Vitamin Treatment of Hyperactivity in Children and Youth: Review of the Literature and Practical Treatment Recommendations

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Abstract *Approximately 3-5% of children receive a diagnosis of Attention Deficit Hyperactivity Disorder (ADHD). Some 3% of all youth (less than 19 years old) diagnosed with ADHD in the United States take stimulant medication. It is unfortunate that options other than stimulant medication are not typically provided to patients and their families. The vitamin approach, a plausible alternative treatment, has been dismissed as ineffective and potentially dangerous in spite of the fact that numerous publications on vitamin therapy for the treatment of childhood hyperactivity suggest that this approach deserves to be taken seriously. Several compelling single-blind studies show benefits from high-doses of single B vitamins and indicate an acceptable risk-to-benefit (i.e. safety) profile. The results from three double-blind studies are equivocal due to methodological flaws so these cannot be used to support or refute the safety or conclude about the merits of treating childhood hyperactivity with high-doses of several B vitamins and ascorbic acid. It may be preferable to treat hyperactive children and youth with a simplified vitamin regimen, since a complicated orthomolecular regimen involving numerous daily interventions can prove too cumbersome and onerous for the majority of parents and their children to follow. The reviewer proposes an algorithmic approach using single B vitamins.*

Introduction

Attention Deficit Hyperactivity Disorder (ADHD) involves symptoms such as hyperactivity, inattention, and impulsivity, leading to impairments in daily functioning, scholastic performance, and relationships with peers. Stimulant medication has been used to treat problems associated with ADHD for more than 50 years. Approximately 3-5% of children receive a diagnosis of ADHD.[1] Some 2.8% of United States youth (aged 5-18) received stimulant medication in mid-1995.[2] In a more recent publication, the prevalence of stimulant use among youth under 19 was reported to be about 2.9%, amounting to some 2.2 million youth.[3] The data is fairly consistent, demonstrating that nearly 3% of all youth are diagnosed with ADHD and prescribed stimulant medication.

While the rationale for stimulant medication is to reduce the symptoms associated with ADHD, critics have argued that Ritalin (methylphenidate) and similar stimulant medications are overly prescribed and inherently dangerous.[4] Based on double-blind, placebo-controlled clinical trials and animal laboratory research, Breggin has suggested that stimulant medication itself can contribute to abnormal behaviours by causing

adverse drug effects on the central nervous system of the child.[5] It is unfortunate that options other than stimulant medication are not typically provided to patients and their families. Promoting stimulant medication implies that ADHD is a homogenous medical disorder and that stimulant medication is the only effective treatment. However, the etiology of ADHD is not homogeneous. Numerous possible contributory factors may include sensitivities to food additives, intolerances to foods, nutrient deficiencies and imbalances, heavy metal intoxication, toxic pollutant burden, or abnormal thyroid activity.[6] Given the heterogeneous nature of this disorder, treatments other than stimulant medication might be better suited to some youth with ADHD.

The vitamin approach, a plausible alternative treatment, has been dismissed as ineffective and potentially dangerous.[7] After reviewing several publications on vitamin therapy for the treatment of childhood hyperactivity, I will demonstrate that vitamin therapy deserves to be taken seriously since there are compelling single-blind studies showing benefits from high-doses of single B vitamins with an acceptable risk-to-benefit (i.e., safety) profile. The results from double-blind studies are equivocal due to methodological flaws. Therefore, those reports cannot be used to support or dismiss the merits of combining high doses of several B vitamins and ascorbic acid for the treatment of childhood hyperactivity.

