Impact of Trace Elements and Vitamin Supplementation on Immunity and Infections in Institutionalized Elderly Patients

A Randomized Controlled Trial

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Background: Antioxidant supplementation is thought to improve immunity and thereby reduce infectious morbidity. However, few large trials in elderly people have been conducted that include end points for clinical variables.

Objective: To determine the effects of long-term daily supplementation with trace elements (zinc sulfate and selenium sulfide) or vitamins (beta carotene, ascorbic acid, and vitamin E) on immunity and the incidence of infections in institutionalized elderly people.

Methods: This randomized, double-blind, placebo-controlled intervention study included 725 institutionalized elderly patients (>65 years) from 25 geriatric centers in France. Patients received an oral daily supplement of nutritional doses of trace elements (zinc and selenium sulfide) or vitamins (beta carotene, ascorbic acid, and vitamin E) or a placebo within a 2 × 2 factorial design for 2 years.

Main Outcome Measures: Delayed-type hypersensitivity skin response, humoral response to influenza vaccine, and infectious morbidity and mortality.

Results: Correction of specific nutrient deficiencies was observed after 6 months of supplementation and was maintained for the first year, during which there was no effect of any treatment on delayed-type hypersensitivity skin response. Antibody titers after influenza vaccine were higher in groups that received trace elements alone or associated with vitamins, whereas the vitamin group had significantly lower antibody titers (P<.05). The number of patients without respiratory tract infections during the study was higher in groups that received trace elements (P = .06). Supplementation with neither trace elements nor vitamins significantly reduced the incidence of urogenital infections. Survival analysis for the 2 years did not show any differences between the 4 groups.

Conclusions: Low-dose supplementation of zinc and selenium provides significant improvement in elderly patients by increasing the humoral response after vaccination and could have considerable public health importance by reducing morbidity from respiratory tract infections.

Arch Intern Med. 1999;159:748-754

It is well known that aging is often associated with a poor immune response, particularly the cell-mediated response,1 and substantial vulnerability to respiratory tract infections. The latter are significant causes of morbidity and mortality in the elderly, particularly those with chronic diseases.2

Nutritional status has been recognized as a strong factor in immune impairment, especially in elderly persons in institutions.3 Moreover, there is a high incidence of malnutrition among long-term nursing home residents because of inadequate intake of several nutrients,4 which increases impairment of natural immunity.

It has been shown that in this population, supplementation with different nutrients enhances immune status, such as the delayed-type hypersensitivity skin response,5 the proliferative response to mitogens,6 and natural killer cells,7 and the antibody response to vaccine.8,9 Nevertheless, in a few studies,10-13 immunologic responses were found to be impaired with large quantities of nutrients. In addition, results of a recent study14 demonstrate an improvement in immunity and a decrease in the incidence of infections after supplementation with low doses of micronutrients.

This trial was performed within a large multicentric study to determine the effects of long-term daily supplementation with trace elements (zinc and selenium sulfide) or vitamins (beta carotene, ascorbic acid, and vitamin E) on immunity and the incidence of infections in institutionalized elderly people.
PATIENTS AND METHODS

PATIENTS

A total of 725 long-term institutionalized elderly patients (185 men and 540 women) with a mean age of 83.9 years (age range, 65-103 years) were recruited in 25 nursing homes throughout France between April 1992 and April 1993 (Figure 1). A medical history was obtained for each patient before enrollment. They had no acute illness and were at least 65 years of age but often required long-term care because of age-related diseases (osteoarthritis, hypertension, residual stroke, etc.). Patients with a history of cancer or those taking medication that might interfere with nutritional status, immunocompetence, or vitamin or mineral supplements were excluded.

Written informed consent was obtained from patients before participation. The research protocol was approved by the ethics committee of Cochin Hospital, Paris, France.

