up a problem with which the individual cannot or will not deal. TMA research allows us to see how regulatory minerals can be affected by psychological and emotional factors which then have a profound physical effect. In the case of an elevated Ca/Mg ratio, the associated physiological craving for sugar, alcohol, or other substances can lead to an addictive pattern.

TMA research suggests that a high Ca/Mg ratio tends to be an excellent indicator of a trend towards a significant glucose metabolism problem. However, this ratio also tends to be an excellent index of an addiction pattern in a particular individual and in that person's family history. The TMA Ca/Mg ratio can be reflective of a trend towards problems with both glucose metabolism and addictions.

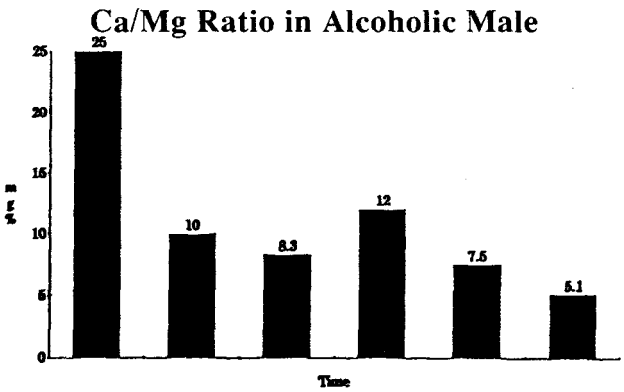
Clinically, a high Ca/Mg ratio can be relied on as an indicator of addiction trends in a particular individual and his/her family history. As this ratio normalizes, the risk for relapse may be reduced. Also, as the Ca/Mg ratio normalizes, the individual's calcium shell may be disintegrating. When this occurs, a flood of denied or blocked feelings may start pouring out and possibly overwhelm the person. Psychotherapy and counseling are essential in order to support a person through the break-up of the calcium shell.

The Alcoholism/Addiction Ratio

The Alcoholism/Addiction TMA ratio is Ca/Mg; the ideal ratio is 7/1. The following case illustrates some of the characteristics found in a 39 year-old depressed male seen initially for an adjustment reaction depression.

A long-term underlying depression (DSM-III-R 300.4) was evident as his family's dysfunction and alcoholism became apparent. This man also was alcoholic. Emotionally, he presented with a very flat dead affect. His body was very rigid and tight. The graph below shows his Ca/Mg ratios over a 4 year period of time:

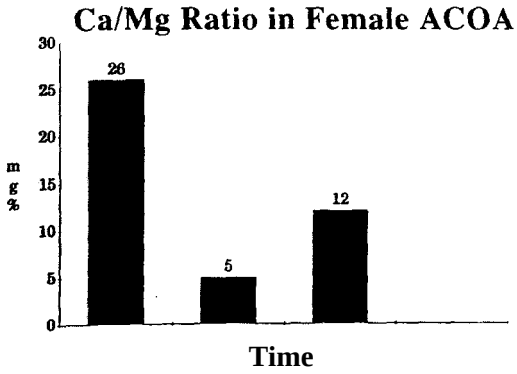
The initial 25/1 ratio far exceeds the ideal Ca/Mg ratio of 7.0 and is a strong indicator of



alcoholism as well as a trend towards glucose metabolism problems. However, within 7 months, the Ca/Mg ratio dropped to 10.0 after

he began a nutritional supplement program in conjunction with psychotherapy. The ratio tended to remain very stable over the next three years as his calcium shell also broke up allowing him to access very intense feelings of rage, anxiety, and panic. He also broke through his denial of his own alcoholism, began working a 12-step program through AA, and has maintained his sobriety. He has come alive emotionally and he no longer is clinically depressed. He has become a much warmer and highly energetic person with a positive outlook on life.

Another clinical example of the Ca/Mg ratio is reflected in the graph below:

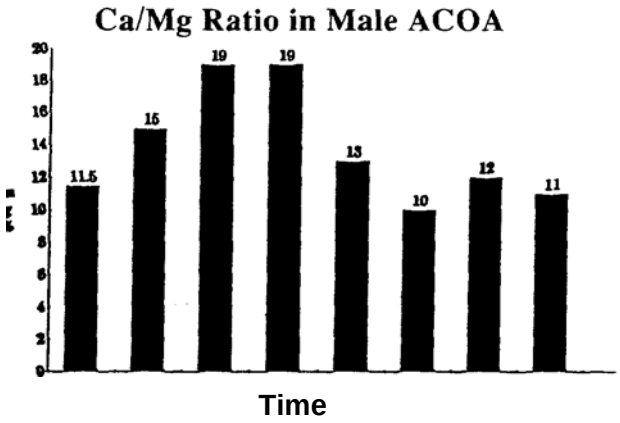


As in the above male case, the initial Ca/Mg ratio in this 35 year-old female's TMA is very high (26) in relation to the ideal ratio of 7/1. She is an Adult Child of an Alcoholic parent (ACOA). She has been severely depressed for many years, probably since childhood. When asked about her feelings; this very bright woman would reply, "I don't know; I'm numb; my feelings are dead."