Review of Double-Blind Studies

Orthomolecular pioneer Dr. Allan Cott was probably the leading proponent of using the vitamin approach for treating childhood learning disabilities.[8,9] He treated 500 children with vitamins and reported that vitamin therapy was more effective than any other treatment available. Cott's programme involved the following vitamins taken orally – in pill, capsule, or liquid form – in daily doses:

1. Niacin or niacinamide (vitamin B_3): 1,000-2000 mg, increasing to 3000 mg if the child weighed more than 45 pounds
2. Ascorbic acid (vitamin C):1,000-2,000 mg
3. Pyridoxine (vitamin B_6): 200-400 mg
4. Calcium pantothenate (vitamin B_5): 400-600 mg

Cott noted that vitamin therapy decreased hyperactivity and improved concentration and attention span, yielding a greater capacity for learning. The programme sometimes afforded dramatic results in a very short time, but normally 3-6 months of treatment was needed to produce significant changes. With respect to safety, Cott found no negative effects, except for brief flushing when starting niacin and nausea when taking too much niacinamide.

Following Cott's reports and reports by other clinicians,[10-13] three double-blind, placebo-controlled trials were conducted to assess the vitamin approach for children with hyperactivity.

Controlled Clinical Trial #1

In this study, children (ages 5-12) with a diagnosis of minimal brain dysfunction (MBD) were given either the placebo or megavitamin regimen.[14] MBD, an older term for ADHD, was diagnosed when children displayed a combination of symptoms, such as hyperactivity, distractibility, short attention span, incorrigibility, labile explosiveness, incoordination, and perceptual motor problems. Sixteen children were given placebo, while fifteen children were given the vitamin treatment program which was comprised of 2,000 mg vitamin B_3 (as niacin), 2,000 mg vitamin C, 200 mg vitamin B_6, 400 mg vitamin B_5, and 1,000 mg of glutamic acid taken orally in twice daily divided doses. The length of the trial was two weeks. The differences between the placebo and vitamin groups, as determined by several different rating scales, were not statistically significant. The authors recommended against the vitamin approach unless dietary history, specific symptoms, or biochemical findings suggest a specific vitamin deficiency.

When reviewing the data more closely, there were greater improvements in the ratings of children in the vitamin group compared to children in the placebo group. This

suggests that either the patient number was too small for statistical significance, or that the trial duration was insufficient to demonstrate a therapeutic effect. Since Cott observed that 3-6 months of treatment are usually required before benefits can be obtained, the results of this two-week controlled clinical trial should not be used to dismiss the possible benefits that vitamin therapy might confer upon hyperactive children.

Controlled Clinical Trial #2

This six-month trial included 20 youth (ages 7-14), comprising 17 boys and three girls.[15] Even though the diagnoses of the participants were heterogeneous, each one had been diagnosed as hyperactive, or as having MBD, or both. Participants taking psychostimulant medication were withdrawn from their medication at least three months before the controlled clinical trial. Eight boys and two girls were randomly assigned to the vitamin group, whereas nine boys and one girl were assigned to the placebo group. Each participant in the vitamin group received daily dosages (according to weight) of 1,000-3,000 mg of vitamin C, 1,000-3,000 mg of vitamin B_3 (as niacinamide), 200-600 mg of vitamin B_5, and 500-750 mg of vitamin B_6. All participants, regardless of treatment, followed a high-protein, low-carbohydrate, sugar-free diet. On one day during each weekend, participants were allowed a "junk food" day to ensure compliance and manageability for the parents. Most of the participants did not need the "junk food" day after they acclimated to the diet. Numerous rating scales were administered before and following the trial. In addition, urine testing for the Mauve factor (i.e., urinary excretion of kryptopyrrole, a marker for overactive oxidation) was done to see if elevated levels of the Mauve factor predicted a better response from the vitamin treatment. The results demonstrated no significant differences between the vitamin and placebo groups on the rating scales administered before and after the trial. There were also no significant differences in how participants responded to megavitamin treatment even if it was determined at trial entry that they had abnormal Mauve factor test results. Mauve factor testing did not identify participants that might be more "vitamin dependent." No severe side effects were reported in any participant from either group. Three participants in the vitamin group did have some cutaneous reactions to vitamin B_3, while another two participants in the vitamin group had gastrointestinal side effects that did not prevent them from completing the trial. Four participants (three from the vitamin group and one from the placebo group) had an increase in hyperactivity perhaps associated with deficiencies in magnesium and calcium. As a result, these participants received additional supplementation of magnesium and calcium (as dolomite) for the duration of the trial.