PROTOCOL

The study had a double-blind, placebo-controlled, 2 × 2 factorial design. Elderly patients were stratified by sex and age and randomly assigned to 1 of 4 treatment groups using block randomization in each geriatric center. Patients received 1 capsule daily, with their breakfast, for 2 years. The capsule contained 1 of the 4 following preparations: (1) zinc sulfate (providing 20 mg of zinc and 100 µg of selenium)—the trace element (T) group; (2) ascorbic acid (120 mg), beta carotene (6 mg = 1000 retinol equivalents), and alpha-tocopherol (15 mg)—the vitamin (V) group; (3) trace element and vitamin supplements—the vitamin and trace element (VT) group; or (4) placebo (calcium phosphate and microcrystalline cellulose)—the placebo (P) group.

Supplements and placebo were provided in capsules of identical aspect and were prepared specifically for this study (Produits Roche SA, Fontenay-aux-Roses, France). The capsules were given to the geriatric centers in individual pill boxes every 6 months.

Levels of nutrients used in this study were nutritional doses, lower than or equal to 2-fold the French and US recommended daily allowances.

Compliance was verified first by the nursing teams that administered the pills every morning and then at the end of each 6 months by counting the remaining capsules in the pill boxes. Another way of assessing compliance was to examine the course of blood micronutrient concentrations.

Twenty-five milliliters of whole blood was withdrawn from each fasting patient by venipuncture between 7:00 and 8:00 AM at study inclusion and after 6 and 12 months of supplementation for the whole population for blood nutrient determinations. In 4 centers (135 patients), another blood sample was taken at the end of the trial.

BIOCHEMICAL MEASUREMENTS

Biological factor determinations have been described in detail elsewhere. Low levels of nutrients were defined according to results from the literature.

Continued on next page

RESULTS

Baseline demographic, clinical, and biological characteristics of all patients are presented in Table 1 and Table 2. The 4 groups were similar in terms of medical history, age, body mass index (BMI or Quetelet index)—calculated as weight in kilograms divided by the square of the height in meters: weight (kg)/[height (m)]²—and vitamin and trace element baseline serum levels. Prevalence of the main diseases (coronary heart disease, high blood pressure, and bronchitis) was similar in all groups.

NUTRIENT DEFICIENCY

At baseline, the prevalence of nutrient deficiency—expressed as the proportion of patients with values below the deficient cutoff value—did not differ between the 4 groups. However, after 6 months of supplementation, a significant increase in serum nutrient values was observed in the respective treated groups, and the number of deficient patients was significantly reduced. For selenium, deficient patients decreased from 79% to 5% and from 81% to 9% in the T and VT groups, respectively. Correction of nutrient deficiencies was maintained during the 2 years of supplementation in the supplemented groups (Table 2), whereas no change in serum values was noted in the P group.

DELAYED-TYPE HYPERSENSITIVITY

Delayed-type hypersensitivity, explored by positive responses and cumulative scores, significantly decreased during the first year in all groups (Table 3 and Table 4) (P<.001). No supplement group was affected by any delayed-type hypersensitivity skin test
IMMUNE FACTORS

At baseline and after 6 and 12 months of supplementation, delayed-type hypersensitivity skin test responses to 7 antigens were assessed in a representative subsample of 173 elderly people using the Merieux Multitest applicator (Pasteur-Merieux, Lyon, France). The antigens were tetanus toxoid antigen, diphtheria toxoid antigen, streptococcus antigen, tuberculin, Candida albicans antigen, Proteus mirabilis antigen, and Trichophyton mentagrophytes antigen. Glycerine was used as a control injection. All skin tests were administered and the results read by the same investigator (F.G.), who did not know the type of supplement for each patient. Skin reactions were assessed 48 hours after injection by measuring mean induration diameter. Only inductions larger than 2 mm were considered positive. For each patient, we reported the number of positive responses and total sum of induration sizes in millimeters (indurations <2 mm were not counted in the sum of induration sizes).