These are very common responses of individuals who present with a very high Ca/Mg ratio, especially in the Slow Metabolic Type. As her Ca/Mg ratio decreased significantly with nutritional supplementation and psychotherapy, she was able to mobilize much more energy with which to cope with the stresses in her life. She was able to access her feelings much more clearly and effectively. Her very severe depression also lifted as her energy and self-esteem increased to much higher levels. These changes occurred over a period of two years.

The following graph shows the Ca/Mg ratios of a 40 year-old male executive who also is ACOA.

For many years, this man was suffering from a very heavy pervasive depression with high levels of anxiety. He also had strong tendencies towards obsessive-compulsive behavior. He was extremely judgmental and felt very vulnerable to other



people's judgments which made him feel highly anxious. No matter how well he performed on his job, he felt vulnerable to judgmental criticism. He also was constantly worried that he was having a heart attack.

In these three individuals whose family backgrounds all had a history of alcoholism, a series of TMA profiles reflected the presence of very high Ca/Mg ratios. All three individuals experienced severe depression and very high anxiety levels. The high anxiety bordered on panic attacks for all of them. Psychologically, all three individuals were dominated by judgmental thinking. As the calcium shell broke down and they were able to deal with their deeper emotional issues in psychotherapy, their severe psychological symptoms abated.

The Ca/Mg ratio data suggest that these patterns may become chronic and eventually lead to disease and physical disorders. Hypoglycemia and diabetes can be associated with a chronic imbalance in this critical ratio. Neuromuscular disorders especially involving spasm are commonly found with high Ca/ Mg ratios. Depression and panic attacks are also very commonly found with a high Ca/Mg ratio. The data also indicate that the very high Ca/Mg ratio can be substantially reduced and brought into a more normal range.

Magnesium "Loss" Personality

From the TMA general systems perspective being presented here, there appears to be an important clinical subtype who presents the characteristics of a person with a chronic magnesium loss. This metabolic subtype may have a psychological history of significant abuse from childhood - physical, emotional,

and/or sexual. The abuse trauma, especially when it has been repetitive, results in a severe chronic stress response which is so strongly conditioned that it is stored and held within the body. This chronic stress response seems to result in an inability to retain adequate magnesium reserves (relative to calcium) in the cells and tissues. Magnesium tends to be constantly lost from cells and tissues in large quantities. This magnesium loss condition may occur in both metabolic types - fast or slow.

The magnesium loss mineral pattern appears in the TMA profile as an "inversion" of the Ca/Mg ratio, i.e. the ratio is significantly below its ideal value of 7.0 (see Fig. 5). The chronic tension which is associated with this strongly conditioned stress response tends to produce a high TMA magnesium level relative to calcium. This apparently occurs because relatively large quantities of magnesium are continuously being lost from within cells and tissues. The forming hair follicle then accumulates large quantities of this magnesium which is being lost from cell and tissue storage.

The person with a magnesium loss condition tends to experience recurring or occasional anxiety and a "jittery" feeling in the stomach or the chest. Emotionally, in extreme cases, the person feels out of control and very unstable. A very high Na/K ratio accompanies the magnesium loss condition. Therefore, very intense anger and/or anxiety are often felt and expressed. Usually, difficulties with establishing and sustaining close intimate relationships are found in individuals with this Ca/Mg inversion pattern.

Physically, the person with the Ca/Mg inversion is highly susceptible to excess muscle tension and cramping. Very high levels of soft tissue calcification may develop in the slow oxidizer with a magnesium loss pattern, especially if high copper and/or estrogen levels are present. Calcium supplementation will usually exacerbate this person's condition on both a physical and a psychological level.

Depression and panic attacks are also very commonly found with a high Ca/Mg ratio.

Magnesium "Loss" in Low Ca/Mg Ratio

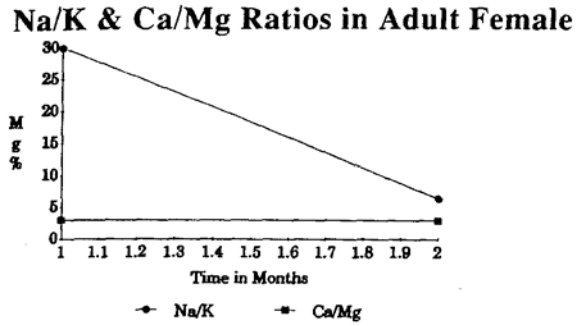
A clinically important variation of the Ca/ Mg ratio is the low (inverted) Ca/Mg ratio. This is almost always associated with a very high Na/K ratio because Mg is lost from intracellular concentrations under high stress conditions. The high Na/K ratio reflects a chronically high state of stress. As magnesium is lost in large quantities from intracellular concentrations, it is carried through the blood stream and the hair tissue temporarily accumulates large quantities of magnesium in relation to calcium. Therefore, when a very low Ca/Mg ratio is noted in the TMA, it usually reflects a cellular magnesium loss rather than an excess of magnesium over calcium. The following case is a good example of this important clinical phenomenon.

