INTRODUCTION

Vitamins are essential micronutrients for maintenance of tissue functions. Vitamin deficiency is one of the most serious and common health problems among both chronic alcoholics and the homeless. However, the vitamin-level statuses of such people have been little studied. We evaluated the actual vitamin statuses of alcoholic homeless patients who visited an emergency department (ED). In this study the blood levels of vitamins B1, B12, B6, and C of 217 alcoholic homeless patients were evaluated retrospectively in a single urban teaching hospital ED. Vitamin C deficiency was observed in 84.3% of the patients. The vitamin B1, B12, and B6 deficiency rates, respectively, were 2.3%, 2.3%, and 23.5%, respectively. Comparing the admitted patients with those who were discharged, only the vitamin C level was lower. \( P = 0.003 \) In fact, the patients’ vitamin C levels were markedly diminished, vitamin C replacement therapy for homeless patients should be considered in EDs.

**Keywords:** Vitamin B Complex; Ascorbic Acid Deficiency; Homeless Persons; Alcoholics

MATERIALS AND METHODS

**Study design**

This study was a retrospective chart review conducted at a single academic teaching hospital with 53,000 annual ED visits.

**Study subjects**

All of the patients were treated by trained triage nurses according to the emergency severity index (ESI) (12). All of the ESI levels 1 or 2 patients, including level 1 and 2 homeless patients, were moved either to the resuscitation area or the acute care monitoring area, as individual circumstances dictated. Meanwhile, all of the homeless patients excepting those of level 1 or 2 were moved to a special observation area allocated for the homeless. The initial evaluation and stabilization were conducted there. The attending emergency physician ordered vitamin levels if patients were alcohol-intoxicated and needed intravenous fluid hydration, or basic laboratory tests. These were the patients deemed eligible for analysis. All samples were drawn prior to administration of intravenous fluids or medications. After the initial evaluation and stabilization, individual dispositions were determined based on clinical conditions. Patients were permitted to stay several days in the ED if they desired, providing that they did not have any specific diseases.

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Measurement

Vitamin B1, B6, and C levels were assessed by subjecting blood samples to high performance liquid chromatography (HPLC) (Perkin-Elmer Series 200, PerkinElmer, Inc., Waltham, Massachusetts, US). The vitamin B12 levels were determined by electrochemiluminescence immunoassay (Roche E170, Roche Diagnostics, Basel, Switzerland). Because the maximal vitamin B12 measurable limit at our center is 1,800 pg/mL, values over 1,800 pg/mL were regarded as 1,800 pg/mL for the purposes of the analysis.

In our hospital laboratory, Vitamin B1 levels of 59 to 213 nM/L, B6 levels of 20 to 202 nM/L, and C levels of 26.1 to 84.6 nM/L were considered normal.

Statistical analysis

The Shapiro-Wilk test was used to evaluate the normality of the continuous variables. Because none of the continuous variables were normally distributed, the Wilcoxon-Mann-Whitney test was used. Data are presented as median and interquartile range. For the categorical variables, chi square test or Fisher exact test was used as appropriate. All of the analyses were performed with R, version 3.0.2 (R Foundation for Statistical Computing, Vienna, Austria). A P value of 0.05 or less was considered to indicate statistical significance.

Ethics statement

This study was approved by the institutional review board of Seoul Metropolitan Government-Seoul National University Hospital Boramae Medical Center (IRB No. 20131206/26-2013-128/122). Informed consent was waived by the board.

RESULTS

Vitamin levels were examined in 217 patients during the study period. The patients’ mean age was 51 yr, and 8.8% had some form of infection. One hundred and seventy-three patients (79.7%) were discharged, 25 (11.5%) were admitted, 5 (2.3%) were transferred to a lower-tier hospital, 13 (6%) disappeared, and one (1%) died (Table 1).

With regard to vitamin C, 84.3% of the patients had blood levels below the reference range. As for vitamins B1, B12, and B6, 2.3%, 2.3%, and 23.5% of patients, respectively, had blood levels below the reference range. No patient showed a vitamin C level above the reference range (Tables 1 and 2, Fig. 1).

The vitamin C levels of the admitted patients (including those transferred) were all lower than those of the discharged and lost patients (13.25 [3.9-22.2] μM/L vs. 7.7 [1.8-11.1] μM/L, P = 0.003). None of the other vitamin levels were significantly different between the admitted and discharged patients (Fig. 2).

Information about smoking status was available for 112 (51.6%) patients, 90 (80.4%) were smokers and 22 (19.6%) were non-smokers. The differences in the vitamin B1, B12, and C levels were all lower than those of the discharged and lost patients (26.1 [8.8-35.9] μM/L vs. 18.3 [6.4-31.7] μM/L, P = 0.001). The differences in the vitamin B1, B12, and B6 levels were not significant between smokers and non-smokers.

