

Vitamin D Has Mild Effect on Falls, Fracture Risk

BY JEFF EVANS
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ARLINGTON, VA. — People who take sufficiently high supplement doses of vitamin D or those who already have adequate levels of vitamin D were found to have a small but significantly reduced risk of specific fractures, falls, and low bone mineral density, according to an Agency for Healthcare Research and Quality report on the effect of vitamin D

supplements on bone health outcomes.

Dr. Ann B. Cranney and her associates at the University of Ottawa Evidence-Based Practice Center extensively reviewed the literature regarding the effects of 25-hydroxyvitamin D (25[OH]D) concentration or vitamin D supplementation. She presented the results of meta-analyses based on studies that met eligibility criteria at a conference sponsored by the American Society for Bone and Mineral Research.

It was not possible to quantitatively summarize the results of 10 randomized controlled clinical trials or 31 observational studies that examined the effect of 25(OH)D levels on bone health outcomes in postmenopausal women and older men, so Dr. Cranney and her colleagues categorized the evidence supporting the effect of the vitamin D metabolite as good, fair, or inconsistent. For serum 25(OH)D levels of at least 50-80 nmol/L, there was good evidence of an association

with increased bone mineral density in the hip, fair evidence of an inverse association with the risk of hip fracture, and inconsistent evidence of an association with a reduction in falls and functional measures such as grip strength and body sway.

In 74 randomized controlled trials of supplementation with either vitamin D₃ or vitamin D₂, the investigators found that 25(OH)D levels increased more with supplementation with vitamin D₃ than with vitamin D₂. Data collected from 16 randomized controlled trials provided enough information on 25(OH)D levels in both the control group and treatment group at baseline as well as at the end of the study to enable the investigators to determine

In eight clinical trials, vitamin D₃ supplements of 700 IU/day or more significantly reduced the risk of nonvertebral fractures by 15%, a meta-analysis showed.

that supplementation with 700 IU/day or more of vitamin D₃ was associated with a drop in serum parathyroid hormone levels.

The investigators also calculated from the clinical trial results that 1 IU vitamin D₃ raises the serum 25(OH)D concentration by 0.016 nmol/L. Clinical trials that used supplements with either vitamin D₃ or vitamin D₂ did not show a significant effect on reducing the risk of fractures overall or on the risk of hip fractures in particular. Also, supplementation with vitamin D plus calcium or vitamin D alone did not have a significant effect on the risk of nonvertebral fractures. But in eight clinical trials, vitamin D₃ supplements of 700 IU/day or more significantly reduced the risk of nonvertebral fractures by 15%.

This risk reduction was driven primarily by two clinical trials that involved individuals in an institutional setting, who had a 22% reduction in the risk of nonvertebral fractures. Supplements of 700 IU/day or more vitamin D₃ also significantly lowered the risk of hip fractures; clinical trials in an institutional setting, rather than in the community, factored strongly in the overall results, Dr. Cranney noted.

The investigators found that participants in trials of vitamin D₃ supplementation that recorded serum 25(OH)D concentrations of 74 nmol/L or higher had a significant 23% lower risk of nonvertebral fractures than did participants of trials that did not achieve a 25(OH)D level of 74 nmol/L.

Vitamin D supplements did not reduce the risk of falls overall in 12 clinical trials. But vitamin D supplements did significantly lower the risk of a fall by 11% in six clinical trials in which falls were defined or independently ascertained, Dr. Cranney said.

The Agency for Healthcare Research and Quality requested the report on behalf of the National Institutes of Health Office of Dietary Supplements.

Zegerid[®]
omeprazole/sodium bicarbonate

Brief Summary of Prescribing Information

INDICATIONS AND USAGE

Duodenal Ulcer

ZEGEERID is indicated for short-term treatment of active duodenal ulcer. Most patients heal within four weeks. Some patients may require an additional four weeks of therapy.

Gastric Ulcer

ZEGEERID is indicated for short-term treatment (4-8 weeks) of active benign gastric ulcer. (See CLINICAL PHARMACOLOGY, Clinical Studies, Gastric Ulcer.)