This 52 year-old adult female was referred by her chiropractor. She had low back problems, muscle spasms, calcium spurs, and tinitis. She also reported that she had fallen asleep at the wheel of her car and rammed another car. She said she had to frequently slap herself to keep awake while driving. She had an early hysterectomy and had been on estrogen replacement therapy with progesterone for the preceding 8 years. She used her work as an "escape" and had become a "workaholic". She is addicted to "nervous" energy. She said, "When stress goes away, there's no point in living." This woman's SCL-90-R profile reflects a clinically high level of anxiety (T score = 66). She also reported urges to break or smash things. At times, she felt so restless she couldn't sit still.

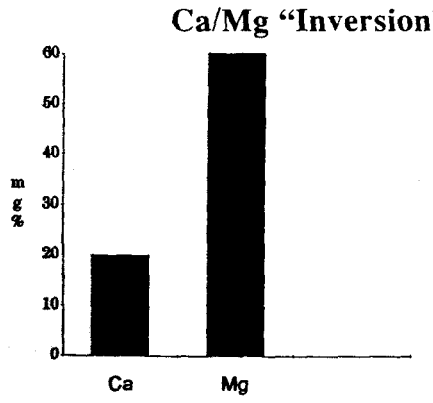
The TMA profile of this woman is shown below: Her Na/K ratio (63/1) is extremely high in comparison with the ideal TMA Na/K ratio (2.4). The magnitude of this ratio is more in the range of rage and/or panic than just fight or flight. This extremely high Na/K ratio is commonly found with an extremely low Ca/Mg ratio (2.3/1). When these two ratios are combined, they suggest a clinical profile of a highly stressed person with a severe magnesium loss. Within 3 weeks of starting to supplement with magnesium, potassium, zinc, and GT Formula, she reported she felt "a lot better", felt reduced muscle spasms, and could "stay awake while driving".

Another example of a Ca/Mg inversion (low Ca/Mg ratio) is seen in the case of a young woman who had post-partum depression. She had recently been treated with Prozac for depression. She had difficulty

becoming pregnant and was treated with drugs for fertility problems. Prior to coming for this assessment, she reported feeling uncontrollable panic attacks, rages, and anger outbursts. She said that she was "numb" to her feelings since being on Prozac. She also reported having extremely severe headaches and a very uncomfortable change in her visual field on Prozac so her doctor switched her to Zoloft. On Zoloft, she developed hypoglycemic symptoms, felt very jumpy, felt numb, and felt tremors related to the hypoglycemia. Her anger and rage were somewhat reduced. Two TMA ratios (Na/K & Ca/Mg) are shown below for this woman:



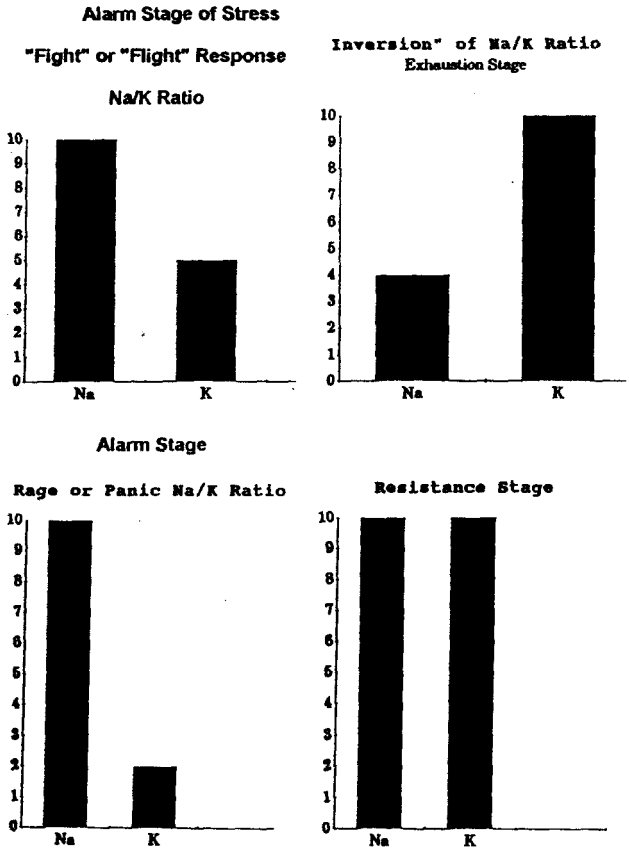
The above graph shows a highly significant drop in this woman's Na/K ratio from 30 to 6.5 (ideal ratio = 2.4). She reported a total elimination of her panic attacks and of her explosive rages. This occurred within a span of 2 months. However, her Ca/Mg ratio remained at 3.0 (ideal ratio = 7.0) suggesting that she was still experiencing some magnesium loss related to a high stress level. The Na/ K ratio of 6.5 still leaves her chronically in a "fight or flight" state, but with greatly reduced intensity. Additional psychological issues remain to be treated in psychotherapy before the chronic magnesium loss becomes stabilized. Biofeed-back and massage therapy may be useful in a case such as this in order to further reduce the body tension and



Anger and Panic Disorders

There are other TMA ratios involving nutrient minerals which play a role in the psychophysiological stress response and, therefore, also play a role in psychoneuro-immunological processes. These other ratios involve the activity of the adrenal glands and the minerals which they affect. Sodium, potassium, zinc, and magnesium are strongly affected by adrenal gland activity. With the activation of the stress response, the adrenal glands increase their secretion of the hormone aldosterone which increases the retention of sodium in the cells and tissues. As sodium is retained, magnesium and zinc are lost from the cells and tissues. The loss of zinc and magnesium under stress appears to facilitate the stress response by allowing for greater retention of sodium.