A closer examination of the trial data revealed that both groups had significant improvements in their behaviour. For example, the total Behaviour checklist score prior to trial was 79.2±19.5 in the vitamin group and 67.2±19.1 in the placebo group. Following the trial, these scores decreased to a 52.6 ±13.6 and 48.6±9.2 in the vitamin and placebo groups respectively. This might mean that the diet employed, rather than the vitamin or placebo treatments, was responsible for the behavioural gains seen in this trial. Since this trial was not designed to assess the therapeutic effects of dietary control upon behaviour, it cannot be assumed that these results arose from adherence to a healthier diet. The Hawthorne effect, a result of the parents' enthusiasm and high expectations, may have influenced the outcome. Additionally, the fact that each participant was 6 months older and presumably more mature at trial conclusion, could have contributed to the gains seen in both groups.

Controlled Clinical Trial #3

This trial was comprised of 41 children with a diagnosis of attention deficit disorder (ADD).[16] There were 6 girls and 35 boys in the vitamin group, and 39 girls and 36 boys in the control group. The design of this trial was complex, in that, there was a 3-month open clinical period (denoted as "stage 1"),

followed by a double-blind crossover trial (denoted as "stage 2") for children that had a positive therapeutic response during stage 1. All children were administered intelligence and achievement tests, given physical and neurological examinations, and had extensive blood work (at baseline and at the end of stages 1 and 2) assessing nutrient levels and testing elements by blood chemistry analysis (e.g., fasting glucose, creatinine, calcium, phosphorus, and alkaline phosphatase). Behavioural assessments were done throughout the trial. All medications or programmes used to treat ADD were discontinued one week before study entry.

During stage 1, the daily vitamin regimen was gradually increased, depending on tolerability, from 1,000 mg of vitamin B_3 (as niacinamide) and 1,000 mg of vitamin C, 200 mg of vitamin B_6, and 400 mg of vitamin B_5, to 3,000 mg of vitamin B_3 (as niacinamide) and 3,000 mg of vitamin C, 600 mg of vitamin B_6, and 1,200 mg of vitamin B_5. A washout period of six weeks separated stages 1 and 2. Stage 2 was comprised of 4 trial periods, each 6 weeks in duration. During stage 2, the assignment of treatment was done randomly in 2 possible arrangements: (1) drug (vitamin)-placebo-drug-placebo; or (2) placebo-drug-placebo-drug. No specific dietary plan was prescribed or recorded during stages 1 and 2, except that parents were instructed to provide well-balanced and wholesome meals.

Twelve children (29%) showed behavioural improvements during stage 1 and were given the opportunity to participate in stage 2 of the trial. Only seven children participated in stage 2 of the trial. Five of the 12 children did not enter stage 2 due to a variety of somatic complaints resulting from the vitamin regimen, including nausea, anorexia, gagging, and abdominal pain. All seven children in stage 2 of the trial were boys with a mean age of 8.9 years. One child was removed during stage 2 as a result of unacceptable behaviour. The overall results demonstrated that during stage 2 there were no statistically significant differences in the rating scales between the vitamin and placebo treatments. In some cases, teachers and mothers noted declines in behaviour problems (e.g., improved conduct, better learning and less hyperactivity) resulting from the vitamin regimen compared to placebo. No statistically significant differences were found in serum vitamin C or B_6 levels of the treatment or the control participants. During vitamin treatment, seventeen of the 41 participants (42%) had significant elevations of serum transaminase levels that exceeded the upper limits of normal. In some cases these levels required 4-6 weeks to return to baseline values. The investigators of this study concluded that the vitamin approach had no benefits, and was possibly dangerous due to hepatic enzyme abnormalities resulting from quantities of vitamins exceeding recommended dietary allowance ranges.

