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Magnesium in Primary Care and Preventive Medicine: Clinical Correlation of Magnesium Loading Studies

Sidney MacDonald Baker

Princeton Bio Center, Skillman, N.J., USA

Key Words. Magnesium deficiency · Primary care · Preventive medicine · Computerized clinical data base · Magnesium-loading studies · Depression · Anxiety · Skin inflammation

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Introduction

In primary care, patients often have more subtle, varied and multisystem problems than in specialty practices. Preventive medicine is directed at patients who may be free of overt disease but, on careful questioning, report symptoms that could be clues of future problems. Mg deficiency is common in North Americans and should be considered in patients with mild or moderate symptoms seen in office practice as well as those seeking preventive medical advice. There are no simple criteria for making a clinical decision to give magnesium supplementation to such patients, and intramuscular magnesium-loading studies (IMMLS) involve barriers of pain and inconvenience beyond most laboratory screening procedures. In my practice, which includes patients with complex problems as well as primary care and preventive medicine patients, I have used a therapeutic trial of magnesium chloride in those who have mild problems or for whom a magne-

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Introduction

In primary care, patients often have more subtle, varied and multisystem problems than in specialty practices. Preventive medicine is directed at patients who may be free of overt disease but, on careful questioning, report symptoms that could be clues of future problems. Mg deficiency is common in North Americans and should be considered in patients with mild or moderate symptoms seen in office practice as well as those seeking preventive medical advice. There are no simple criteria for making a clinical decision to give magnesium supplementation to such patients, and intramuscular magnesium-loading studies (IMMLS) involve barriers of pain and inconvenience beyond most laboratory screening procedures. In my practice, which includes patients with complex problems as well as primary care and preventive medicine patients, I have used a therapeutic trial of magnesium chloride in those who have mild problems or for whom a magne-

sium supplement is indicated as a general preventive measure, considering that they are likely to have had or will have low dietary intakes of magnesium. I have done IMMLS in patients with moderate to severe problems, especially those in whom I found a history that I considered indicative of Mg deficiency. Mild to moderate nutritional (or metabolic) compromise has varied expression in different individuals because mild impairment does not interfere with the expression of individuality.

The purpose of the study described in this paper was to explore symptom patterns of patients with varying degree of Mg retention in the hope of refining our guidelines for detecting individuals with mild or occult Mg deficiency. Published descriptions [1, 2] of

Skeletal muscle	*Central nervous system*
Muscle twitches	Insomnia
Muscle cramps	Anxiety
Muscle tension	Hyperactivity
Muscle soreness	And restlessness, constant movement
Including back ache, neck pain, tension headache, temporomandibular joint dysfunction	Panic attacks
Chest tightness	Agoraphobia
Or a peculiar 'I can't seem to take a deep breath' or 'I have to think about my breathing' sometimes as hysterical, in children this symptom may be seen as sighing	Premenstrual irritability
	And breast tenderness
Other muscles	*Peripheral nervous system*
Constipation	Numbness
Urinary spasm	Tingling
Menstrual cramps	Other abnormal sensation
Difficulty swallowing	Including zips, zaps, vibratory and other peculiar sensations
Or 'lump in the throat' or globus hystricus, especially when provoked by eating sugar	*Cardiovascular*
Photophobia	Palpitations
Especially difficulty adjusting to oncoming bright headlights in the absence of eye disease	Arrhythmias
Loud-noise sensitivity	Vasospastic angina
From stapedius muscle tension	Hypertension
	Mitral valve prolapse
	Other
	Salt craving
	Carbohydrate craving
	Carbohydrate intolerance

the clinical picture of Mg deficiency, my own anecdotal experience [3] and that of colleagues give a portrait that is depicted by the vernacular expression 'up tight'. The symptoms include several categories of both the muscular and neural sense of tightness:

I find the above catalog of 'Mg indicators' a useful guide for selection of patients who warrant an IMMLS or therapeutic trial of Mg supplementation. Relatively often, however, patients convincingly report consistent benefits that lie beyond the picture given

above. The following case report provides an example:

G.Q. is a 60-year-old Caucasian, Gr 4 P 4, former alcoholic businesswoman who consulted me for a lifelong history of inhalant allergy and chemical sensitivities, and a long-standing problem with depression, anxiety, urinary frequency and chronic tendinitis of her right upper arm. On review of systems she had insomnia, constipation, carbohydrate and salt craving, and muscle spasms of her neck and back. Laboratory evaluation revealed a folate deficiency and hypersensitivity to molds and foods. Treatment of her allergy with mold desensitization and avoidance and folate supplementation relieved many of her symptoms. A therapeutic trial of Mg as 25% Mg chloride solution, 2 teaspons (260 mg elemental Mg) per day gave her relief of tendinitis. If she stops taking her Mg supplement, the tendinitis returns, only to remit promptly with reinstitution of treatment.

Two other cases provide examples of a straightforward example of Mg deficiency and one that is more complex.