Treatment of Gastroesophageal Reflux Disease (GERD)

Symptomatic GERD

ZEGEERID is indicated for the treatment of heartburn and other symptoms associated with GERD.

Erosive Esophagitis

ZEGEERID is indicated for the short-term treatment (4-8 weeks) of erosive esophagitis which has been diagnosed by endoscopy. (See CLINICAL PHARMACOLOGY, Clinical Studies.)

The efficacy of ZEGEERID used for longer than 8 weeks in these patients has not been established. In the rare instance of a patient not responding to 8 weeks of treatment, it may be helpful to give up to an additional 4 weeks of treatment. If there is recurrence of erosive esophagitis or GERD symptoms (eg, heartburn), additional 4-8 week courses of omeprazole may be considered.

Maintenance of Healing of Erosive Esophagitis

ZEGEERID is indicated to maintain healing of erosive esophagitis. Controlled studies do not extend beyond 12 months.

Reduction of Risk of Upper Gastrointestinal Bleeding in Critically Ill Patients

ZEGEERID Powder for Oral Suspension 40 mg/1680 mg is indicated for the reduction of risk of upper GI bleeding in critically ill patients.

CONTRAINDICATIONS

ZEGEERID is contraindicated in patients with known hypersensitivity to any components of the formulation.

PRECAUTIONS

General

Symptomatic response to therapy with omeprazole does not preclude the presence of gastric malignancy.

Atrophic gastritis has been noted occasionally in gastric corpus biopsies from patients treated long-term with omeprazole.

Each ZEGEERID Capsule contains 1100 mg (13 mEq) of sodium bicarbonate (equivalent to 300 mg of Na+). Each packet of ZEGEERID Powder for Oral Suspension contains 1680 mg (20 mEq) of sodium bicarbonate (equivalent to 460 mg of Na+).

The sodium content of ZEGEERID products should be taken into consideration when administering to patients on a sodium restricted diet. Sodium bicarbonate is contraindicated in patients with metabolic alkalosis and hypocalcaemia. Sodium bicarbonate should be used with caution in patients with Bartter's syndrome, hypokalaemia, respiratory alkalosis, and problems with acid-base balance. Long-term administration of bicarbonate with calcium or milk can cause milk-alkali syndrome.

Information for Patients

ZEGEERID should be taken on an empty stomach at least one hour prior to a meal.

ZEGEERID is available either as 40 mg or 20 mg capsules with 1100 mg sodium bicarbonate. ZEGEERID is also available either as 40 mg or 20 mg single-dose packets of powder for oral suspension with 1680 mg sodium bicarbonate.

Directions for Use:

Capsules: Swallow intact capsule with water. DO NOT USE OTHER LIQUIDS. DO NOT OPEN CAPSULE AND SPRINKLE CONTENTS INTO FOOD.

Powder for Oral Suspension: Empty packet contents into a small cup containing 1-2 tablespoons of water. DO NOT USE OTHER LIQUIDS OR FOODS. Stir well and drink immediately. Refill cup with water and drink.

Drug Interactions

Omeprazole can prolong the elimination of diazepam, warfarin and phenytoin, drugs that are metabolized by oxidation in the liver. There have been reports of increased INR and prothrombin time in patients receiving proton pump inhibitors, including omeprazole, and warfarin concomitantly. Increases in INR and prothrombin time may lead to abnormal bleeding and even death. Patients treated with intraput pump inhibitors and warfarin may need to be monitored for increases in INR and prothrombin time. Although in normal subjects no interaction with theophylline or propranolol was found, there have been clinical reports of interaction with other drugs metabolized via the cytochrome P-450 system (eg, cyclosporine, diazepam, benzodiazepines). Patients should be monitored to determine if it is necessary to adjust the dosage of these drugs when taken concomitantly with ZEGEERID.