The increased retention of sodium in the tissues increases the Na/K ratio which is associated with the first or alarm stage of stress - commonly know as the "fight or flight" response. Fear and anger are the emotions most strongly associated with this stage. When Na increases and Mg decreases in the cells and tissues, there also is an associated increase in the Na/Mg ratio or the TMA "adrenal" ratio. A high TMA Na/K ratio tends to be associated stress



psychologically with fear and/or anger because it is reflective of the alarm stage of stress - the "fight or flight" stage.

In a TMA, when sodium significantly exceeds potassium, then psychologically, the person will be more likely to manifest signs of the alarm stage of stress. The person will experience intense feelings associated with "fight" or "flight". That is, such a person will tend to be hostile, aggressive, and/or dominating and controlling. The other way in which a high Na/K ratio may manifest is with fear, heightened anxiety, and panic. A tendency to be submissive is also seen.

Psychologically, a high Na/K ratio is extremely important because an individual with such a ratio will tend to "feel anger or fear", but for no apparent reason. The person is aware of having the feeling which is associated with this mineral imbalance, but the person is not angry at another individual for a particular reason. In other words, this mineral pattern gives rise to the feeling of anger or fear, but there is usually no specific action by another person which is "causing" this feeling to be elicited. This is a very different type of emotional reaction than is one triggered by another person's actions.

Clinically, this distinction is very important for psychotherapy. If the feeling is brought on by the high Na/K ratio, then psychotherapy will do very little to bring it under control, whereas nutritional supplementation which corrects or normalizes the ratio will drastically reduce or even eliminate the intensity of the feeling. If the feeling is associated with the actions of a particular person or situation, then psychotherapy can help the person confront and deal with feelings elicited by the other person's actions.

Na/K "Inversion"

An opposite TMA pattern is seen wherein the sodium is significantly lower than the potassium, i.e. an inversion of the Na/K ratio. A person with an inversion of the Na/K ratio tends to suppress anger and to be passive aggressive. A tremendous amount of cellular energy is consumed in such a personality pattern. It takes a great deal of energy to "sit on" the adrenal glands and to keep them from reacting. It is not surprising that such a person experiences chronic prolonged stress which does not allow the adrenal glands to rest and "re-charge". Therefore, the Na/K inversion is associated with the third or exhaustion stage in Selye's stress system. This mineral pattern may be the underlying pattern in what has recently been described as the Type C personality which is susceptible to cancer (Temoshok, L & Dreher, H., 1994).

A person with a sodium/potassium inversion feels more and more chronically exhausted with very little awareness or understanding of what is happening to him/her. Indecision is commonly observed in individuals with this type of mineral imbalance. The person feels blocked by the fear of making a mistake or making the wrong decision. Such a person usually needs psychological support in making some kind of decision regardless of what it is. Making a decision often allows the person's psychophysiological system to begin to correct itself. The Na/K inversion will usually start to correct itself following a decision.

The Na/K ratio has important implications for psychoneuroirnmunology because different diseases or medical problems are associated with different magnitudes of the ratio. The high Na/K ratio tends to be associated with chronic pain and/or inflammatory conditions, whereas the "inversion" of the Na/K ratio tends to be associated with kidney problems, protein catabolism, and diabetes. These disease and metabolic conditions also tend to be associated with emotional patterns. The high Na/K person is a very angry enraged person who also may be susceptible to intense anxiety and panic attacks. Some individuals with this ratio tend to fluctuate between angry explosive outbursts and high anxiety levels and panic attacks.

When a high Na/K ratio is reduced in the direction of the ideal ratio of 2.4, the individual often reports a reduction of fear and anger. He/she is better able to cope with stress without experiencing intense anxiety and anger. TMA charts illustrate these changes. Case #1 is that of a 10 year-old boy diagnosed with Attention Deficit Hyperactivity Disorder. Case # 2 is that of the boy's mother.

When this 10 year-old boy's TMA chart showed a Na/K ratio of 27/1 (ideal ratio = 2.4), his mother described him as being volatile and explosively angry. Under this mineral imbalance condition, he had a great deal of difficulty dealing with the

intensity of his anger and rage. When the ratio dropped from 27/1 to 1.8/1, his mother reported that he was much calmer, not nearly as prone to violent outbursts, and that he was able to deal much more appropriately with his anger. This boy's mother also had a high Na/K ratio which dropped significantly with nutritional supplementation. She reported feeling much less angry and more in control of herself and her intense emotions. She said that her children "used to hide from my anger."

A third case is that of an 8 year-old girl who was referred because of a school phobia. Rather than assuming that the school phobia was totally psychological, a TMA was done to ascertain whether this child's phobic reactions might be associated with a high Na/K ratio. Her TMA chart showed that she had a Na/K ratio 18/1! Within a week of starting on vitamin/mineral supplementation, her phobic reactions were so drastically reduced that she was back in school and functioning very well. There was no relapse reported over a period of 6 months.