M.M. is a 60-year-old caucasian, married, Gr 5 P 5, woman teacher who consulted me in June 1990 with a history of chronic allergic sinusitis for 40 years, joint pain and stiffness for 40 years, anxiety and panic attacks for 35 years, numbness of her hands on awakening for 20 years, recurring cystic lesions of her skin, breasts and vagina for 14 years, recurring sciatica for 5 years, recurring vaginitis for 10 years and hypertension for 10 years since the beginning of menopause. While remaining an active productive mother and teacher, she was never free of mild to moderate incapacitating symptoms. Mrs. M.'s daily medications were conjugated estrogens 0.625 mg, methyldopa 1,000 mg and hydrochlorothiazide 50 mg. Her blood pressures were approximately 140/90 on this regimen. Physical examination was unremarkable except for sparse body and pubic hair, frayed finger nails and a fetid breath odor. Previous laboratory studies showed hypercholesterolemia, otherwise normal chemistry screens, blood counts, chest X-ray, cardiogram, colonoscopy and mammography.

My laboratory studies showed on day 1 an Mg excretion of 75 mg/24 h and a 172 mg/24 h excretion following a 200-mg IMMLS for a retention of 51%. Plasma zinc was 64 μg/dl, salivary secretory IgA was 28.9 μg/ml (8–20) and serum folate was 14.2 ng/ml (5–25).

After completion of her IMMLS she was begun on $MgCl_2$ 64-mg tablets, working up to 8 tablets daily. Her allergies were treated with mold desensitization, her vaginitis with antifungal medications, and she was given a supplement of flax seed oil, 1 tablespoon per day. Her blood pressure fell to 100–100/70–80, and her antihypertensive medications were tapered and disocntinued. Mrs. M. is emphatic in identifying the Mg at the treatment responsible for restoring normal sensation in her hands, normal blood pressure, bowel patterns, sleep patterns and mood.

M.F. is a 5-year-old Caucasian girl whose mother consulted me in October 1990 because of M.'s complex partial seizures, beginning when she was 3 years old. When having a seizure M. would spin to the left, lose neck control, fall to the ground and her eyes would flutter. The daily frequency increased over 6 weeks to 6–10 seizures lasting 30 s. M. was born after an uncomplicated, full-term pregnancy, labor and delivery, was breast fed, and developed normally. At 2 months of age, the evening after her DPT immunization, she had an episode of high-pitched screaming followed by 36 h of deep sleep. She was otherwise completely healthy until her seizures began. Within the month following the onset, a neurologist made the diagnosis of complex partial seizures with a right temporal lobe focus on the electroencephalogram. Seizure control was achieved with daily doses of phenytoin 75 mg and carbamazine 750 mg. Phenytoin was discontinued following the development of hirsutism, facial thickening, dark urine, reduced attention span, enuresis and mood swings with periods of fatigue alternating with irritability, all of which subsided off phenytoin. Episodes of facial edema and hyperactivity stopped after sugar was taken out of her diet.

At the time of my first consultation, M.'s mother described the following symptoms: chocolate, ice cream and bread craving; moderate daytime sleepiness and difficulty attending, alternating mild diarrhea and constipation, a mild facial rash and mild generalized muscular twitches during sleep. Physical examination revealed normal height and weight and vital signs (blood pressure 92/60), allergic shiners, dry lackluster skin, hyperkeratosis follicularis of the backs of her arms and hirsutism of her legs, back and pubic

area. Neurologic examination, including facial and Chvostek's reflex, was normal. Laboratory studies revealed a plasma zinc of 79 μg/dl, ferritin of 16.3 ng/ml, vitamin D (1,25-dihydroxy) of 42 pg/ml, ionized calcium of 5.12 mg/dl and blood thiamin level of 16 ng/ml (25–75). Quantitative red blood cell phospholipids revealed a pattern consistent with a δ-6-desaturase deficiency with a ratio of n–6 precursor to metabolites of 0.51 (0.30–0.45). Quantitative 24-hour urinary amino acids revealed marked carnosinuria. IMMLS revealed a 66% retention of a 50-mg load.

M.'s twitching during sleep diminished by 80% after beginning daily doses of $MgCl_2$ 25% solution, 1 teaspoon (130 mg) diluted in juice, thiamin 50 mg, γ-linolenic acid 135 mg and avoidance of carnosine-containing foods. Reintroduction of carnosine-containing foods made no difference, and diet restriction was discontinued.

Her mother would like to try to wean her from carbamazine, and it will be attempted in view of the documentation of several factors that may contribute to cerebral irritability, particularly magnesium deficiency.

These case reports provide examples of the difficulty of identifying Mg-related symptoms and separating Mg effects from other therapies that are appropriate for the mild to moderate and multifaceted problems seen in primary care and preventive medicine. In order to explore Mg-related symptoms in a varied patient population I have reviewed the symptom patterns in patients divided into four groups based on IMMLS.