Because of its profound and long-lasting inhibition of gastric acid secretion, it is theoretically possible that omeprazole may interfere with absorption of drugs where gastric pH is an important determinant of their bioavailability (eg, ketoconazole, ampicillin esters, and iron salts). In the clinical efficacy trials, antacids were used concomitantly with the administration of omeprazole. Concomitant administration of omeprazole and alizaxanvir has been reported to reduce the plasma levels of alizaxanvir. Concomitant administration of omeprazole and tacrolimus may increase the serum levels of tacrolimus.

Co-administration of omeprazole and dantrolene have resulted in increases of plasma levels of omeprazole, clarithromycin, and 14-hydroxy-clarithromycin (see also CLINICAL PHARMACOLOGY, Pharmacokinetics).

Carcinogenesis, Mutagenesis, Impairment of Fertility

In two 24-month carcinogenicity studies in rats, omeprazole at daily doses of 1.7, 3.4, 13.8, 44.0 and 140.8 mg/kg/day (approximately 0.5 to 28.5 times the human dose of 40 mg/day, based on body surface area) produced gastric ECL cell carcinomas in a dose-related manner in both male and female rats; the incidence of this effect was markedly higher in female rats, which had higher blood levels of omeprazole. Gastric carcinomas seldom occur in the untreated rat. In addition, ECL cell hyperplasia was present in all treated groups of both sexes. In one of these studies, female rats were treated with 13.8 mg omeprazole/kg/day (approximately 2.8 times the human dose of 40 mg/day, based on body surface area) for one year then followed for an additional year without the drug. No carcinomas were seen in these rats. An increased incidence of treatment-related ECL cell hyperplasia was observed at the end of one year (94% treated vs 10% controls). By the second year the difference between treated and control rats was much smaller (46% vs 26%) but still showed more hyperplasia in the treated group. Gastric adenocarcinoma was seen in one rat (2%). No similar tumor was seen in male or female rats treated for two years. For this strain of rat no similar tumor has been noted historically, but a finding involving only one tumor is difficult to interpret. In a 52-week toxicity study in Sprague-Dawley rats, brain astrocytomas were found in a small number of males that received omeprazole at dose levels of 0.4, 2, and 16 mg/kg/day (about 0.1 to 3.3 times the human dose of 40 mg/day, based on body surface area). No astrocytomas were observed in female rats in this study. In a 2-year carcinogenicity study in Sprague-Dawley rats, no astrocytomas were found in males and females at the high dose of 140.8 mg/kg/day (about 28.5 times the human dose of 40 mg/day, based on body surface area). A 78-week mouse carcinogenicity study of omeprazole did not show increased tumor occurrence, but the study was not conclusive. A 26-week p53 (+/-) transgenic mouse carcinogenicity study was not positive. Omeprazole was positive for clastogenic effects in an *in vitro* human lymphocyte chromosomal aberration assay, in one of two *in vivo* mouse micronucleus tests, and in an *in vivo* bone marrow cell chromosomal aberration assay. Omeprazole was negative in the *in vitro* Ames Test, an *in vitro* mouse lymphoma cell forward mutation assay and an *in vivo* rat liver DNA damage assay.

Omeprazole at oral doses up to 138 mg/kg/day (about 28 times the human dose of 40 mg/day, based on body surface area) was found to have no effect on the fertility and general reproductive performance in rats.

Pregnancy

Pregnancy Category C

There are no adequate and well-controlled studies on the use of omeprazole in pregnant women. The vast majority of reported experience with omeprazole during human pregnancy is first trimester exposure and the duration of use is rarely specified, e.g., intermittent vs. chronic. An expert review of published data on experiences with omeprazole use during pregnancy by TERIS—the Teratogen Information System—concluded that therapeutic doses during pregnancy are unlikely to pose a substantial teratogenic risk (the quantity and quality of data were assessed as fair).

