

An Investigation of Hypomagnesemia Among Ambulatory Urban African Americans

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BACKGROUND. Magnesium represents the fourth most abundant cation in the body and plays an integral role in intracellular metabolism. Although magnesium deficiency states have been associated with a variety of medical conditions, the prevalence of hypomagnesemia has not been well studied, particularly in ambulatory settings.

METHODS. We performed a period prevalence study using 120 patients seen for routine medical care at an urban family medicine center. Chart reviews were completed for these subjects. We used univariate and multivariate analyses to correlate magnesium levels with demographic and clinical factors.

RESULTS. There was a 20% overall prevalence of hypomagnesemia among this predominantly female, African American population. The prevalence of hypomagnesemia was greatest among patients with a history of alcoholism (odds ratio [OR] = 6.00; 95% confidence interval [CI], 1.41 - 26.1) and among those having 1 or more of the following medical conditions: diabetes, hyperlipidemia, hypertension, renal disease, and asthma (OR = 4.69; 95% CI, 1.37 - 17.65).

CONCLUSIONS. The prevalence of hypomagnesemia among patients from this urban minority community exceeds that reported in previous studies of the general population. This may be reflective of greater comorbidity, diminished nutritional status, or poorer overall health among patients from this community. The association between hyperlipidemia and magnesium deficiency warrants further investigation.

KEY WORDS. Magnesium; magnesium deficiency; biological markers; comorbidity. (*J Fam Pract* 1999; 48:636-639)

Magnesium represents the fourth most abundant cation in the body and plays an integral role in more than 300 enzyme systems, including adenosine triphosphate metabolism.¹ Magnesium deficiency has been reported to result in neuromuscular manifestations, psychiatric problems, derangements in calcium or potassium flux, and cardiac arrhythmias.²

The Atherosclerosis Risk in Communities study, a large epidemiologic study with more than 15,000 subjects observed for more than 5 years, reported that participants with hypertension, diabetes, or cardiovascular diseases had lower mean serum magnesium levels than patients who did not have these diseases.³ This study also demonstrated that serum magnesium levels and dietary magnesium intake were lower for black patients than for whites.³ Clinical conditions reported among patients with hypomagnesemia included alcoholism (24%), diabetes (38%), diuretic use for hypertension (7%), and chronic renal failure (7%).³ A variety of clinical disease states have been reported to be associated with magnesium deficiency, including hypertension, diabetes, hyperlipidemia, angina, acute myocardial infarction, congestive heart failure, hypokalemia, hypocalcemia, alcoholism, and diuretic therapy.³

In addition to the general population-based epidemiological evidence, several studies have reported a high prevalence of hypomagnesemia among varied patient populations. The prevalence of hypomagnesemia has varied widely in previous studies (Table 1). The prevalence of low magnesium levels has been reported as 2.5% of a group of hospital employees and blood donors,⁴ 6.9% of inpatients at a veterans' hospital,⁵ and 25% of outpatients with diabetes.⁶ Acute physiologic stress also seems to represent an important factor, as 65% of postoperative intensive care unit patients were found to be magnesium deficient.⁷ Together, these studies suggest potentially unrecognized magnesium deficiency among selected patient subgroups.

On the basis of our review of the literature on magnesium deficiency, we designed a prevalence study of patients from an urban, predominantly minority community in New York State. Our goals were to (1) determine the extent of undiagnosed hypomagnesemia among these patients and (2) examine whether low magnesium levels were related to hypertension, diabetes, or other chronic medical conditions.

METHODS

DESIGN AND SETTING

Our prevalence study took place in a family medicine center located in an urban area in April and May of 1995. The family medicine center serves as a community-based ambu-

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TABLE 1

Prevalence Studies of Magnesium Deficiency

| Author(s) | Population Characteristics | Definition of Magnesium Deficiency (mg/dL) | % Deficient |
|--------------------------------------|--|--|-------------|
| Wong et al, 1983 ^a | 621 inpatients 341 hospital employees and blood bank volunteers | <1.2 | 11 |
| Whang et al, 1980 ^b | 2300 inpatients at veterans' hospitals | <1.25 | 6.9 |
| Mather, 1979 ^c | 582 outpatient diabetics | <1.58 | 25 |
| Jackson and Meier, 1968 ^d | 5100 inpatients at community hospitals | <1.53 | 10.2 |

latory clinic operated by a consortium of tertiary-care hospitals and is also part of a university-based resident training program.