Purified split virion vaccine containing a strain of influenza virus (A/Singapore/6/86 (H1N1)-like, A/Beijing/32/92 (H3N2)-like, and B/Panama/45/90-like) was injected into a representative subsample of 140 patients after 15 to 17 months of supplementation. Serum samples were frozen and stored at −20°C. Antibody titers against the vaccinal strain were assessed by a standard hemagglutination inhibition test before injection of the vaccine and after 28, 90, 180, and 270 days. Titers of less than 9 were arbitrarily coded as 5. An antibody titer of 80 or greater was unequivocally considered to be a protective titer.

CLINICAL STUDIES

In each nursing home, a diagnosis of infectious events was made by the same physician. We considered an infection as urologic when it was symptomatic and associated with more than 1 × 10⁵/mL of the same bacteria and more than 1 × 10⁶/mL leukocytes in urine. Respiratory tract infections were based on clinical symptoms (cough, fever, and purulent sputum) and radiological test results. Only respiratory tract and urogenital infections were recorded because they are well standardized, frequent, and often severe in this population.

STATISTICAL ANALYSIS

Statistical analyses were performed on an intention-to-treat basis on all randomized patients using the SAS software program. Mean comparisons were determined by 2-way analysis of variance testing for a trace element effect, a vitamin effect, and a trace element–vitamin interaction. Statistical significance was based on P < .05. Validity of the assumptions was checked by a normal probability plot of residuals and the Bartlett F test of homogeneity of variances. When normal distribution was not obtained, logarithmic transformation was used to improve normality and stabilize variances.

The impact of supplementation on infectious incidence was assessed using logistic regression after grouping infectious events that occurred during follow-up into 4 groups: no infection and 1, 2, and 3 or more infectious events.

Table 1. Demographic, Biological, and Clinical Data Before Supplementation

<table>
<thead>
<tr>
<th></th>
<th>P (n = 182)</th>
<th>T (n = 182)</th>
<th>V (n = 180)</th>
<th>VT (n = 181)</th>
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<tr>
<td>Age, y</td>
<td>83.7 ± 7.4</td>
<td>83.6 ± 7.8</td>
<td>83.8 ± 7.9</td>
<td>83.4 ± 7.5</td>
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<td>Men/women, No.</td>
<td>46/136</td>
<td>49/133</td>
<td>46/134</td>
<td>44/137</td>
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<tr>
<td>BMI, kg/m²</td>
<td>24.5 ± 5.8</td>
<td>23 ± 5.7</td>
<td>24.5 ± 6.7</td>
<td>24 ± 5.7</td>
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<td>CHD, No.</td>
<td>37</td>
<td>30</td>
<td>23</td>
<td>30</td>
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<tr>
<td>OCPD, No.</td>
<td>10</td>
<td>12</td>
<td>9</td>
<td>13</td>
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<tr>
<td>HBP, No.</td>
<td>38</td>
<td>36</td>
<td>39</td>
<td>36</td>
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<td>Creatinine level, μmol/L</td>
<td>83 ± 24</td>
<td>90 ± 32</td>
<td>91 ± 35</td>
<td>87 ± 26</td>
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<tr>
<td>Cholesterol level, μmol/L</td>
<td>5.77 ± 1.32</td>
<td>5.61 ± 1.32</td>
<td>5.77 ± 1.11</td>
<td>5.74 ± 1.24</td>
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<tr>
<td>Hemoglobin level, g/L</td>
<td>132 ± 14</td>
<td>132 ± 15</td>
<td>128 ± 15</td>
<td>131 ± 15</td>
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</tbody>
</table>

*Data are shown as mean ± SD unless otherwise indicated. P indicates placebo; T, trace elements; V, vitamins; VT, vitamins and trace elements; BMI, body mass index; CHD, coronary heart disease; OCPD, obstructive chronic pulmonary disease; and HBP, high blood pressure. To convert creatinine to milligrams per liter, divide by 0.1131. To convert cholesterol to milligrams per liter, divide by 2.586.

The antibody response to influenza vaccine was better in the T and VT groups for the 3 serotypes studied in a 2-way analysis of variance, particularly at 28 and 90 days after injection (Figure 2).