Three epidemiological studies compared the frequency of congenital abnormalities among infants born to women who used omeprazole during pregnancy to the frequency of abnormalities among infants of women exposed to H₂-receptor antagonists or other controls. A population-based prospective cohort epidemiological study from the Swedish Medical Birth Registry, covering approximately 99% of pregnancies, reported on 955 infants (824 exposed during the first trimester with 39 of these exposed beyond first trimester, and 131 exposed after the first trimester) whose mothers used omeprazole during pregnancy.¹ In utero exposure to omeprazole was not associated with increased risk of any malformation (odds ratio 0.82, 95% CI 0.50-1.34), low birth weight or low Apgar score. The number of infants born with

ventricular septal defects and the number of stillborn infants was slightly higher in the omeprazole exposed infants than the expected number in the normal population. The author concluded that both effects may be random.

A retrospective cohort study reported on 689 pregnant women exposed to either H₂-blockers or omeprazole in the first trimester (134 exposed to omeprazole).¹ The overall malformation rate was 4.4% (95% CI 3.6-5.3) and the malformation rate for first trimester exposure to omeprazole was 3.6% (95% CI 1.5-8.1). The relative risk of malformations associated with first trimester exposure to omeprazole compared with nonexposed women was 0.9 (95% CI 0.3-2.2). The study could effectively rule out a relative risk greater than 2.5 for all malformations. Rates of preterm delivery or growth retardation did not differ between the groups.

A controlled prospective observational study followed 113 women exposed to omeprazole during pregnancy (89% first trimester exposures).¹ The reported rates of major congenital malformations were 4% for the omeprazole group, 2% for controls exposed to nonteratogens, and 2.8% in disease-paired controls (background incidence of major malformations 1-5%). Rates of spontaneous and elective abortions, preterm deliveries, gestational age at delivery, and mean birth weight did not differ between the groups. The sample size in this study has 80% power to detect a 5-fold increase in the rate of major malformation. Several studies have reported no apparent adverse short term effects on the infant when single dose oral or intravenous omeprazole was administered to over 200 pregnant women as premedication for cesarean section under general anesthesia.

Toxicology studies conducted in pregnant rats at doses up to 138 mg/kg/day (about 28 times the human dose of 40 mg/day, based on body surface area) and in pregnant rabbits at doses up to 69 mg/kg/day (about 28 times the human dose of 40 mg/day, based on body surface area) did not disclose any evidence for a teratogenic potential of omeprazole.

In rabbits, omeprazole in a dose range of 6.9 to 69 mg/kg/day (about 2.8 to 28 times the human dose of 40 mg/day, based on body surface area) produced dose-related increases in embryolethality, fetal resorptions and pregnancy disruptions. In rats, dose-related embryo/fetal toxicity and postnatal developmental toxicity were observed in offspring resulting from parents treated with omeprazole at 13.8 to 138.0 mg/kg/day (about 2.8 to 28 times the human dose of 40 mg/day, based on body surface area).

Chronic use of sodium bicarbonate may lead to systemic alkalosis and increased sodium intake can produce edema and weight increase. There are no adequate and well-controlled studies in pregnant women. Because animal studies and studies in humans cannot rule out the possibility of harm, omeprazole should be used during pregnancy only if the potential benefit to pregnant women justifies the potential risk to the fetus.

Nursing Mothers

Omeprazole concentrations have been measured in breast milk of a woman following oral administration of 20 mg. The peak concentration of omeprazole in breast milk was less than 7% of the peak serum concentration. The concentration would correspond to 0.004 mg of omeprazole in 200 mL of milk. Because omeprazole is excreted in human milk, because of the potential for serious adverse reactions in nursing infants from omeprazole, and because of the potential for tumorigenicity shown for omeprazole in rat carcinogenicity studies, a decision should be taken to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother. In addition, sodium bicarbonate should be used with caution in nursing mothers.

Pediatric Use

Clinical studies have been conducted evaluating delayed-release omeprazole in pediatric patients. There are no adequate and well-controlled studies in pediatric patients with ZEGEERID.

Geriatric Use

Omeprazole was administered to over 2000 elderly individuals (≥ 65 years of age) in clinical trials in the U.S. and Europe. There were no differences in safety and effectiveness between the elderly and younger subjects. Other reported clinical experience has not identified differences in response between the elderly and younger subjects, but greater sensitivity of some older individuals cannot be ruled out.