Table 1. Basal characteristics, laboratory test results and dispositions of patients

| Variables                      | No. (%) of patients (n = 217) |
|--------------------------------|--------------------------------|
| Age, median (IQR, yr)          | 51 (44-56)                     |
| Male                           | 208 (95.9)                     |
| Combined conditions            |                                |
| Liver cirrhosis                | 20 (9.2)                       |
| Diabetes mellitus              | 17 (7.8)                       |
| Any kind of infection          | 19 (8.8)                       |
| Pneumonia                      | 7 (3.2)                        |
| Soft tissue infection          | 5 (2.3)                        |
| Pulmonary tuberculosis         | 4 (1.8)                        |
| Tuberculosis peritonitis       | 1 (0.5)                        |
| Biliary infection              | 1 (0.5)                        |
| Infective spondylitis          | 1 (0.5)                        |
| Acute appendicitis             | 1 (0.5)                        |
| Pancreatitis                   | 3 (1.4)                        |
| Laceration                     | 22 (10.1)                      |
| Fracture                       | 3 (1.4)                        |
| Contusion                      | 17 (7.8)                       |
| Traumatic brain hemorrhage     | 3 (1.4)                        |
| Disposition                    |                                |
| ER discharge                   | 173 (79.7)                     |
| Ward admission                 | 25 (11.5)                      |
| Transfer                       | 5 (2.3)                        |
| Disappear                      | 13 (6)                         |
| ER death                       | 1 (0.5)                        |
| Laboratory results             |                                |
| WBC, median (IQR, /μL)         | 6,560 (5,240-9,040)            |
| Hemoglobin, median (IQR, g/dL) | 14 (12.4-15.3)                 |
| Platelet, median (IQR, × 10^3/μL) | 224 (151-284)             |
| Sodium, median (IQR, mEq/L)    | 140.5 (137.8-143.4)            |
| Potassium, median (IQR, mEq/L) | 3.8 (3.5-3.8)                  |
| Chloride, median (IQR, mEq/L)  | 102.4 (98.1-106.1)             |
| Blood urea nitrogen, median (IQR, mg/dL) | 12 (9-16) |
| Creatinine, median (IQR, mg/dL) | 0.71 (0.62-0.82)              |
| AST, median (IQR, IU/L)        | 53 (31-114)                    |
| ALT, median (IQR, IU/L)        | 24 (16-47)                     |
| Total bilirubin, median (IQR, mg/dL) | 0.9 (0.6-1.5)          |
| CK, median (IQR, IU/L)         | 196 (128-394)                  |
| Ethanol, median (IQR, mg/dL)   | 253 (126-330)                  |
| Osmolarity, median (IQR, mosm/kg) | 358 (311.5-383.0)          |
| Vitamin B1, median (IQR, μM/L) | 145.8 (108.5-197.7)            |
| Vitamin B12, median (IQR, pg/mL) | 617 (458-918)                |
| Vitamin B6, median (IQR, μM/L) | 34.2 (20.5-65.45)             |
| Vitamin C, median (IQR, μM/L)  | 11.60 (6.35-21.55)             |

Data are expressed as No. (%) or median (IQR) as appropriate. ER, emergency room; WBC, white blood cells; AST, aspartate aminotransferase; ALT, alanine aminotransferase; CK, creatine kinase.

Table 2. Status of blood vitamin levels

| Vitamin    | Reference range | No. (%) of cases by blood level |
|------------|-----------------|--------------------------------|
|            |                 | Low (200-950 ng/L) | Normal* (200-950 ng/L) | High (200-950 ng/L) |
| Vitamin B1 | 59-213          | 5 (2.3)            | 174 (80.2)              | 38 (17.5)           |
| Vitamin B12| 200-950         | 5 (2.3)            | 162 (74.7)              | 50 (23)             |
| Vitamin B6 | 20-202          | 51 (23.5)          | 162 (74.7)              | 4 (1.8)             |
| Vitamin C  | 26.1-84.6       | 183 (84.3)         | 34 (15.7)               | 0 (0)               |

*In reference range.
els between the smokers and nonsmokers were not significant (Table 3).

**DISCUSSION**

Micronutrient deficiency is common in cases of chronic disease. The homeless are exposed to many chronic ailments and infirmities, and their access to medical services is limited. A common nutrition source for homeless people, moreover, is alcohol, and indeed, in cases where alcohol is seriously abused, many kinds of vitamin deficiencies are to be expected (6,8,9,11,13).

Thiamine, the lack of which causes Wernicke’s encephalopathy, is believed to be insufficient in alcoholics, as are many other vitamins. However, Li et al. (10) reported no cases of thiamine or folate deficiency among 75 acutely alcohol-intoxicated patients in an ED. They concluded that routine supplemental intravenous vitamin complex doses are not required for acute-alcohol-intoxicated patients.

Malmauret et al. (9) evaluated the vitamin levels of homeless individuals in four CHUSI units (emergency homeless shelters). High alcohol consumption and vitamin C deficiency both were very common (95%). The rates of vitamin A, B1, B6, B12, and E deficiency were 43.6, 5.6, 5.6, 14.1, and 19.7%, respectively.