Materials and Methods

IMMLS were performed on 172 initial patients in whom clinical suspicion of magnesium deficiency was based on a history of symptoms of skeletal and smooth muscle tension. In the context of this report an initial patient is one who entered my practice after the full implementation of a computer-based medical record system that I designed to provide accurate, detailed, structured records. The records are structured so that the meaning of every symptom is defined as it is recorded. The definition is made in multiple dimensions (or fields) including optional descriptions of severity, onset, frequency, duration, alleviating and aggravating factors, and other modifiers. As each symptom is recorded, the computer software supplies compulsory dimensions that define each symptom by its body system, function and topography. The system is designed to record, as closely as possible, the meaning of the language used to describe symptoms as they are perceived rather than the underlying physiology that may be assumed to be the basis for the symptom. For example paresthesias are recorded as an abnormal sensation of the skin rather than a disturbance of the peripheral nervous system. System dimensions include familiar ones (e.g. digestive, reproductive, respiratory) as well as others that come from the translation of patients' histories into the logic of the system. Warmth, for example, is a system used to define fever, chills, feeling cold all over, cold intolerance, cold hands and feet and other symptoms in which the patient reports an alteration (increase or decrease) in his or her body's capacity to regulate warmth. Descriptions of symptoms referable to warmth come up frequently in clinical practice, so warmth is designated as a system (with only two functions: increase and decrease) as a practical matter of capturing the everyday language of medical practice. Craving is a system because it is so frequently reported with respect to drug- and food-related disorders that it requires a separate designation even though it has only one functional dimension: increase. 'No system' is used to define symptoms which do not have a definite body system, and in such cases a topographic dimension description is always recorded. Headache, for example, is recorded as the intersection of the system, function and topographic dimensions: no system/pain/head. Vision and hearing embrace all associated symptoms so that middle ear infections are coded as hearing/inflammation/middle ear. Immune system refers not only to what we understand to be the cellular and humoral responses to environmental challenges but the whole range of sensitivities reported by patients. The functional dimension characterizes the symptom's principal physiologic aberration. Pain, itching, inflammation, bleeding, increased size, abnormal sensation, dryness and disruption (fracture, wound, sprain) are straightforward. Increase is used to describe an abnormal increase in the usual activity of a system, and decrease defines a pathological decline in the activity. Anxiety

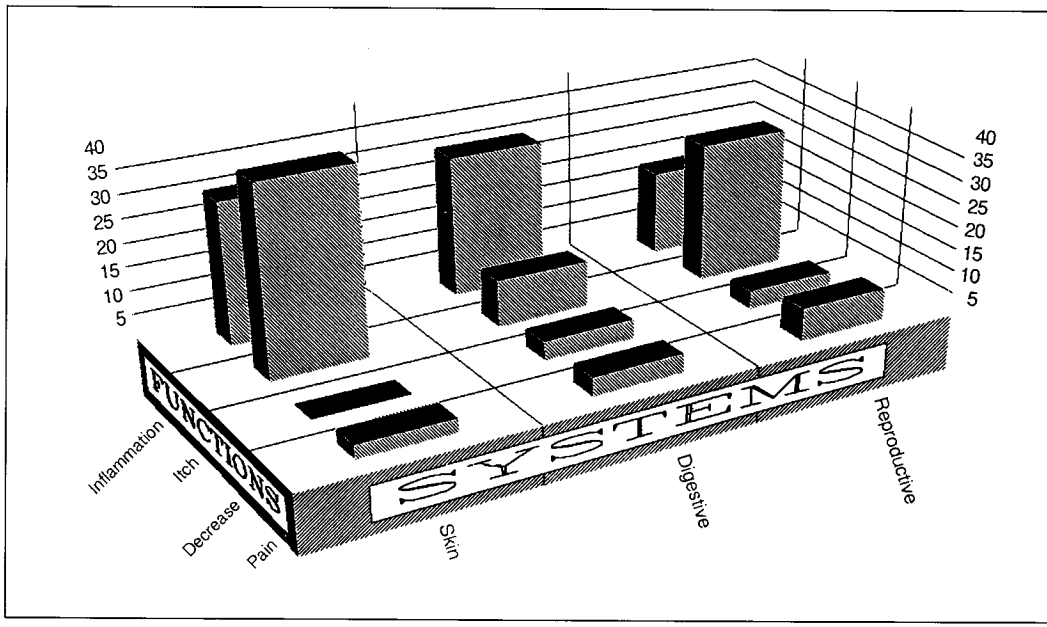


Fig. 1. The distribution of all symptoms described by the 4 functions and 3 systems is shown for a sample of 36 patients. Comparison with another group of 36 patients can be done by subtraction of its system/function matrix from this one.

and related symptoms are emotion/increase, and depression is emotion/decrease. Muscle cramps, twitches and spasms are muscle/increase, and muscle weakness is muscle/decrease. Difficulty refers to symptoms in which the patient encounters a difficulty in executing the normal activity of a system e.g. difficulty urinating or difficulty concentrating. Abnormal is reserved for nonspecific functional aberrations.