Another case illustration is that of a 26 year-old woman whose TMA charts showed a chronically high Na/K ratio associated with very high levels of copper. With high stress, an individual with a high TMA copper level and a very low potassium level will tend to be highly emotional and volatile. This woman fluctuated between explosive blind rage reactions and intense fear and panic for "no apparent reason". This woman had fractured her hand when she smashed a door or a wall. As she eliminated excess stored copper and restored a better balance between sodium and potassium, she became calmer and had more emotional control. She also experienced fewer and less intense homicidal and suicidal feelings.

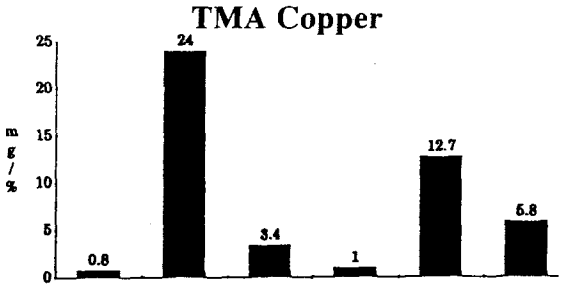
Hyperactivity and Attention Deficit Disorder

TMA profiles strongly suggest that there are two basic factors involved in hyperactivity (ADHD) and attention deficit disorder (ADD). One factor involves a significant accumulation of one or more toxic heavy metals, the most common of which are lead, mercury, aluminum, and cadmium. Excess copper is also found in TMA profiles of many ADD/ADHD children and adolescents.

The other major factor related to ADHD/ ADD involves significant imbalances between essential nutrient minerals, especially those more prominently involved in the regulation of glucose metabolism and cellular energy production. These nutrient minerals are calcium, magnesium, sodium, potassium, copper, zinc, and chromium.

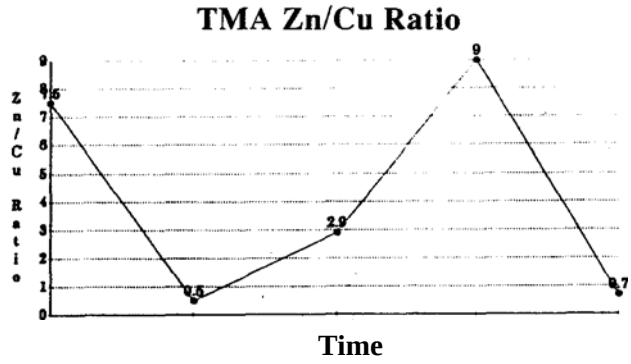
Copper plays a unique role in the TMA profiles of hyperactive and attention deficit disorder children in that copper is both (a) an essential nutrient mineral with a critical role in energy production and (b) a toxic metal when it accumulates in the body's tissues in excessive amounts (Pfeiffer, 1975; 1987).

One of the most dramatic cases of copper toxicity in a very hyperactive child was that of a 9 year - old boy (Malter, 1984b; 1993). The boy's mother initially rated his behaviors 36/ 36 on the Davids rating scale (maximum rating of hyperactivity is 36). His first TMA chart showed him to be a fast oxidizer with excessive amounts of lead, cadmium, and aluminum reported. However, in this first TMA chart, his copper was reported at .8 mg% which is far below the ideal TMA copper level (2.5 mg%). His second TMA obtained 3 months later showed that he had gone into a slow oxidizer pattern as his copper level increased from .8 mg% to 24 mg%! The sharp increase in the hair TMA copper level most often indicates the elimination of excess copper from tissue storage. During the process of this copper "dumping" from within cells and tissues, the hair temporarily picks up the increased amount of copper from circulation.



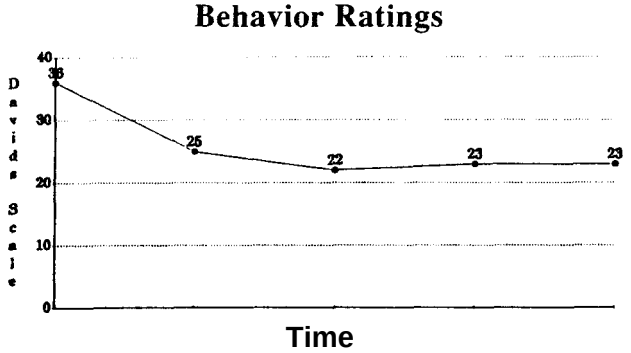
There are two points in Fig. 10 which reflect significant copper "dumps" or elimination of copper from tissue storage. The first point is the increase in copper from .8 to 24 mg/%. The second point is the increase from 1.0 to 12.7.

Copper "dumping" is also seen in the changing zinc/copper ratio over time as shown in Fig. 11:



Copper "dumping" is reflected in the substantial decreases in zinc/copper ratio. The ideal zinc/copper ratio is 8.0. There are two very large decreases in the zinc/copper ratio which reflect a copper "dump". The first is the drop in the ratio from 7.5 to 0.5 and the second is the drop from 9 to 0.7.