PATIENT POPULATION

The study sample was developed through the consecutive enrollment of 120 nonpregnant patients aged 18 years and older who required routine blood work for purposes other than our study. All subjects sought ambulatory care at the family medicine center during the designated 2-month period. Use of dietary magnesium supplementation was not permitted.

DATA ACQUISITION

Using the standardized ambulatory protocol, all patients were triaged on arrival and had routine vital signs taken, and a physician took a history and performed a physical examination. If it was determined that it was necessary to draw blood, informed consent was obtained to permit collection of 1 additional vial of blood to determine serum magnesium levels. Medical charts were also reviewed to abstract information on subject demographics (eg, age, sex, and race) and comorbid medical conditions. In particular, conditions noted to be common in low magnesium states were recorded, including hypertension, diabetes, cardiovascular disease, renal disease, hyperlipidemia, and asthma, as well as any other active medical problem. Use of diuretics, which has been reported to lower serum magnesium, was noted. Social habits (eg, use of alcohol, drugs, and tobacco) were also recorded.

The standard for hypomagnesemia at the hospital reference laboratory where the specimens were analyzed was a serum magnesium level of 1.5 mg/dL. This level represents a value 2 standard deviations below the mean value among 1000 Red Cross volunteer donors. Levels less than and equal to 1.5 mg/dL were defined as demonstrating hypomagnesemia. Using this criterion, we split the subjects in our study into hypomagnesemic (eg, serum mag-

nesium ≤ 1.5 mg/dL) and normal (eg, serum magnesium > 1.5 mg/dL) groups.

DATA ANALYSES

Descriptive data analysis was performed to explore the prevalence of hypomagnesemia and the relationship between the dependent variable (serum magnesium levels) and various independent variables (demographics, clinical status). Odds ratios and 95% confidence intervals were used to assess the likelihood of hypomagnesemia with selected independent variables. In addition, SAS software⁹ was used to construct hierarchical logistic models to predict hypomagnesemia. Demographics and health behavior indicators entered the model first.

Indicators of hypertension and diabetes were subsequently added to the analysis, thus capturing the potential contribution of comorbidity to serum magnesium levels. A dichotomous measure of hypertensive and diabetic comorbidity was used.

RESULTS

A total of 120 patients was enrolled. Before the analyses, 1 patient was eliminated from the study after it was determined that the patient's medical regimen included magnesium supplements. This yielded a total of 119 patients for analysis. Demographic breakdowns revealed majorities of women ($n = 84$, 71%) and blacks ($n = 105$, 87%). Most subjects were older than 40 years ($n = 75$, 63%). A majority reported having medical insurance through Medicaid or Medicare ($n = 85$, 71%). Among these subjects, 59 had previously had a diagnosis of either hypertension ($n = 47$; 39%) or diabetes ($n = 38$, 32%).

The overall prevalence of hypomagnesemia was 20% ($n = 24$). Table 2 summarizes univariate analyses for selected demographic and medical characteristics. We did not find magnesium status to be related to age, sex, race, hyperlipidemia, diabetes, hypertension, renal disease, or smoking status. Hypomagnesemia was increased 6-fold among subjects with a history of alcoholism (odds ratio [OR] = 6.0; 95% confidence interval [CI], 1.41 - 6.91). Hypomagnesemia was also increased among subjects with 1 or more comorbid medical conditions, including hypertension, diabetes, alcoholism, renal disease, and reactive airways disease (OR = 4.69; 95% CI, 1.37 - 17.65).

A logistic model was constructed that included terms for sex, age, race, alcoholism, diabetes, and hypertension; however, the only significant term was alcoholism (OR = 7.8; 95% CI, 1.82 - 33.6). The final model explained 19% of the variance in serum magnesium levels.