The coding system is based on a concept first described by Brunjes [4] and further by Baker [5, 6]. The scheme intends to provide the patient and clinician with a tool for accurate description of symptoms so that the medical record serves as an instrument for gathering, maintaining and reporting the patient's problem in its raw descriptors in addition to standard diagnostic categorizations. The system is suited for clinical research in primary care and preventive medicine because most patients in those fields are more accurately described by symptom data than by major diagnostic designations. It lends itself to exploratory studies of complex data sets for which visual inspection of graphic data representation may permit recognition of patterns not apparent in the informational chaos of day-to-day practice. A simplified graphic representation of symptoms from a fictitious patient sample is shown in figure 1. Symptoms reflective of skin inflammation such as eczema, pyoderma or sunburn are maintained in the medical record with their ordinary names, while simultaneously being coded by symptom, function, topography, onset, duration, periodicity, etiology (if known), and so on. Figure 1 shows only the data represented by the total count system/function intersections in a fictitious patient sample.

From the total patient population of my practice, a subset of 597 initial patients was identified and includes outpatients who were seen for their first visit with me after the full implementation of my computer system so that the complete content of their initial questionnaire and initial interview with a nurse and with me was entered into their computer files. The questionnaire covers approximately 300 specific

symptoms as well as information about biography, diet, medications, environmental factors, family, occupational and psychological history. I excluded from this group of initial patients all patients who were under my care before the full implementation of my computer system. Less of the staff time is available for creating a workable computer record on such patients, and their computer records are less exhaustive. One hundred and seventy-two initial patients had magnesium-loading studies done according to the usual protocol [7]. Each patient was provided with a detailed, verbal explanation of the test and a written protocol proscribing any mineral supplements, alcohol or diuretics for 5 days prior to the study. Patients recorded all food taken in on the day before and the 2 days of the urine collections, and they were asked not to vary their intake of food, beverage or their level of physical activity.

The 172 initial patients who had magnesium-loading studies were 127 females and 45 males (2.82:1). The ratio of female to male patients in the total population of 597 initial patients in my file at the time this review was begun was 402/195 (2.06:1). The age range was 5.6–75 years (mean = 37.6, median = 36.2). The mean female and male ages were 39.5 and 31.94 years, respectively. Four groups were created for the purpose of data analysis: those who excreted > 15 mg over the 200 mg given as the load (hyperexcreterts; 14 patients, 361 symptoms), those who retained between $\geq 15\%$ and $\leq 49\%$ (moderate retainers; 91 patients, 3,102 symptoms) and those who retained $\geq 50\%$ (high retainers, 31 patients, 1,007 symptoms) of the 200 mg i.m. load were compared with the group whose values fell between the excretion of 15 mg more than the 200-mg load and the retention of 15% of the load (0 ± 15 reference group, 36 patients, 1149 symptoms).

System/function symptom data were tabulated to demonstrate that the 13×13 system/function matrix of the most frequently reported symptoms in patients who had undergone IMMLS did not differ from the total group of initial patients. For example, in my general population the skin, respiratory tract and digestive tract are the three most common systems of symptoms given by my patients. The first three most common functions are inflammation, increase and decrease. The same is true in the sample of initial patients who had magnesium-loading studies and remains true through the 13 systems and functions used in this study. It was important, in other words, to make sure that the sample population did not have large numbers of symptoms that lay outside the 13×13 matrix and which would serve as a useful added basis for comparison among the groups. There are more than 13 systems and functions used to describe symptoms in my software system. More than 90% of all symptoms are, however, described by the top 13 systems and functions. Note that the cardiovascular system is not represented among the 13 most common systems in my patient sample. Of all the common disturbances of cardiovascular functions, only angina, mitral valve prolapse, murmurs, hypertension and arrhythmias are directly reflective of cardiovascular problems and reported by patients in their history as cardiovascular descriptors. The distolic and systolic blood pressures taken in the left arm (sitting) were recorded at the time of each patient's initial visit. The measurements were tabulated and analyzed for each group. Statistical tests of the differences of the means of the groups were done using a two-tailed t test.

The medical records of all patients were exported from the medical record system to Paradox, a relational data base system. In Paradox, the symptoms representing the 13 most common systems and 13 most common functions were selected and cross-tabulated to produce a 13×13 array for each of the four IMMLS groups. To create visually informative graphics the matrix for each group was exported to Quattro, a spreadsheet program, for normalization to $n = 36$ patients and subtraction of one matrix from another. Two groups of subtractions were performed on the matrices. The first three subtractions are the < -15, the 15–49, and the > 49, each minus the 0 ± 15 group. The second three subtractions are the 0 ± 15 group minus each of the other groups. 'Three-dimensional' bar graphs were created. For graphic clarity, only the positive values are shown. A positive value in the first group of subtractions is achieved when the frequency of a symptom in groups < -15, 15–49 or > 49 is higher than the 0 ± 15 group. A positive value of a second group of subtractions is achieved when the frequency of a symptom in groups < -15, 15–49, or > 49 is lower than the 0 ± 15 group.