Pharmacokinetic studies with buffered omeprazole have shown the elimination rate was somewhat decreased in the elderly and bioavailability was increased. The plasma clearance of omeprazole was 250 mL/min (about half that of young subjects). The plasma half-life averaged one hour, about the same as that in nonelderly, healthy subjects taking ZEGEERID. However, no dosage adjustment is necessary in the elderly. (See CLINICAL PHARMACOLOGY.)

ADVERSE REACTIONS

Omeprazole was generally well tolerated during domestic and international clinical trials in 3096 patients.

In the U.S. clinical trial population of 465 patients, the adverse experiences summarized in Table 11 were reported to occur in 1% or more of patients on therapy with omeprazole. Numbers in parentheses indicate percentages of the adverse experiences considered by investigators as possibly, probably or definitely related to the drug.

Table 11: Adverse Experiences Occurring in 1% or More of Patients on Omeprazole Therapy

	Omeprazole (n = 465)	Placebo (n = 64)	Ranitidine (n = 195)
Headache	6.9 (2.4)	6.3	7.7 (2.6)
Diarrhea	4.0 (1.3)	3.1 (1.6)	2.1 (0.5)
Abdominal Pain	2.4 (0.4)	3.1	2.1
Nausea	2.2 (0.9)	3.1	4.1 (0.5)
URI	1.9	1.6	2.6
Dizziness	1.5 (0.6)	0.0	2.6 (1.0)
Vomiting	1.5 (0.4)	4.7	1.5 (0.5)
Rash	1.5 (1.1)	0.0	0.0
Constipation	1.1 (0.9)	0.0	0.0
Cough	1.1	0.0	1.5
Asthenia	1.1 (0.2)	1.6 (1.6)	1.5 (1.0)
Back Pain	1.1	0.0	0.5

Table 12: Incidence of Adverse Experiences ≥ 1% Causal Relationship Not Assessed

	Omeprazole (n = 2631)	Placebo (n = 120)
Body as a Whole, site unspecified		
Abdominal pain	5.2	3.3
Asthenia	1.3	0.8
Digestive System		
Constipation	1.5	0.8
Diarrhea	3.7	2.5
Flatulence	2.7	5.8
Nausea	4.0	6.7
Vomiting	3.2	10.0
Acid regurgitation	1.9	3.3
Nervous System/Psychiatric		
Headache	2.9	2.5

A controlled clinical trial conducted in 359 critically ill patients, comparing ZEGEERID 40 mg/1680 mg suspension once daily to I.V. cimetidine 1200 mg/day for up to 14 days. The incidence and total number of AEs experienced by ≥ 3% of patients in either group are presented in Table 13 by body system and preferred term.

Table 13: Number (%) of Critically Ill Patients with Frequently Occurring (≥ 3%) Adverse Events by Body System and Preferred Term

	ZEGEERID* (N=178)	Cimetidine (N=181)
MedDRA Body System Preferred Term	All AEs n (%)	All AEs n (%)
BLOOD AND LYMPHATIC SYSTEM DISORDERS		
Anaemia NOS	14 (7.9)	14 (7.7)
Anaemia NOS Aggravated	4 (2.2)	7 (3.9)
Thrombocytopenia	18 (10.1)	11 (6.1)
CARDIAC DISORDERS		
Atrial Fibrillation	11 (6.2)	7 (3.9)
Bradycardia NOS	7 (3.9)	5 (2.8)
Supraventricular Tachycardia	6 (3.4)	2 (1.1)
Tachycardia NOS	6 (3.4)	6 (3.3)
Ventricular Tachycardia	8 (4.5)	6 (3.3)
GASTROINTESTINAL DISORDERS*		
Constipation	8 (4.5)	8 (4.4)
Diarrhoea NOS	7 (3.9)	15 (8.3)

Gastric Hypomotility 3 (1.7) 6 (3.3)