On days 28 and 90, we observed a higher number of serologically protected patients in the T and VT groups (44.1% in T and 30.0% in VT) than in the other groups (27.7% in P and 12.1% in V) (P < .05) (Table 5). However, these differences in antibody titers did not significantly affect the incidence of respiratory tract events, which represented 29% in the P group, 21% in the T group, 22% in the V group, and 16% in the VT group (P > .10) during the 7 months after vaccination.

Vitamin supplementation had a negative effect on the influenza vaccine response because antibody titers in the V and VT groups were lower than in the P and T groups on days 28 and 90 after injection for serotype A/Beijing (P < .05).
INFECTIOUS EVENTS

Respiratory tract and urogenital infections were the most common infectious events (491 and 197 infections, respectively, during the 2 years).

Among those who became infected, most had 1 or 2 infectious events (170 and 109 patients, respectively). Three hundred sixty-nine patients (50.9%) remained free of infection during the study: 87 in the P group, 104 in the T group, 95 in the V group, and 83 in the VT group.

The overall proportion of patients who remained free from respiratory tract infections was higher in those with mineral supplementation than in those without (P = .06). When classifying into numbers of infectious events, however, there was no significant difference between groups.

MORTALITY

After 1 year, 628 patients were still alive; 109 died during the second year. The number of deaths after 2 years of supplementation was 51 in the P group, 55 in the T group, 45 in the V group, and 55 in the VT group (P = .10).

The most common causes were cardiovascular diseases (myocardial infarction [n = 11], stroke [n = 18], heart failure [n = 22], pulmonary embolism [n = 5], and arterial thrombosis [n = 7]). Respiratory tract infections were implicated in 24 deaths. Survival analysis of the 2 years did not show any difference between the 4 groups.

Few such trials of vitamin–trace element supplementation in elderly patients have been carried out, and

Table 2. Vitamin (V) and Trace Element (T) Status Before and After 6, 12, and 24 Months of Supplementation

<table>
<thead>
<tr>
<th>Supplement, No. of Months</th>
<th>Patients, No.</th>
<th>P</th>
<th>Patients, No.</th>
<th>T</th>
<th>Patients, No.</th>
<th>V</th>
<th>Patients, No.</th>
<th>VT</th>
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<td>α-Tocopherol, mg/L</td>
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<tr>
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<td>180</td>
<td>12.65 ± 3.58</td>
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<td>12.40 ± 3.24</td>
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<td>12.49 ± 3.27</td>
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<td>13.84 ± 3.61†</td>
<td>155</td>
<td>13.83 ± 3.73†</td>
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<td>12</td>
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<td>12.00 ± 3.37</td>
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<td>13.86 ± 3.45†</td>
<td>149</td>
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<td>Beta carotene, µg/L</td>
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<td>404 ± 307</td>
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<td>1308 ± 796†</td>
<td>155</td>
<td>1523 ± 959†</td>
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<tr>
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<td>1309 ± 788†</td>
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<td>1488 ± 932†</td>
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<td>24</td>
<td>ND</td>
<td>ND</td>
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<td>Vitamin C, µg/mL</td>
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<td>0</td>
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<td>3.29 ± 2.90</td>
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<td>3.39 ± 3.23</td>
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<td>7.69 ± 3.56†</td>
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<td>7.84 ± 3.24†</td>
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<td>6</td>
<td>153</td>
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<td>10.90 ± 2.08†</td>
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<td>150</td>
<td>10.74 ± 1.73</td>
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<td>11.18 ± 2.12</td>
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<td>12.27 ± 2.16</td>
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<td>Selenium, µmol/L</td>
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<tr>
<td>0</td>
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<td>0.71 ± 0.25</td>
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<td>153</td>
<td>0.73 ± 0.27</td>
<td>150</td>
<td>1.15 ± 0.18‡</td>
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<td>0.72 ± 0.20</td>
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<td>1.08 ± 0.23‡</td>
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<tr>
<td>12</td>
<td>160</td>
<td>0.73 ± 0.24</td>
<td>148</td>
<td>1.18 ± 0.23‡</td>
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<td>24</td>
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<td>0.79 ± 0.28</td>
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<td>1.06 ± 0.17†</td>
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<td>0.67 ± 0.31</td>
<td>28</td>
<td>1.08 ± 0.22‡</td>
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</tbody>
</table>

*Serum values are shown as mean ± SD. Statistical comparison between groups for identical time was performed using analysis of variance in a 2 × 2 factorial analysis (P < .05). P indicates placebo; ellipses, data not applicable; and ND, not done.
†Vitamin effect (V+VT vs P+T).
‡Trace element effect (T+VT vs P+V).
§Vitamin–trace element interaction.