Symptoms (symtem/function) incidence per patient was calculated, and intergroup comparisons were analyzed by χ^2 test. Significant differences in the group were scrutinized for clinical or biological relevance, keeping in mind that in such an exploratory study strict criteria for statistical significance must be combined with an eye for statistical noise.

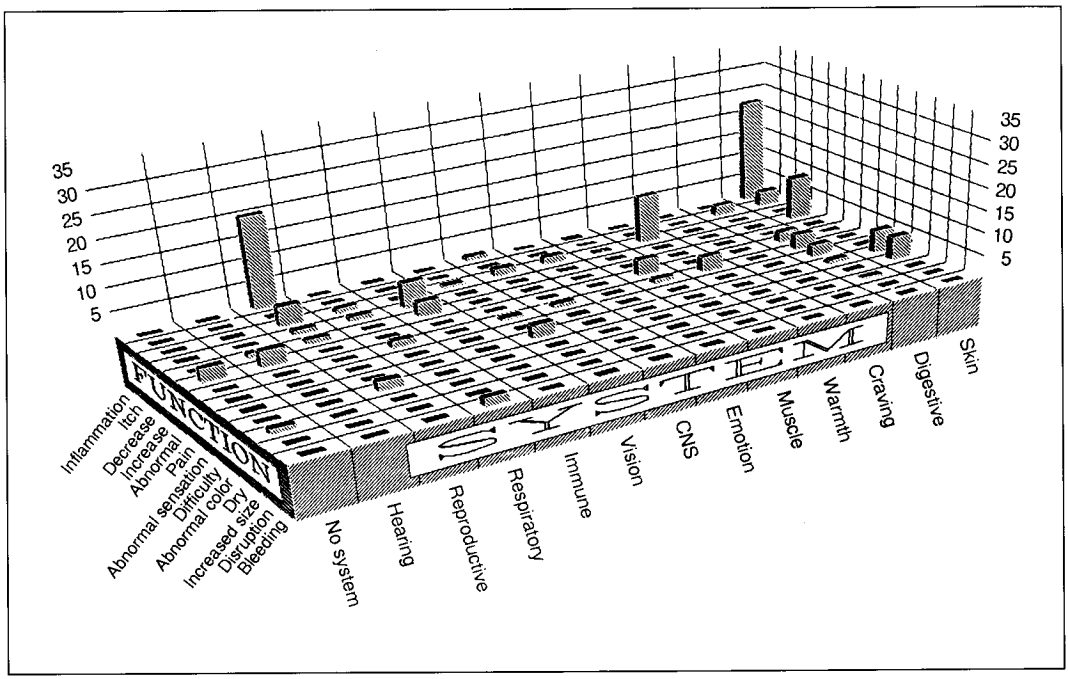


Fig. 2. The symptom/function frequency count matrix for the high-retainer group (retention of $> 49\%$ of the IMMLS) has been subtracted from that of the 0 ± 15 group. For visual clarity only the positive values are shown here (= lower incidence in the $> 49\%$ group; see fig. 4 for the negative values). (Counts were normalized based on a patient number of 36 before subtraction.)

Results

Figures 2 and 3 show the matrices that result from the subtraction of normalized system/function frequency counts of high retainers and hyperexcreters from the 0 ± 15 group. Figures 4 and 5 show the reverse subtractions. The negative values are deleted from each pair of results (they are the positive values in the other pair) for the sake of visual clarity. Statistical significance cannot be accurately visualized by the height of the bars because of the effects of variance within each group. The height of the bars is not reflective of a large proportional difference between two groups when the total number of symptoms in one group is small.

Compared with the 0 ± 15 group there is a significantly higher incidence of emotion/increase (mostly anxiety; $p < 0.05$) and emotion/decrease (depression; $p < 0.05$) in the hyperexcreter group, and the incidence of emotion symptoms overall is higher at the $p = 0.01$ level of significance. On the other hand the hyperexcreter group had, at the $p < 0.01$ level, a significantly lower incidence of symptoms of skin/inflammation or skin/abnormal color, and digestive/itch, digestive/abnormal and digestive symptoms overall. Overall the hyperexcreter group had fewer