GENERAL DISORDERS AND ADMINISTRATION SITE CONDITIONS

Hyperpyrexia 8 (4.5) 3 (1.7)

Oedema NOS 5 (2.8) 11 (6.1)

Pyrexia 36 (20.2) 29 (16.0)

INFECTIONS AND INFESTATIONS

Candidial Infection NOS 3 (1.7) 7 (3.9)

Oral Candidiasis 7 (3.9) 1 (0.6)

Sepsis NOS 9 (5.1) 9 (5.0)

Urinary Tract Infection NOS 4 (2.2) 6 (3.3)

INVESTIGATIONS

Liver Function Tests NOS Abnormal 3 (1.7) 6 (3.3)

METABOLISM AND NUTRITION DISORDERS

Fluid Overload 9 (5.1) 14 (7.7)

Hyperglycaemia NOS 19 (10.7) 21 (11.6)

Hyperkalaemia 4 (2.2) 6 (3.3)

Hypermataemia 1 (1.7) 9 (5.0)

Hypocalcaemia 11 (6.2) 10 (5.5)

Hypoglycaemia NOS 6 (3.4) 8 (4.4)

Hypokalaemia 22 (12.4) 24 (13.3)

Hypomagnesaemia 18 (10.1) 18 (9.9)

Hyponatremia 7 (3.9) 5 (2.8)

Hypophosphataemia 11 (6.2) 7 (3.9)

PSYCHIATRIC DISORDERS

Agitation 6 (3.4) 16 (8.8)

RESPIRATORY, THORACIC AND MEDIASTINAL DISORDERS

Acute Respiratory Distress Syndrome 6 (3.4) 7 (3.9)

Nosocomial Pneumonia 20 (11.2) 17 (9.4)

Pneumothorax NOS 1 (0.6) 8 (4.4)

Respiratory Failure 3 (1.7) 6 (3.3)

SKIN AND SUBCUTANEOUS TISSUE DISORDERS

Decubitus Ulcer 6 (3.4) 5 (2.8)

Rash NOS 10 (5.6) 11 (6.1)

VASCULAR DISORDERS

Hypertension NOS 14 (7.9) 6 (3.3)

Hypotension NOS 17 (9.6) 12 (6.6)

*Clinically significant UOI bleeding was considered an SAE but it is not included in this table.

Additional adverse experiences occurring in < 1% of patients or subjects in domestic and/or international trials conducted with omeprazole, or occurring since the drug was marketed, are shown below within each body system. In many instances, the relationship to omeprazole was unclear.

Body As a Whole

Allergic reactions, including, rarely, anaphylaxis (see also Skin below), fever, pain, fatigue, malaise, abdominal swelling.

Cardiovascular

Chest pain or angina, tachycardia, bradycardia, palpitation, elevated blood pressure, and peripheral edema.

Gastrointestinal

Pancreatitis (some fatal), anorexia, irritable colon, flatulence, fecal discoloration, esophageal candidiasis, mucosal atrophy of the tongue, dry mouth, stomatitis. During treatment with omeprazole, gastric fundic gland polyps have been noted rarely. These polyps are benign and appear to be reversible when treatment is discontinued.

Gastrointestinal carcinoids have been reported in patients with Zollinger-Ellison syndrome on long-term treatment with omeprazole. This finding is believed to be a manifestation of the underlying condition, which is known to be associated with such tumors.

Hepatic

Mild and, rarely, marked elevations of liver function tests (ALT (SGPT), AST (SGOT), γ-glutamyl transpeptidase, alkaline phosphatase, and bilirubin (jaundice)). In rare instances, overt liver disease has occurred, including hepatocellular, cholestatic, or mixed hepatitis, liver necrosis (some fatal), hepatic failure (some fatal), and hepatic encephalopathy.

Metabolic/Nutritional

Hyponatremia, hypoglycemia, and weight gain.

Musculoskeletal

Muscle cramps, myalgia, muscle weakness, joint pain, and leg pain.