From my analysis, conclusions different from those of the study investigators can be drawn. In stage 1 of the trial, 12 children (29%) had significant therapeutic responses to the vitamin regimen. The duration of treatment during stage 1 was three months, a sufficient period of time to observe potential therapeutic benefits from the vitamin regimen. Seven children participated in stage 2, but were taken off their vitamin regimen for six weeks, and were then provided either alternating placebo or the vitamin regimen in six week intervals for a total of 24 weeks or six months. The six week intervals might not have been sufficient to observe therapeutic responses from the vitamin regimen, especially since the duration of time given during stage 1 of the trial was 12 weeks. It might have been destabilizing for the vitamin responders to be placed on and then off treatment in six week intervals during stage 2 of the trial. This could have negatively influenced the results. As for the vitamin approach being potentially harmful to the liver, none of the children developed clinical jaundice, hepatomegaly or sustained weight loss during the trial. Increased transaminase levels require clinical vigilance, but are not normally a clinical concern unless the values are markedly elevated in conjunction with relevant patient symptomatology.

Review of Single-Blind Studies

Orthomolecular pioneer Dr. William Kaufman published a report in 1953 describing how therapeutic doses of niacinamide (900-4,000 mg in divided daily doses) alleviated agitated hyperkinesis and depression in elderly patients as long as they remained on the vitamin.[17] None of Kaufman's patients had classic pellagra. To the author's knowledge, Kaufman's report was one of the first to establish a relationship between vitamin B_3 and hyperkinesis.

Single-Blind Trial #1

Almost two decades later, Dr. Abram Hoffer published a single-blind, placebo-controlled trial design that assessed the therapeutic effects of administering niacin or niacinamide to children under 13 years of age exhibiting disturbing behaviour.[18] The diagnoses of these children varied, but they were all ill; some were very disturbed, most had hyperactivity. Thirty-eight children entered the study in 1967, but six could not complete the required three-year study period. All children were given 1,500-6,000 mg of niacinamide, or rarely, niacin, if there was no response to the niacinamide. Each child also took 3,000 mg of ascorbic acid daily, and rarely, very small doses of tranquilizers or antidepressants. After the child recovered, even if it took three months or two years, vitamin B_3 was discontinued and the child continued with an equivalent dose of placebo, along with ascorbic acid and very small doses of tranquilizers or antidepressants (if previously prescribed). Each child was kept on placebo until he/she relapsed, at which point the parents resumed the vitamin B_3 treatment. The vitamin C and drug therapies were unaltered during the entire study period. Of the 32 children in the study, 24 went through the treatment-placebo-treatment cycle. Only Hoffer and the children's' parents were privy to the exact treatment, but the children were blinded. In all 24 cases, the children recovered while taking vitamin B_3, then relapsed within one month of taking placebo, and recovered again when resuming vitamin B_3. Hoffer noted that the recovery from vitamin B_3 was slower following placebo. The remaining eight patients in this study were almost recovered, and had yet to be placed on placebo.

In a later publication, Hoffer reported additional findings from this study.[19] At the conclusion of the trial in 1974, he had a cohort of 37 children to report on. Out of 37 children in total, 19 were normal and six were much improved. Of the remaining 12 children, three were not improved and the results for nine were not known. Thus, 25 out of 37 children (68%) were normal or much improved by the addition of niacinamide or niacin. Hoffer reported that the chief reason for failure was the inability of the child to remain on the vitamins prescribed. These results, according to Hoffer, confirmed a vitamin B_3 dependency syndrome in some children. He concluded that children should be given a therapeutic trial of vitamin B_3 if they exhibit 3 of 4 specific features: (1) hyperactivity; (2) deteriorating school performance; (3) perceptual changes; and/or (4) the inability to acquire or maintain social relationships.