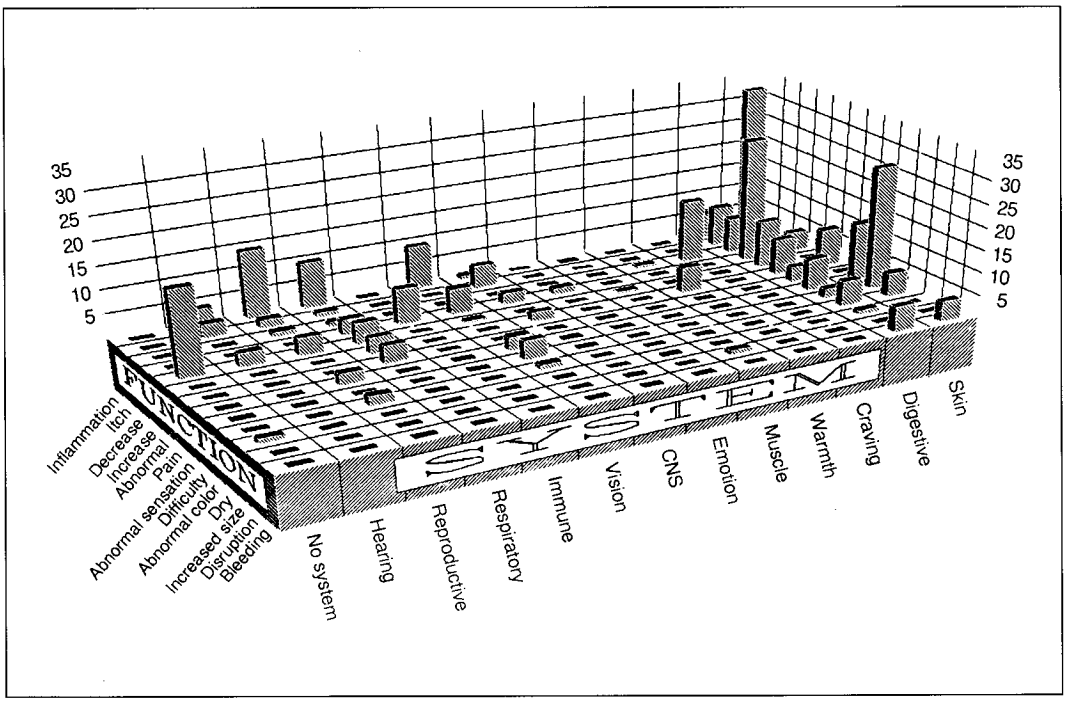


Fig. 3. The symptom/function frequency count matrix for the hyperexcreter group, those who excreted > 15 mg over the 200 mg given as the load of the IMMLS, has been subtracted from that of the 0 ± 15 group. For visual clarity only the positive values are shown here (= lower incidence in hyperexcreters; see fig 5 for the negative values). (Counts were normalized based on a patient number of 36 before subtraction.)

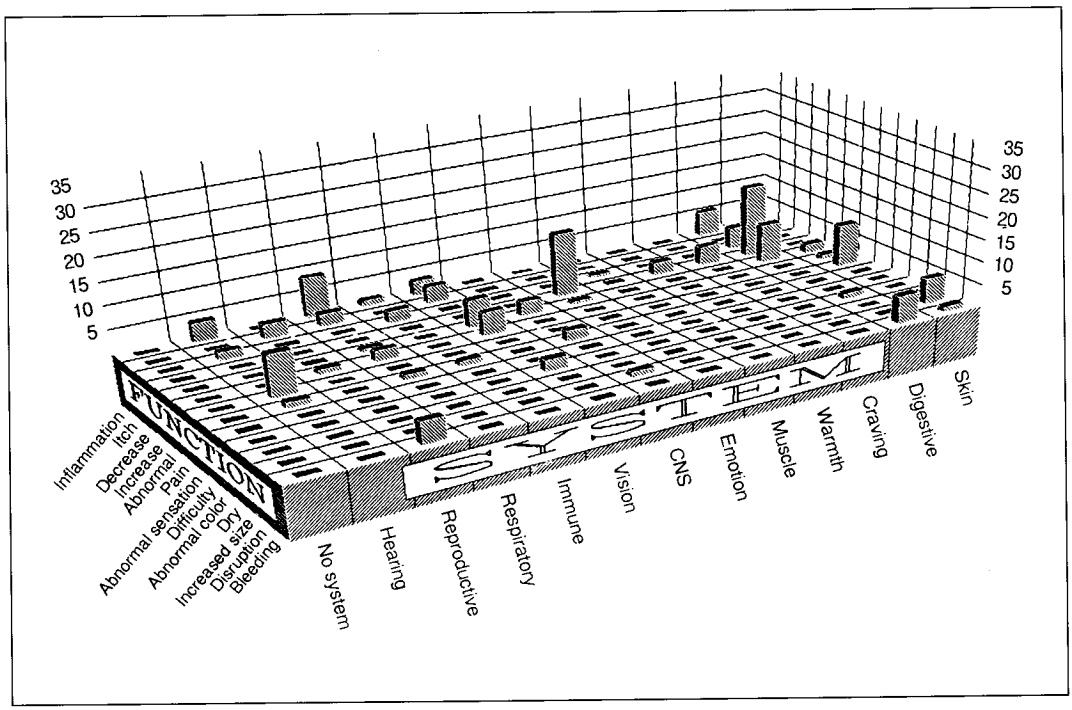
physiologic symptoms ($p = < 0.01$) and more emotional symptoms.