TABLE 2

Univariate Analysis of Demographic and Medical Characteristics

| Characteristic | Serum Magnesium Level (mg/dL) | | OR (95% CI) |
|---------------------------------|----------------------------------|------|---------------------|
| | ≤1.5 | >1.5 | |
| Age, years | | | |
| ≤40 | 12 | 32 | 1.97 (0.73 - 5.35) |
| >40 | 12 | 63 | |
| Sex | | | |
| Men | 5 | 30 | 0.57 (0.17 - 1.83) |
| Women | 19 | 65 | |
| Race | | | |
| African American | 22 | 82 | 1.74 (0.33 - 35.5) |
| Other | 2 | 13 | |
| Hypertension | | | |
| Yes | 11 | 36 | 1.39 (0.51 - 3.75) |
| No | 13 | 59 | |
| Diabetes | | | |
| Yes | 10 | 28 | 1.71 (0.61 - 4.72) |
| No | 14 | 67 | |
| Alcoholism | | | |
| Yes | 6 | 5 | 6.00 (1.41 - 26.1) |
| No | 18 | 90 | |
| Renal disease | | | |
| Yes | 2 | 3 | 2.79 (0.80 - 22.41) |
| No | 22 | 92 | |
| Reactive airways disease | | | |
| Yes | 3 | 7 | 1.79 (0.10 - 8.71) |
| No | 21 | 88 | |
| Chronic medical problem | | | |
| Any* | 20 | 49 | 4.69 (1.37 - 17.65) |
| None | 46 | | |
| Hyperlipidemia | | | |
| Yes | 14 | 34 | 2.51 (0.92 - 6.91) |
| No | 10 | 61 | |
| Smoking | | | |
| Yes | 10 | 33 | 1.34 (0.49 - 3.67) |
| No | 14 | 62 | |

Note: Analysis by serum magnesium level, among study subjects (n = 119) presenting to an urban family medical center.

*Includes hypertension, diabetes, alcoholism, renal disease, and reactive airways disease.

OR denotes odds ratio; CI, confidence interval.

DISCUSSION

Previous studies of serum magnesium have focused nearly exclusively on inpatient populations. Although this

approach simplified collection of serum specimens for analyses, it overlooked examination of the magnesium status for the majority of patients who are typically seen as outpatients. Our study was unique in undertaking an examination of serum magnesium level in an ambulatory setting. Results from this study are consistent with prevalence rates noted by Mather and colleagues,⁶ who reported hypomagnesemia among 25% of patients with diabetes.

Although these findings should be considered suggestive and certainly worthy of further investigation, the observation of an overall 20% prevalence of hypomagnesemia among clinically stable outpatients was unanticipated. The prevalence of low magnesium levels noted in this study of ambulatory patients may have important clinical implications. It is possible that magnesium supplementation may improve clinical status among these patients with hypomagnesemia. It is uncertain whether low magnesium levels are reflective of poor overall health status among these subjects, or result from chronic diseases, poor nutritional status, a combination of these factors, or from other factors.

It is known that low magnesium results in a variety of nonspecific clinical manifestations. Unfortunately, there is no distinct constellation of features associated with a low magnesium state, and for this reason low magnesium levels are not clinically obvious. It is likely that complex interrelationships exist among various clinical and temporal factors that relate to magnesium homeostasis.

LIMITATIONS

Since this represented an exploratory study of 120 patients, statistical power is limited, as evidenced by broad confidence intervals for calculated odds ratios. Although several of the results in this study fail to achieve statistical significance, they may have clinical relevance. Two major nutritional and epidemiologic studies have shown decreased magnesium intake

among African Americans.^{3,10} Moreover, numerous smaller studies of magnesium supplementation report significant improvements in blood pressure measurements.¹¹⁻¹⁶ The American Diabetes Association has issued a consensus statement recommending that magnesium be replaced if patients with diabetes are proved to have low levels of serum magnesium.¹⁷

CONCLUSIONS

Although these findings should be confirmed in other ambulatory settings, it is possible that low serum magnesium levels may be contributing to the exacerbation of other clinical conditions. Results from this study suggest that ambulatory patients, particularly those with coexistent chronic disease, may also have an increased risk of hypomagnesemia. As a result, a high index of suspicion for hypomagnesemia is encouraged in all clinical settings.

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