Single-Blind Trial #2

In 1982, Dr. Arnold Brenner reported on his experiences with 100 youth (ages 4-15) given brief therapeutic trials with single doses of specific B-complex vitamins.[20] He hypothesized that subgroups of youth with hyperkinesis might respond to pharmacologic doses of specific B-complex vitamins. The majority of youth had a diagnosis of MBD with hyperkinesis, attention span deficit, distractibility, impulsivity, emotional instability and learning deficits. Six youth with hyperkinesis were also phobic, neurotic, or borderline schizophrenic. The majority of youth were on stimulant medication (i.e., d-amphetamine or methylphenidate), which was discontinued prior to clinical trials with specific B-complex vitamins. Brenner conducted two complex single-blinded controlled trials with these 100 youth. In all cases, the parents and youth were blinded, but not Brenner.

In Trial 1, patients were given four coded envelopes with specific instructions:

(1) 100 mg vitamin B_1 (thiamine) four

times daily for three days; (2) one lactose (placebo) pill given twice daily for three days; (3) 218 mg of vitamin B_5 (calcium pantothenate) twice daily for three days; and (4) 100 mg of vitamin B_6 (pyridoxine) three times daily for three days. In most cases, the tablets were crushed and ingested with applesauce. The interval or time between envelopes was usually one day and not the recommended 3-4 days. If there was no benefit or if an adverse reaction resulted, the treatment was discontinued and then therapeutic trials with other treatments (i.e., other envelopes) were attempted. Once there was a noted benefit from one of the particular treatments, the youth was entered into Trial 2. **Table 1**, below, describes the results from Trial 1.

In Trial 2, youth were maintained for an additional seven day period on the specific treatments (vitamins or placebo) which they responded to in Trial 1. Following this additional seven day period, youth that responded were placed on placebo to assess for relapses, while youth that did not respond were put back on medication and/or received behaviour therapy. If relapses resulted when on placebo, youth were then placed on the specific vitamins they had previously responded to – or placebo if they did not relapse – for long-term treatment with frequent follow-up. The long-term treatment and follow-up extended to four years, and the daily doses of the vitamins or placebo were periodically reduced or discontinued to assess their ongoing therapeutic value. In addition, two-thirds of youth that did not respond in a robust manner during Trial 2 were provided with niacinamide, various B-complex vitamins, minerals, or elimination diets to further assess the value of these treatment combinations. A full response was deemed to be equal to or better than stimulant medication. **Table 2**, (p.123) describes the results from Trial 2.

With respect to side effects, some youth had a worsening of their behaviour when taking specific B vitamins. The administration of pharmacologic doses of one vitamin might have caused depletions of other nutrients, or secondary vitamin refractoriness. For example, the 9 of 16 vitamin B_1 responders worsened when they were given vitamin B_6, while 6 of 10 vitamin B_6 responders worsened when given vitamin B_1. In the initial trials, some youth relapsed for no apparent reason after having had dramatic responses to vitamin B_6. The pharmacological effects of vitamin B_6 led to marked reductions in blood zinc levels. Once zinc was supplemented with the vitamin B_6, the majority of these youth had a return to their previous level of improvement. Another example occurred in two children that initially responded to vitamin B_6. Their blood folate levels were low when they relapsed, but their behaviour improved after folate was added.

Given the heterogeneous nature of the hyperkinetic syndrome, Brenner concluded that some youth with the hyperkinetic syndrome might benefit from a programme of B-complex vitamins. He noted that vitamin responsiveness was likely dependent on such physiological factors as decreased ingestion, intestinal absorption, impaired utilization, increased metabolic requirements, increased

Table 1. Results from Trial 1 – therapeutic responses to specific B vitamins and placebo

Therapeutic agent	**Improved**	Worsened	No Change
Vitamin B_1	26	22	52
Lactose (placebo)	6	19	75
Vitamin B_5	23	9	68
Vitamin B_6	18	16	66
No change with any therapeutic agent	N/A	N/A	38