Table 3. Delayed-Type Hypersensitivity at Baseline and After 6 and 12 Months of Supplementation

<table>
<thead>
<tr>
<th>Supplement†</th>
<th>Patients, No.</th>
<th>Baseline</th>
<th>Patients, No.</th>
<th>6 mo</th>
<th>Patients, No.</th>
<th>12 mo</th>
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<tr>
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<td>47</td>
<td>1.94 ± 1.30</td>
<td>44</td>
<td>1.50 ± 1.42</td>
<td>41</td>
<td>1.44 ± 1.20</td>
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<tr>
<td>T</td>
<td>45</td>
<td>1.58 ± 1.18</td>
<td>41</td>
<td>1.27 ± 1.23</td>
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<td>V</td>
<td>41</td>
<td>1.88 ± 1.60</td>
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<td>1.42 ± 1.54</td>
<td>34</td>
<td>1.24 ± 1.30</td>
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<td>VT</td>
<td>45</td>
<td>1.98 ± 1.41</td>
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<td>1.76 ± 1.27</td>
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<td>.38</td>
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</table>

*Values are shown as the mean (±SD) number of positive responses.
†P indicates placebo; T, trace elements; V, vitamins; and VT, vitamins and trace elements.

ARCH INTERN MED/VOL 159, APR 12, 1999
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most have been of limited size. Patients were stratified by sex and age and randomly assigned to 1 of 4 treatment groups using block randomization in each geriatric center to avoid selection bias. Study duration was 24 months to exclude seasonal variation in infectious morbidity. Moreover, clinical benefits were evaluated in addition to biological factors. Finally, doses of nutrients used were moderate, compared with previous studies that reported adverse effects with use of large doses.12,13

Dietary intakes were not assessed by food records. However, results of a previous epidemiological study20 show that the serum values of antioxidant nutrients closely correlated with intakes.

In our study, supplementation with low doses of nutrients improved serum concentrations, with good efficiency at reducing the proportion of patients with low initial levels. Except for zinc, the serum concentration reached a plateau after 6 months. For zinc, the serum concentration increased slowly during the study. It is well known that zinc has low intestinal absorption, especially in the elderly.21 In elderly patients receiving supplementation for 1 year, Bogden et al13 described an increase in plasma zinc concentration in the group receiving 100 mg/d but no change in the group receiving 15 mg/d. As in other studies6,22 in elderly patients, selenium supplementation induced an increase in the level of serum selenium. In the same way, a significant improvement was also effected in serum vitamin values, which confirmed previously published results.3

High compliance (85%) was observed, as confirmed by the increase in serum nutrient values in the treated groups and no changes in the P group.

Regarding delayed-type hypersensitivity responses, we observed a decrease in the number of positive responses and the sum of induration sizes in all groups with time; supplementation was unable to limit this decrease in cellular immunity. Our results contrast with others,3 in which an improvement in delayed-type hypersensitivity was reported after low-dose multivitamin-mineral (24 different nutrients) supplementation. This difference may be caused, in part, by the composition of supplements and populations studied elsewhere, in which delayed-type hypersensitivity was enhanced after supplement use in apparently healthy and independently living younger patients.

The antibody response on days 28 and 90 after influenza vaccine was improved in the T groups (alone or associated with vitamins) in a 2 × 2 factorial analysis of variance. In the same way, there were more serologically protected patients in the T groups than in the non-T groups (P = .04).