The group of high retainers showed two statistically significant differences ($p = < 0.01$) from the 0 ± 15 group: a lower incidence of reproductive/inflammation (mostly vaginitis) and a lower incidence of skin/inflammation. The high, as well as the moderate retainer group showed a higher frequency of emotion/increase symptoms but not at a level reaching statistical significance.

The mean initial blood pressure data represent values obtained at the time of the initial visit for all patients (not only initial

Fig. 4. The symptom/function frequency count matrix for the 0 ± 15 group has been subtracted from that of the high-retainer group (retention of $> 49\%$ of the IMMLS). For visual clarity only the positive values are shown here (= higher incidence in $> 49\%$ group; see fig. 2 for the negative values). (Counts were normalized based on a patient number of 36 before subtraction.)

Fig. 5. The symptom/function frequency count matrix for the 0 ± 15 group has been subtracted from that of the hyperexcreter group, those who excreted > 15 mg over the 200 mg given as the load of the IMMLS. For visual clarity only the positive values are shown here (= higher incidence in hyperexcreters; see fig. 3 for the negative values).(Counts were normalized based on a patient number of 36 before subtraction.)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FUNCTION
Inflammation
Itch
Decrease
Increase
Abnormal
Pain
Abnormal sensation
Difficulty
Abnormal color
Dry
Increased size
Disruption
Bleeding
SYSTEM
No system
Hearing
Reproductive
Respiratory
Immune
Vision
CNS
Emotion
Muscle
Warmth
Craving
Digestive
Skin

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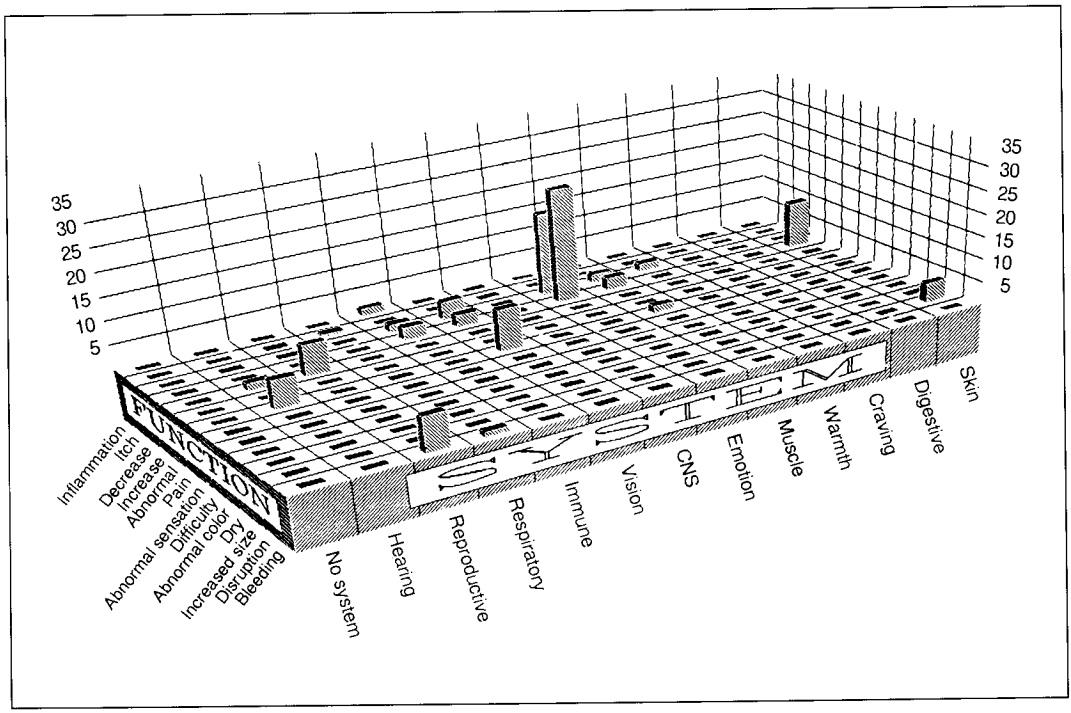
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Digestive
Skin

5

patients) who had IMMLS done. The blood pressure sample included patients who did not have complete computer records of all of their questionnaire information from the time of their initial visit, which had occurred before the computer-based medical record system was fully functional.

Hyperexcreters:
107/72 (n = 13; SD 11/8.2, SEM 3.175/2.373);
0 ± 15 group:
113/75 (n = 43; SD 17.2/9.7, SEM 2.633/1.475);
≥ 15% to ≤ 49% group:
110/72 (n = 86; SD 13.9/9, SEM 1.5/0.97);
> 49 group:
123/79 (n = 52; SD 26.5/12.5, SEM 3.7/1.745).

The difference between the > 49 group's mean systolic blood pressure and that of the 0 ± 15 group is significant ($p < 0.02$). The difference between the > 49% group and the hyperexcreters was significant at the $p < 0.002$ level.