During this period of time when such a large amount of copper was being eliminated from tissue storage, the boy's mother reported that she and others who knew the boy observed improvements in his behavioral control, increased calmness, and a better capability to anticipate the consequences of his behavior. The boy was also able to express an awareness of having more self-control, liking himself more, and having a better understanding of what behavioral consequences meant. Over a period of 2 and a half years, the mother continued to rate this boy's behavior on the Davids rating scale and these results are shown in the accompanying graph.



Several years ago, a study of TMA patterns of hyperactive and ADD children showed that the dominant profile was that of a fast oxidizer with an Na/K "inversion" (Malter, 1984a). A much smaller proportion of children in the sample studied were slow oxidizers with an ideal or a high Na/K ratio. These two types of TMA profile tend to reflect different stages of stress. The fast oxidizer with a Na/K "inversion" reflects an early trend towards adrenal insufficiency, whereas the slow oxidizer profile tends to reflect a more advanced chronic state of adrenal insufficiency. This is a much later stage of stress than is indicated by the fast oxidizer with a Na/K "inversion".

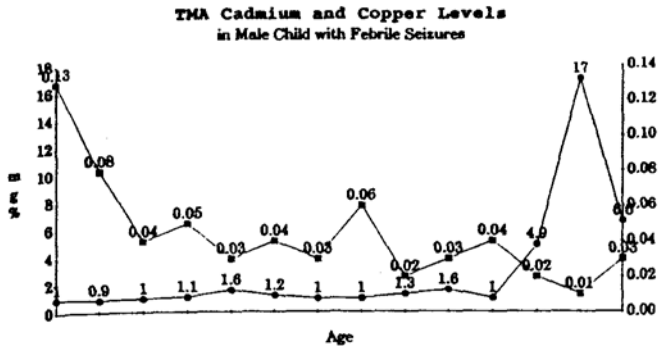
In more recent years, there appear to be fewer profiles of hyperactive and ADD children reflecting fast oxidation with a Na/K "inversion". There are now more profiles of slow oxidation without a Na/K "inversion". If this trend is, in fact real, it may be explained by an increase in copper toxicity from one generation to the next (Malter, 1990). The effect of increasing copper toxicity would be to first induce a Na/K "inversion" in a fast oxidizer. With increasing copper toxicity, this latter pattern would shift to a slow oxidizer without a Na/K "inversion". This latter pattern is reflective of a more advanced stage of adrenal insufficiency. As this latter condition worsens, an adrenal "burn-out" is experienced by the individual.

TMA data indicate that more and more children carry a very heavy toxic metal load in the body's tissues and are showing signs of early adrenal insufficiency. This appears to be occurring at younger and younger age levels. Under the Cumulative Toxic Metal Hypothesis (Malter, 1990), we would expect to find more and more children being born with high tissue levels of different toxic metals such as lead, cadmium, aluminum, and mercury.

Elimination of Toxic Metals

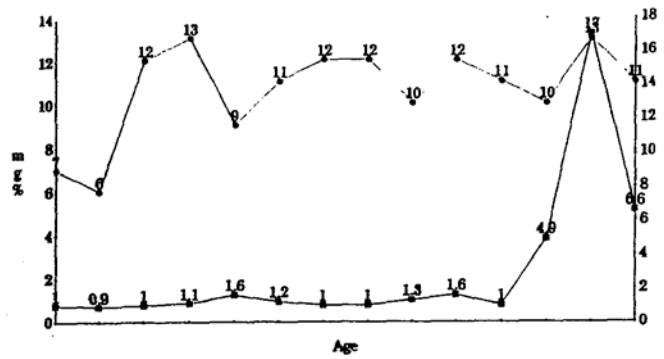
The manner in which toxic metals (and excesses of nutrient minerals) are accumulated, stored, and eventually eliminated reflects a complex metabolic process which occurs over time (Mehta, S. W. & Eikum, R., 1989). The elimination of these toxic excesses from tissue storage also involves complex metabolic processes with highly variable times for this elimination to occur. In some cases, the elimination of a toxic excess may occur very quickly (see above case of ADHD boy in longitudinal study). In other cases, it may take several years before a toxic excess is eliminated and observed. This is seen in the longitudinal data following of a male child who had febrile seizures at 1-1/2 years of age.

His cadmium level was extremely high at the time of the seizures. Within a year, the cadmium level decreased to much lower levels.



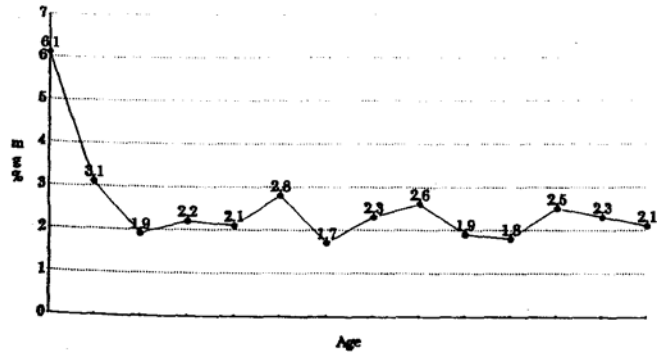
He also had very high aluminum levels at the time of the seizures (see graph below).