Our results suggest that zinc and selenium supplementation improves the humoral response after influenza vaccine in elderly people. It has been shown that supplementation with the same dose of zinc (20 mg/d) leads to a significant restoration of serum thymulin activity in elderly patients.23 This thymic hormone requires the presence of zinc to express its biological activity and is involved in thymocyte proliferation. The antibody response to influenza vaccine is T-lymphocyte dependent, suggesting that more effective thymulin activity could induce a better anti-influenza response.

Moreover, it is well known that protein-energy malnutrition induces a weak immune response, whereas nutritional supplementation is effective in restoring responses to vaccines.24 In a previous study, Chandra and Puri2 recruited 30 elderly people who had nutritional deficiencies: 15 received supplements and 15 did not. An improvement in antibody response to the influenza vac-
Vitamin supplementation was associated with a weaker humoral response. Our results agree with those of a previous trial that studied the impact of 200- and 400-mg vitamin E supplementation on humoral response after influenza vaccine in 103 men. No benefit of vitamin E was observed in terms of serum titers or the incidence of pulmonary, urinary tract, or other infections in that study, in which 75% of the patients were older than 69 years.

In the subsample of 140 vaccinated patients, no significant reduction in respiratory tract infections clearly appeared ($P > .10$) during the 7 months after the influenza vaccine, but there were only 31 respiratory tract infections and we probably lacked power to observe a reduction in infectious morbidity during such a short time.

Feverous respiratory tract infections were found in patients who received trace elements, whereas no reduction in urogenital infections was noted during the 2-year supplementation. Nevertheless, logistic regression analysis showed that the infections resumptions (0, 1, 2, and $\geq 3$) showed no benefit of trace element supplementation in respiratory tract infections. This discrepancy between the 2 methods used to explore respiratory tract infections might be explained by the higher rate of repeated infections in the VT group (Table 6). There were 3 patients in the T and VT groups and only 1 patient in the P and V groups with more than 4 infections.

Table 6. Distribution of Respiratory and Urogenital Infections*

<table>
<thead>
<tr>
<th>Patients, No. (%)</th>
<th>P</th>
<th>T</th>
<th>V</th>
<th>VT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory infections, No.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>100 (54.9)</td>
<td>118 (64.8)</td>
<td>104 (57.7)</td>
<td>110 (60.7)</td>
</tr>
<tr>
<td>1</td>
<td>44 (24.1)</td>
<td>35 (19.2)</td>
<td>50 (27.7)</td>
<td>39 (21.5)</td>
</tr>
<tr>
<td>2</td>
<td>22 (12.0)</td>
<td>19 (10.4)</td>
<td>19 (10.5)</td>
<td>15 (8.3)</td>
</tr>
<tr>
<td>$\geq 3$</td>
<td>16 (8.8)</td>
<td>10 (5.5)</td>
<td>7 (3.9)</td>
<td>17 (9.4)</td>
</tr>
<tr>
<td>Urogenital infections, No.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>146 (80.2)</td>
<td>150 (82.4)</td>
<td>154 (85.5)</td>
<td>139 (76.8)</td>
</tr>
<tr>
<td>1</td>
<td>24 (13.2)</td>
<td>19 (10.4)</td>
<td>12 (6.6)</td>
<td>32 (17.7)</td>
</tr>
<tr>
<td>2</td>
<td>9 (4.9)</td>
<td>11 (6.0)</td>
<td>11 (6.1)</td>
<td>6 (3.3)</td>
</tr>
<tr>
<td>$\geq 3$</td>
<td>3 (1.6)</td>
<td>2 (1.1)</td>
<td>3 (1.6)</td>
<td>4 (2.2)</td>
</tr>
</tbody>
</table>

*P indicates placebo; T, trace elements; V, vitamins; and VT, vitamins and trace elements.

Concerning the use of a single nutrient, results of recent studies demonstrate the role of modest doses of zinc (10-20 mg/d) in reducing the occurrence of diarrheal infections in children, but zinc supplementation did not decrease the incidence of respiratory tract infections. Only 1 trial performed on children with Down syndrome who received 1 mg of zinc per 1 kg of body weight per day showed a reduction in respiratory tract infections, but this effect was restricted to boys ($n = 12$) and the duration of supplementation was only 4 months.