Table 2. Results from Trial 2 – 7-day trials and long-term follow-up of youths taking specific B vitamins and placebo

Therapeutic agent	Number of patients	Full Responders	Long-term follow-up showing sustained clinical response	Additional information
Vitamin B_1	21	11	8	Four patients were able to discontinue the vitamin after three months of treatment; four patients continued to require the vitamin for more than three years, either continuously or intermittently; and an additional four patients that initially responded to the vitamin became resistant, but their behaviour normalized once they were given 500 mg of niacinamide twice daily
Lactose (placebo)	6	1	1	This patient remained on placebo treatment for three months and discontinued the treatment without relapse
Vitamin B_5	15	4	2	One patient required additions of folic acid and zinc to sustain his clinical response, which was maintained during the four year follow-up period
Vitamin B_6	18	9	9	Six patients required the addition of zinc to maintain their clinical responses; later observations on an additional five patients showed that much higher daily dosages of vitamin B_6 in the range of 500-2,000 mg were necessary to achieve a sufficient clinical response, with some of these patients requiring additional vitamins and minerals

excretion, or degradation of the vitamin. He also noted that some youth required only short-term administration of specific vitamins, which likely meant that treatment corrected a specific deficiency. On the other hand, other youth required long-term administration, which was suggestive of biochemical dependencies.

Discussion

Only one of three controlled trials (i.e., Controlled Clinical Trial #2) raised some doubts as to the merits of a vitamin regimen using several B vitamins and vitamin C for the treatment of childhood hyperactivity. The remaining two controlled trials (i.e., Controlled Clinical Trials 1 and 3) had methodological problems meaning that their conclusions refuting the vitamin approach should be questioned until better designed studies are completed. Hoffer asserted that the double-blind approach is flawed since only the vitamin-dependent children would adequately respond to treatment.[12] Until investigators can prove their groups of youth to be homogenous with respect to etiology, Hoffer argues that double-blind studies evaluating the vitamin approach will yield inconclusive results.

As for the single-blind studies, the results are promising. The pooled data from Brenner's study demonstrated that 20 out of 60 youth (33%) had sustained clinical responses from the long-term use of individual B vitamins, sometimes in combination with other nutrients (i.e., folic acid, niacinamide, and zinc), for up to four years. Hoffer's single-blind results showed an astounding 68% response rate from the long-term use of niacinamide (and rarely niacin) among hyperactive youth when followed for up to seven years.

Using single doses of a specific B vitamin does appear to be a viable option, especially if stimulant medication is to be avoided or if the clinical response from stimulant medication becomes undesirable for a variety of reasons (e.g., weight loss, anorexia, and lack of clinical improvement). Having each patient complete therapeutic trials of one B vitamin at a time seems preferable to using a daily programme consisting of several B vitamins, vitamin C and minerals, since compliance issues would be less likely to result from this approach. I have developed an algorithmic approach based on efficacy (i.e., from the cited data). This approach simplifies treatment when a single nutrient dependency is implicated in a patient's hyperactivity and associated problems (**Table 3,** p.125).

It is appropriate to consider vitamin dependencies in the differential diagnosis of hyperactivity. The 16th edition of The Merck Manual of Diagnosis and Therapy defines a vitamin dependency as that which relates to "coenzyme function and results from an apoenzyme abnormality that can be overcome by administration of doses of the appropriate vitamin that are many times the recommended dietary allowance (RDA)."[21] In the 17th edition of this prestigious medical text, the definition of a vitamin dependency was slightly modified as resulting "from a genetic defect in the metabolism of the vitamin or in the binding of the vitamin-related coenzyme to its apoenzyme."[22] The authors note that to correct the altered metabolic pathway, vitamin doses of 1,000 times the RDA are sometimes necessary.