Initially, this boy's copper levels tended to be very low, but when he was 5 years old, he began to "dump" excess copper (4.9 mg%). At age 6, he had an extremely heavy copper "dump" (17 mg%) followed a year later by another copper "dump", but of lesser magnitude (6.6 mg%). The TMA zinc and copper levels are shown below for this same male child:



At the time of his seizures, he had a very low TMA zinc level (7 mg%). It took several years for him to build up and stabilize his zinc reserves. In his case, this may have been necessary before his body initiated the heavy copper "dumps".

This boy' s TMA aluminum levels are shown below:



These data indicate that very high levels of cadmium and aluminum were present at the time of this boy's febrile seizures which occurred at 1 and a half years of age. The data also suggest that excess copper levels were latent in tissue storage at that time and did not become manifest until several years later. There has been no recurrence of his seizures since he first went on nutritional supplementation at 1 and a half years of age.

Another example of the long tissue storage time and elimination of excess copper is seen in the chart below for a gifted (WISC-R Verbal and Performance IQ scores of 139) female child with a mild auditory processing problem (Malter, R. & L. Frank, 1993):

A copper "dump" is first seen in the graph when her tissue copper increases from 1.5 to 3.9. The TMA copper level dropped back to 1.9 before copper "dumping" resumed for a longer time period with much larger quantities being eliminated. This girl's parents reported that she experienced intense irritability and moodiness while going through the copper dumping phase.

From a clinical viewpoint, it is very important that this girl eliminated the excess copper before she enters puberty because of the strong relationship between estrogen and copper. Were she to enter puberty with such a large quantity of excess stored copper, she is likely to experience severe psychological and/or physical problems. The psychological problems may include severe depression, obsessive-compulsive disorder, anxiety and panic attacks, mood swings, memory and concentration problems, and suicidal tendencies.

This girl's case is a good example of the mental health risks carried by large numbers of female children who have excess copper tissue burdens as they enter puberty. The excess copper load may become exacerbated with the build-up of the girl's own estrogen levels throughout adolescence.

Since the excess copper levels may affect MAO and serotonin levels, many of these girls will be at high risk for depression.

These data suggest that, in order to more accurately observe the role of excess toxic metals and minerals on psychological and neuroendocrine functions, it is critical to use longitudinal data on individual subjects. The metabolic dynamics of toxic metals and mineral excesses occur within individual subjects and are most clearly seen in TMA data collected longitudinally. These dynamics would most likely be blurred and lost with group data, especially when only cross-sectional data are collected and reported.

High tissue copper levels may be associated with high bilirubin levels at birth. Allergies and recurring infections are commonly reported in the health histories of these children born with high copper levels. In the cases of children who have recurring ear infections, surgeries for inserting tubes in the ears are very commonly found. Auditory processing and memory problems are also frequently found in these children (Malter & Frank, 1993).

Summary and Conclusions

Since TMA patterns tend to reflect psychophysiological phenomena in general as well as psychoneuroimmunological phenomena in particular, certain environmental and social trends may be considered for purposes of predicting the direction in which health trends are likely to progress in the near future.

For example, women recently have been encouraged to substantially increase their dietary intake of calcium in hopes of preventing osteoporosis in their old age. TMA data strongly suggest that most women today are slow oxidizers. Adding significant amounts of calcium to their dietary intake will very likely exacerbate tendencies toward hypothyroidism and adrenal insufficiency (characteristics of slow oxidizers). Increasing calcium intake will further slow the rate of metabolism of these women and allow for greater accumulation of toxic metals in the body. Increasing calcium intake in a slow oxidizer will especially allow for increased accumulations of excess copper. This phenomenon will be intensified by the use of the birth control pill or by estrogen replacement therapy during and after menopause (Mehta & Eikum, 1989). The accumulation of excess copper will lead to greater storage in the liver and in the brain. The excess copper accumulation will further slow the rate of metabolism with both psychological and physical problems manifesting more frequently (Malter, 1985). This process may be leading to a major iatrogenic health disaster.

By applying TMA concepts and data, the mind-body relationships at a cellular metabolic level will be much clearer. We will have a better understanding of how psychological stressors induce metabolic changes affecting the neuroendocrine, neuromuscular, and immunological systems. We will be able to better understand current health problems and to anticipate future health trends. With the application of TMA concepts and data, PNI research and clinical applications will be greatly enhanced. Health policy involving societal and environmental factors can be more intelligently developed. Prevention or reversing adverse trends towards disease and psychological problems can be more intelligently accomplished. This should lead to a reduction of health care costs by applying psychophysiological concepts and techniques more intelligently.

References

1. Asterita, Mary. *The Physiology of Stress with Special Reference to the Neuroendocrine System.* New York, Human Sciences Press, Inc., 1985.
2. Barkley, R. "A review of stimulant drug research with hyperactive children.*"J. of Child Psychology and Psychiatry*, 1977, 18, pp. 137-165.
3. Barnes, Broda O. & Lawrence Galton. *Hypothyroidism: The Unsuspected Illness.* New York, Harper & Row, 1976.
4. Brenner, Arnold. "The effects of megadoses of selected B-complex vitamins on children with hyperkinesis: controlled studies with long-term follow-up.*" J. of Learning Disabilities*, May, 1982, 15, pp. 258-264.
5. Borysenko, Joan. *Minding the Body, Mending the Mind.* New York, Bantam, 1987.
6. Capra, Fritjof. *The Tao of Physics.* Boulder, CO, Shambhala Publications, 1975.
7. Capra, Fritjof. "The new physics: implications for psychology." *The American Theosophist*, Spring, 1980, pp. 114-120.
8. Chopra, Deepak. *Quantum Healing: Exploring the Frontiers of Mind/Body Medicine.* New

York, Bantam, 1989.