There was no correlation in the overall sample between excretion of Mg on day 1 and retention of the Mg load. There was no correlation between age or sex and Mg retention. There was no correlation of various degrees of facial or Chvostek's reflex found in patients at the time of their initial physical examination and Mg retention. There was no correlation between the incidence of mitral valve prolapse with varying degrees of Mg retention.

Discussion

The first case report illustrates a relatively common problem for the primary care practitioner. Hypertension should always be considered a strong clue to the possibility of Mg deficiency. The added features of alcoholism, multiparity and symptoms of tension make the case an example of easy detection and a very satisfying response to therapy, with substitution of a nutrient for drugs. The second case is one of hundreds of examples of unexpected changes in symptoms that are convincingly associated with response to Mg therapy. The reduction in inflammation in the patient's tendons is difficult to explain in direct reference to the role of Mg in the chemistry of inflammation, although prostanoid chemistry is the area one might consider first. The patient's reports are in conflict with evidence cited in the present study that Mg deficiency is associated with significantly lower incidence of inflammation, at least of the skin.

The third case illustrates the complexities of placing the role of Mg among several variables in a person in whom a very exhaustive diagnostic search is justified by the clinical stakes involved in a seizure disorder. Our clinical training supports the notion of parsimony: one disease, one drug, but in nutritional medicine, it is common to encounter individuals like case 3. She has evidence of multiple imbalances. While Mg is a prime candidate to have relevance in lowering her cerebral irritability, it cannot be considered as a single therapy in the presence of several possible contributing factors.

The significant differences and upward trend in the blood pressure comparisons support the hypothesis that there are biological differences between the 0 ± 15 group and the hyperexcreters and high retainers. No differences are found in the blood pressure data or the symptom data that support the notion that patients who retain moderate amounts of magnesium on IMMLS represent a distinct biological group. The data presented do not indicate where the cutoff

point should be made between normal and high retention. The relatively low mean systolic blood pressure of the hyperexcreters is not statistically significantly lower than that of the 0 ± 15 group, but the trend is interesting in light of the other characteristics of the group, that is, less inflammation and generally fewer physiologic symptoms.

The hyperexcreters have represented a problem of interpretation for me. For example, a 36-year-old executive consulted me for facial pain that had been diagnosed as tic douloureux. It was severe to the point of incapacitation despite high doses of carbamazine, which gave some relief. He had numerous Mg indictors. After the injection of Mg for his IMMLS he experienced 24 h of complete relief for the first time in 2 years. His IMMLS showed an excretion of 97 mg more than the 200-mg load of Mg. Oral magnesium supplementation with 640 mg of $MgCl_2$ per day gave him sufficient relief so that he could discontinue carbamazine. When his IMMLS was repeated (which I rarely do) after he had been on oral Mg supplementation for 2 months he retained 52% of the load. Such an experience led me to doubt whether many of the hyperexcreters represented more than a laboratory error. I am not aware of other studies describing the hyperexcreter patients as biologically distinctive. The picture presented by the present data is that of a group of people who are in some way shut down physiologically and activated emotionally. The relative lack of certain skin symptoms is interesting in relation to the finding [unpubl. data] of a significant relative lack of skin symptoms (such as inflammation) in patients with mitral valve prolapse when studied in a model similar to the one described here. Symptoms of increased tension were not more frequent in patients with varying degrees of Mg retention. Patients were selected for clinical reasons to have IMMLS based on such symptoms. A research protocol would be needed to establisnthe value of symptoms of tension, compared with other criteria, as a basis for patient selection for IMMLS. Until such a study is conducted I recommend continuing to use such symptoms for patient selection, especially for therapeutic trials of Mg supplementation. Symptoms of tension are relieved so often in such a high percentage of such patients that it continues to be one of the most useful clinical strategies in my practice.

Conclusion

It is unlikely that 'magnesiumology' will emerge as a new clinical specialty even though Mg deficiency is common. The results of this study confirm that mild to moderate Mg deficiency is sufficiently subtle in manifestation as to deprive the clinician of a definite and uniform set of pathognomonic symptoms. The primary care practitioner may need to depend on clinical trials of Mg unless he or she is willing to turn to IMMLS for guidance, and in my experience a clinical trial of Mg is justified even in patients whose IMMLS appears to show normal excretion of the load. Most of the patients whose data are reported in this study, like the case reports, received multiple therapies, and I do not have treatment response data for the four groups that are clean enough for comparison of the groups. If symptoms of neuromuscular tension are used for patient selection, clinicians should consider that patients with relatively fewer physiologic symptoms and more emotional symptoms may belong to a dis-

tinctive group of 'shut down' individuals with a still poorly defined defect of Mg utilization. In my experience any patient with a puzzling or complex clinical presentation should be considered for assessment of Mg status or a clinical trial of Mg therapy, even if only 1 or 2 Mg indicator symptoms are present.

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