Likewise, supplementation with low doses of selenium has been demonstrated to improve immune factors in the elderly, but their clinical impact remains to be studied.

No effect on mortality of any treatment, alone or in association, was observed in our trial. Nevertheless, our results agree with those of other intervention trials. The benefits of such supplementations in terms of mortality are controversial. In the Linxian trials, in which nearly 30,000 patients randomly received low doses of micronutrients for 5.25 years, a combination of beta carotene (15 mg), vitamin E (30 mg), and selenium (50 µg) induced a reduction in cancer risk and, consequently, a reduction in mortality rate. Nevertheless, the patients were younger (40-69 years) and inhabitants of the Linxian region in China, which has one of the world’s highest rates of gastric cancer.

Results of recent studies indicate that vitamin E supplementation may be helpful in the prevention of new heart attacks in patients with coronary disease, as selenium supplementation was in patients with skin cancer. However, no benefit of beta carotene (20 mg) or vitamin E (50 mg) in terms of cancer mortality was observed in 29,133 male smokers after 5 to 8 years of supplementation or in physicians given long-term antioxidant vitamin supplementation, and daily nutritional supplementation did not increase longevity in users of trace elements and vitamin supplements.

In conclusion, long-term institutionalized elderly people have moderate vitamin and/or trace element biological deficiencies, which are corrected by nutritional dose supplementation with adequate micronutrients. In our study, patients who received zinc and selenium had a better antibody response after influenza vaccine, and the percentage of patients without respiratory tract infections was higher in the T and VT groups. Our results suggest a beneficial effect of these nutrients on the immunity of elderly persons by improving their resistance to infections. Larger trials will be required to confirm our findings, which may have considerable impact on the health of the institutionalized elderly.
Accepted for publication August 15, 1998.

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This work was supported by grants from Produits Roche SA (Paris, France) and Labcatal (Montrouge, France).

We thank Claude Bourgeois, PhD (Société Produits Roche, Paris), Denise Hesse, PhD (Hoffmann-La Roche, Basle, Switzerland), Monique Rousseau, PhD (Institut Pasteur, Paris), and Alain Favier, PhD (Grenoble, France), for helping with some laboratory analyses. This study would not have been possible without the participation of our elderly volunteers.

Members of the MIN.VIT.AOX. geriatric network: Bruno Lesourd, MD (Ivy-sur-Seine), Emmanuel Alix, MD (Le Mans), Christa Boulou, MD (Alloins), Thierry Constans, MD (Tours), Marie-Jeanne Lettre, MD (Colombes), Claire Grosshans, MD (Mulhouse), Clause Jeanedel, MD (Nancy), Dominque Richard, MD, and Marie Lombard, MD (Dijon), Alain Jean, MD (Paris), Anne Lebapt-Sarte, MD, and Jean-Paul Marot, MD (Saint-Nazaire), Marie-Paule Retsch, MD (Strasbourg), Stephanie Carnein, MD (Colmar), Henri Patoureaux, MD, and Dominique Perrier, MD (Nevers), Chantal Fauchier, MD (Brest), Marie-Christine Schatz, MD (Bischwiller), Christophe Dourthe, MD, and Francois Carlier, MD (Cognac), Amel Nairn, MD (Saint Jean D'Angely), Joel Luizy, MD (Rochefort), Philippe Thomas, MD, and Jean-Yves Poupet, MD (Poitiers), Veronique Vassort, MD (Niort), Francois Bouthier-Quintard, MD (Limoges), Francois Lapray, MD (Monteau), Christian Jacques, MD, and Alain Saringar, MD (Troyes), Bernard Frigard, MD, and Nathalie Taillon, MD (Lille), Veronique Petit, MD (La Guchie), and Francois Touchez-Lagarriigue, MD, and Anne-Marie Soulard, MD (Angouleme), France.

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