9. Fein, G, Schwartz, P.,Jacobson, S., & Jacobson, J. "Environmental toxins and behavioral development." *American Psychologist,* November, 1983., pp. 1188-1196
10. Locke, Steven & Douglas Colligan. *The Healer Within: The New Medicine of Mind and Body.* New York, E.P. Dutton, 1986.
11. Malter, Richard F. "Implications of a bio-nutritional approach to the diagnosis, treatment, and cost of Learning Disabilities." Paper presented at the National Convention, Association for Children with Learning Disabilities, Washington, D.C.,February, 1983.
12. Maker, R. F. "Biofeedback and nutrition." Unpublished paper, Maker Institute for Natural Development, Inc., Schaumburg, IL, March, 1984a.
13. Malter, R. F. "Copper toxicity: psychological implications for children, adolescents, and adults." Unpublished paper, Maker Institute for Natural Development, Inc., Schaumburg, IL, April, 1984b.
14. Maker, R. F. "Trace mineral profiles of hyperactive children." Unpublished paper, Maker Institute for Natural Development, Inc., Schaumburg, IL, April, 1984c.
15. Maker, R. F. "Implications of a bio-nutritional approach to the diagnosis, treatment, and cost of Learning Disabilities." *Somatics,* Autumn-Winter, 1984-85, 38-43.
16. Maker, R. F. "Nutritional concerns in learning and psychological disorders." Paper presented to APA Div. 42, Annual Convention of the American Psychological Association, Los Angeles, CA, August, 1985a.
17. Maker, R. F. "Preventing osteoporosis with calcium supplementation: possible psychological hazards." Unpublished paper, Maker Institute for Natural Development, Inc., Schaumburg, IL, August, 1985b
18. Malter, R. F. "Energy, stress, and 'burn-out': a new perspective on addictions." Unpublished paper, Maker Institute for Natural Development, Inc., Schaumburg, IL, June, 1986.
19. Maker, R. F. "The concept of a health-energy continuum: implications for maintaining health." Unpublished paper, Maker Institute for Natural Development, Inc., Schaumburg, IL, August, 1987.
20. Maker, R. F. "Zinc/copper ratios and brain function: implications for education and special education." Unpublished paper, Maker Institute for Natural Development, Inc., Schaumburg, IL April, 1988. Reprinted in Newsletter of Trace Elements, Inc., Dallas, TX, 1988.
21. Maker, R. F. "The cumulative toxic metal hypothesis and attention deficit disorders." Unpublished paper, Maker Institute for Natural Development, Inc., March, 1990.
22. Mason, Karl E. "A conspectus of research on copper metabolism and requirements of man." *J. of Nutrition,* November, 1979.
23. Mehta, S. W. & Eikum, R. "Effect of estrogen on serum and tissue levels of copper and zinc." *Advances in Experimental Medicine & Biology.* 258: 155-62, 1989.
24. Page, Melvin. *Degeneration and Regeneration.* St. Petersburg Beach, FL, 1949.
25. Pfeiffer, Carl. *Mental and Elemental Nutrients: A Physician's Guide to Nutrition and Health Care.* New Canaan: Keats, 1975.
26. Pfeiffer, C. *Nutrition and Mental Illness: An Orthomolecular Approach to Balancing Body Chemistry.* Rochester, VT, Healing Arts Press, 1987.
27. Pfeiffer, C. & Mailloux, R. "Excess copper as a factor in human diseases." *J. of Orthomolecular Med.,* 1987, 2, no. 3, 171-182.
28. Pihl R. & Parkes, M. "Hair element content in learning disabled children."Science, 1977,198, 204-206.
29. Rimland, B. & Larson, G. "Hair mineral analysis and behavior: an analysis of 51 studies." *J. of Learning Disabilities,* May, 1983,16,279-285.
30. Temoshok, L. R. & Dreher, H. "Can Type C contribute to cancer?" *Advances: The Journal of Mind-Body Health,* Spring, 1994, 10, 2, 64-72.
31. Watson, George. *Nutrition and Your Mind.* New York: Harper & row, 1972.
32. Watts, David L. "The nutritional relationships of iron." *J. of Orthomolecular Med.*. 3, 3, 1988.
33. Watts, D. L. "The nutritional relationships of copper." *J. of Orthomolecular Med.*. 4, 2, 1989.
34. Watts, D. L. "Nutritional interrelationships: minerals-vitamins-endocrines." *J. of Ortho-molecular Med.,* 1990.
35. Watts, D. L. "Trace elements and neuro-psychological problems as reflected in tissue mineral analysis (TMA) patterns." *J. of Orthomolecular Med.,* 5, 3, 1990.
36. Weiss, B. "Behavioral toxicology and environmental health science." *American Psychologist,* November, 1983., pp. 1174-1186.