



# LET THE SUN SHINE IN

**Vitamin D deficiency could be the first step toward osteomalacia and osteoporosis.**

**MARY EILEEN K. ANDREASEN  
DEBORAH MARKS CONLEY**

An older patient complaining of bone pain, fatigue, and muscle weakness could be one of the larger group of older adults suffering from vitamin D, calcium, and other dietary deficiencies, common problems among older people. Deficiencies such as these are often undetected, and reasons why they occur are numerous.

Decreased appetite secondary to physical or mental impairment, difficulty obtaining and preparing food, social isolation, economic deficits, inefficient chewing, depression, sensory deficits, and ignorance about appropriate food choices are all possibilities. Inflation and the increased

prices of foods, such as meat, fresh vegetables, and fruit, may force older persons into a dietary pattern that may be high in satiety and calories, but deficient in vitamins, minerals, and trace elements. When treating older adults, the professional nurse must take complaints like those above seriously and stress the importance of dietary vitamin D and calcium intake, as well as emphasize exposure to sunlight.

Older adults, particularly, have been noted to be deficient in vitamin D(1-13). Decreased sunlight exposure is considered to be one of the main causes because some older adults are housebound, deliberately avoid the sun, or are confined indoors in nursing homes(3,13). Other factors contributing to the problem may be impaired intestinal absorption of vitamin D and age changes in the skin that impede vitamin D production(4).

Weisman indicates that aging might cause a decrease in the metabolism of vitamin D by the liver(4). He further suggests that a decrease in the ability of the aging kidney to convert 25-hydroxyvitamin D into an active metabolite is a significant problem. Weisman feels that "me-

tabolism at several points in the metabolic pathway, rather than simple under exposure to sunlight, is a major factor in vitamin D deficiency in older adults"(4).

In addition, cholestyramine (Questran), glutethimide (Doriden), mineral oil, Neomycin, Phenobarbital, phenolphthalein (Prulet), primidone (Mysoline), phenytoin (Dilantin), as well as barbiturates and laxatives, are known to interfere with vitamin D absorption(2). Mineral oil readily absorbs vitamin D and should not be ingested with food or vitamins.

Vitamin D has been known to play a role in calcium metabolism and to permit, with adequate intake, proper absorption of dietary calcium(1). It has now been determined that vitamin D is, in fact, a hormone and has a much more active role in metabolism; not only of the skeletal system but of the immune system as well(1).

Vitamin D aids in the absorption of calcium and phosphorus, contributes to the production of bone tissue, and is necessary for skeletal development and prevention of bone loss. Its major role is still to facilitate absorption of calcium from the small intes-

Mary Eileen K. Andreasen, RN, BSN, MS, is clinical nurse specialist and Deborah Marks Conley, RN, C, BSN, is gerontological nurse coordinator at the Geriatric Assessment Center, University of Nebraska Medical Center, Omaha, NE.



Looking and feeling well can increase one's self-confidence and enjoyment.

tine(1). Synthesized in the skin and stored in fat, vitamin D is transported by a binding protein in the blood and metabolized by hydroxylation in the liver and kidneys to its active forms. The basic substrate, 7-dehydrocholesterol (7-DHC), is always present in the epidermis, but remains inactive until it is exposed to ultraviolet (UV) light, which then results in previtamin D<sub>3</sub>.

Few foods contain vitamin D naturally. Yeast is one source, as well as seafood, which is rich in fish liver oils. Milk is an excellent food because, in addition to providing vitamin D, it also provides calcium and phosphorus. Since the 1930s and 1940s dairy products have been fortified with vitamin D, thus decreasing the incidence of rickets in children. This change also decreased dependence on sunlight for the vitamin(14).

### Clinical Symptoms

The signs and symptoms of vitamin D deficiency can be classified into four distinct stages. The first stage is the most difficult to recognize because neither the patient's complaints of weakness, fatigue, and aching bones nor the clinical findings are specific.

In the second stage, the patient experiences similar musculoskeletal discomforts, but the alkaline phosphatase level is elevated, probably in response to the reabsorption of bone. The third stage is dominated by secondary hyperparathyroidism, re-

flected by severe muscle weakness and pain in the bones that are grossly free of fractures(1).

The serum calcium level is still within the normal range (8.4 to 10.4 mg/dl). The alkaline phosphatase level continues to be elevated, blood phosphorus begins to fall, and metabolic acidosis may develop. X-rays show diffuse osteoporosis, which may be prominent in peripheral bones in the spine, although some patients have "osteoporotic" fractures of the vertebrae.

Barzel describes patients in the fourth stage as extremely ill and usually bedridden because of pain; calcium homeostasis at this point has failed(1). This stage is characterized by hypocalcemia, hypophosphatemia, and acidosis, with a continued high alkaline phosphatase level.

Pseudofractures may now appear on x-rays.

Patient's experiencing vitamin D deficiencies are potential candidates for several nursing diagnoses. Nursing diagnoses should be specific. However, the following can usually be anticipated.