In our study, four vitamin levels were evaluated. Vitamin C deficiencies were very common (84.3%), and no patient showed an excessive blood level. Vitamin B1 or B12 deficiency, by contrast, was not common; in fact, 17.5% of the vitamin B1 and 23% of the vitamin B12 levels were higher than the respective reference ranges. These findings, which can be summarized as a low incidence of vitamin B complex deficiency and a high incidence of vitamin C deficiency, respectively, match those of previous studies (9,10). Also in our study, the vitamin B1, B12, and B6 overexposure rate were 17.5%, 1.8%, and 23%, respectively, markedly lower than those of the French study (in which vitamins B1, B12, and B6 overexposure were found in 35.2%, 50.7%, and 42.2% of patients, respectively) (Table 2, Fig. 1) (9). Our
study population was comprised of homeless patients of a tertiary hospital ED and some of whom had acute medical conditions such as acute infection (8.8%), acute appendicitis (0.5%), pancreatitis (1.4%) and trauma (20.7%) (Table 1). These acute conditions are risk factors for exhaustion of the human vitamin reservoir (14-16).

Among the four vitamins at issue, only the vitamin C levels were related to the admission rate. They were lower in the admitted patients, and the difference was statistically significant. Furthermore, 102 patients (47%) had a blood vitamin C level below 11 μM/L, which is suggestive of scurvy (17,18). Several studies conducted in developed countries have reported both vitamin C deficiency and scurvy (17-19). Skin rash, poor dentation, chronic gingivitis, general myalgia, anemia, arthralgia, and peripheral neuropathy are suggestive symptoms of scurvy and as well as common findings among homeless patients. Moreover, vitamin C deficiency can aggravate symptoms of alcoholic liver disease such as bleeding, jaundice and malaise. It would be expected that many cases of subclinical scurvy among the alcoholic homeless are overlooked (4,17-19).

In our study in fact, the admitted patients’ lower vitamin C levels relative to those of the discharged patients suggested that acutely alcohol-intoxicated homeless patients requiring medical attention and admission to a hospital have lower vitamin C levels. For such patients, vitamin C supplementation should be considered.

Nonetheless, it is difficult to explain exactly why vitamin C deficiency is common among the homeless. What it is well known is that alcohol ingestion inhibits vitamin C absorption, and alcohol metabolism, in turn, consumes the body’s reserves. Insufficient intake of vitamin C among the homeless also has been reported (8,13).

Several studies on smokers have reported deficiencies of several vitamins. More specifically, for example, an inverse relationship between tobacco exposure and plasma vitamin C level has been demonstrated, as have some independent effects of smoking on decreased plasma levels of vitamin C (20-23). In our present results, there were no definite differences in the blood vitamin levels between the smokers and nonsmokers (Table 3). Among the patients whose smoking information was available (n = 112), most (n = 90, 80.4%) were smokers; and, as
other factors such as alcohol ingestion, malnutrition, and other relevant medical conditions were expected to influence the blood vitamin levels, it seems that the effect of smoking was masked.

Thiamine and other vitamin B deficiencies, relative to the case of vitamin C, are uncommon (9-11). The mechanism of thiamine’s conservation in homeless patients is uncertain. Possibly, due to serious concerns for prevention of Wernicke’s encephalopathy in the treatment of alcohol-intoxicated patients, the present subjects had been administered thiamin supplementation on a previous ED visit (10,24). Indeed, for decades now, social support programs such as include homeless shelters or nutritional support have been launched, and these might help to correct the nutritional imbalances typically suffered by homeless patients (25).

High vitamin B12 levels in the blood were relatively common among our patients (23%) (Table 2, Fig. 1). The median levels of the admitted tended to be higher than those of the non-admitted patients (871.0 [434.5-1,319.0] pg/mL vs. 600.5 [465-856.5] pg/mL), though the differences were not statically significant ($P = 0.053$). High vitamin B12 levels also were more common among the admitted ($n = 14, 45.2\%$) than the non-admitted patients ($n = 36, 19.4\%, P = 0.04$). Patients with liver cirrhosis showed higher vitamin B12 levels as well (1,179 [659-1,170] pg/mL vs. 713 [438.0-859.2] pg/mL, $P < 0.001$) (Fig. 3). Some reports have indicated that high vitamin B12 levels are common in critically ill patients and are correlated with renal failure, malignancy, hematologic disease, infection, chronic liver diseases, and alcohol consumption (26-29). The exact mechanism of such increased blood levels is not certain, though a high vitamin B12 level can actually be a sign of functional vitamin B12 deficiency (26,27).

There are some limitations to this study. First, clinical vitamin deficiency can be present even though the blood level is within the normal reference range. In fact, several studies have shown that there can be clinical symptoms of vitamin deficiency despite normal blood vitamin levels (30). However, in the present results, 17.5% of the vitamin B1 and 23% of the vitamin B12 levels were higher than the reference ranges. Vitamin supplementation for such patients should be reconsidered. Second, this
The authors have no potential conflicts of interest to disclose.

AUTHOR CONTRIBUTION
Conception and design: Lee HJ, Shin J. Acquisition of data: Lee HJ, Hong K, Jung IH. Analysis and interpretation of data: Lee HJ, Shin J. Writing of the initial manuscript: Lee HJ. Revision and critical review of the manuscript: Lee HJ, Shin J, Hong K, Jung IH. Agreement with conclusions and final manuscript: all authors.

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