Thus, a vitamin dependency is only correctable by increasing the intake of a particular vitamin to levels greater than could be achieved from dietary sources alone. This is reasonable since many enzyme systems within the body require optimal doses of vitamins to remedy defects in the synthesis of vital metabolic products to sustain adequate health. In Pauling's famous 1968 publication, he reasoned that: "…mental disease is for the most part caused by abnormal reaction rates, as determined by genetic constitution and diet, and by abnormal molecular concentrations of essential substances."[23] He described how vitamin therapy would be necessary for the optimal treatment of mental disease since the saturating capacity would be much greater for defective enzymes that have diminished combining capacity for their respective substrates. In other words, an enzyme-catalyzed reaction could be corrected by increasing the concentration of its substrate through the use of optimal doses of vital micronutrients.

A 2002 report validated the concept of vitamin dependencies for the treatment of 50 common genetic diseases. In this report, the need for doses of vitamins far in excess of RDA amounts (i.e., optimal doses) were deemed necessary as a means of increasing coenzyme concentrations and correcting defective enzymatic activity.[24] The authors

Table 3. An algorithmic approach using single B vitamins to treat patients with hyperactivity and associated problems

Treatment	Daily Dose	Duration	Clinical response
1. Niacinamide	1,500 mg, increasing to 3,000 mg (with comparable amounts of vitamin C)	12 weeks	If sufficient, patient to remain on treatment with regular monitoring (i.e., transaminases); If insufficient, proceed to 2
2. Vitamin B_6	300 mg (consider adding 2 mg folic acid and 50 mg elemental zinc)	12 weeks	If sufficient, patient to remain on treatment with regular monitoring; If insufficient, proceed to 3
3. Vitamin B_6	Increase dose to 1,000 mg	12 weeks	If sufficient, patient to remain on treatment with regular monitoring (i.e., peripheral neuropathy and central nervous system toxicity); If insufficient, proceed to 4
4. Vitamin B_1	400 mg	12 weeks	If sufficient, patient to remain on treatment with regular monitoring (i.e., urticaria or other dermatoses); If insufficient, proceed to 5
5. Vitamin B_5	500 mg	12 weeks	If sufficient, patient to remain on treatment with regular monitoring; If insufficient, reassess patient and provide other treatments

stated that the "examples discussed here are likely to represent only a small fraction of the total number of defective enzymes that would be responsive to therapeutic vitamins." In light of the evidence, it is common for the "orthomolecularly-inclined" clinician to consider vitamin dependencies when proposing various differential diagnoses in the evaluation of their hyperactive patients.

The reader should not consider the vitamin approach presented here to be synonymous with orthomolecular medicine. Orthomolecular medicine goes beyond simply prescribing doses of nutrients in excess of recommended dietary allowance ranges. Orthomolecular medicine involves a careful history, laboratory and other investigative studies, "illuminating one's unique biochemistry and nutrient therapies based on the right proportion," and determining optimal concentrations "by testing, titrating, retesting, adjusting and above all listening to the patient."[25] The prudent orthomolecular clinician, as advocated by Hoffer, should develop a treatment plan based on the presence or absence of nutrient deficiencies, dependencies, and excesses (i.e., sucrose and other sugars, food allergies, and mineral excesses, such as copper and lead).[26] While it would be preferable to treat hyperactive children and youth with the complete orthomolecular approach, I have found it too cumbersome and onerous for the majority of parents and their children to follow, especially when numerous daily interventions are prescribed. As a result, I began to use this specific vitamin approach, and

will report on my findings in future issues of this journal.

Conclusion

Due to methodologically-flawed studies, the results of double-blind studies cannot be used to endorse or dismiss the vitamin approach for the treatment of hyperactivity. The results of single-blind studies are promising. These studies provide evidence that vitamin doses of single B vitamins can ameliorate hyperactivity in vitamin-dependent children and youth. While the vitamin approach is not synonymous with all the procedures involved with orthomolecular medicine, this method of treatment might assist struggling patients and their families when stimulant medication is to be avoided or if the adverse effects of stimulant medication become intolerable.

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Competing Interests

The author declares that he has no competing interests.

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