- Comfort, alterations in: pain
- Activity intolerance
- Nutrition, alterations in: less than body requirements
- Injury; potential for (poisoning, potential for; suffocation, potential for; trauma, potential for)
- Home maintenance management, impaired
- Mobility, impaired physical
- Self-care deficit (specify level): feeding, bathing/hygiene, toileting, dressing/grooming
- Self-concept, disturbance in (body image disturbance, self-esteem disturbance, role performance disturbance, disturbance in personal identity)
- Knowledge deficit, specifically related to foods and medications
- Skin integrity, impairment of: potential

Clues to determine if an older person has a vitamin D deficit can be assessed by asking the following questions(1):

- Does the patient go outdoors in the sun?
- Does the patient drink milk and eat dairy products; if so, how much per day?
- Does the patient eat deep-sea fish; if so, how much?

Vitamin D Content of Selected Foods	
Foods	IU/100 g
Egg yolk	25*
Butter	35
Liver	0-67
Halibut	44
Shrimp	150
Salmon (canned)	220-440
Sardines (canned)	1150-1570
Mackerel (fresh)	1100
Fortified milk	100**

\*IU per yolk.  
 \*\*IU per 8 oz.  
 Note: Recommended dietary allowance of vitamin D = 200 IU for males and females 22 years and older. Recommended dietary allowance of vitamin D = 400 IU for males and females over age 65.  
 Source: Barzel (1).

• Does the patient take a vitamin supplement every day; if so, does it contain vitamin D and how much? If the answers are negative, osteomalacia, a generalized bone disorder, is a strong possibility(1).

Rickets, the childhood equivalent of osteomalacia, is a disorder of the formation of bone, which occurs when there is inadequate doses of vitamin D(2). Osteomalacia is marked by "a softening of the bones," which become bent and deformed. In osteomalacia, the osteoid matrix is formed normally, but fails to calcify properly(2). This causes bone pain, muscle weakness, and a "soft bone" syndrome.

The major types of osteomalacia include those due to insufficient levels of vitamin D, drug side effects, renal failure, and inappropriate absorption of calcium. Vitamin D, calcium, and exercise are all indicated in the treatment of osteomalacia and can result in dramatic improvement in patient comfort and functional abilities(1).

Osteoporosis, another common bone disease in older people, causes the bones to become porous and less dense, therefore making the bones more susceptible to fracture and collapse. Vitamin D deficiency may be an indirect factor in the development of osteoporosis. One theory proposes that older adults with osteoporosis experience an age-related alteration in vitamin D metabolism and are unable to convert vitamin D from an inactive to an active form(11). (For a characteristic history of a patient with osteoporosis due to vitamin D deficiency, see "The Case of Mary Cooke.")

Administering calcium as a treatment for this disease is useless if vitamin D is not present in sufficient quantity to absorb the calcium. Bone fractures, characteristic of osteoporosis, are late symptoms of vitamin D deficiency(1,5).

### Environmental Interventions

Research has shown that vitamin D deficiency is more common in housebound subjects(6,13). While lack of sunlight and fresh air are not the only reasons for vitamin D deficiency, they can be a major concern. Being outdoors provides one with the feeling of freedom and freshness and has a soothing, calm, renewing effect.

Reid and others confirmed that sunlight exposure for about 15 to 30 minutes daily results in a substantial increase in levels of 25-hydroxyvitamin D, the principal vitamin D metabolite in serum(13). They concluded that the prophylaxis of osteomalacia in the frail older population can be achieved without risk or expense.

Natural sunlight, then, is preferable to oral doses of vitamin D because it is easier and less expensive. Providing institutionalized residents with private patios that are safe and accessible to wheelchairs may be one way to expose residents to sunlight. Such patios can be surrounded by a fence for those who wander.

Outdoor patios should be attractive, complete with benches, picnic tables, raised flower beds, and trees that provide some shade. Wide sidewalks where wheelchairs can pass each other are essential so that patients can move freely.

Russian studies cited by Hughes and Neer indicate that UV lighting increases "immunologic responsiveness and promotes good health"(14). These results have led the Russians to set standards for minimal UV lighting in the workplace. Devgun and others concluded that the use of Vita-Lite fluorescent tubes did not result in increased 25-hydroxyvitamin D levels(15). They further suggested that the level of illumination needed might be damaging to the retina and should not be used.

Some researchers have also raised the concern that increased exposure to sunlight or UV light may increase the risk of skin neoplasia and erythema(6,15). However, specific recommendations on the placement, intensity, and length of exposure to UV radiation have not yet been established in the literature. These should all be considered when designing environmental lighting in extended care facilities where geriatric residents may spend endless days indoors.

### Dietary Interventions

Nurses must guard against the nutritional deficiencies in older patients' diets, in addition to improving the environment. Special care must be taken to ensure that older people ingest appropriate amounts of vitamins D and C, iron, calcium, fats, proteins, carbohydrates, and calories. The quality of the diet must be improved if it is poor in nutrients, and products fortified with vitamin D must be offered regularly. Obtaining a diet record kept by the patient or caregiver provides the nurse with information on dietary intake.

If the quality of the diet is not a problem, then measures must be taken to insure that older people are eating the appropriate amounts. Problems with appetite, chewing, poorly or improperly fitting dentures, and physical impairment must be assessed, and interventions must be planned to resolve them. If problems of ingestion persist, daily dietary supplements of vitamin D in the normal physiological dose (400 IU) are readily available in over-the-counter preparations.

Very little can be done to ensure

### Measures to Increase Vitamin D and Calcium Levels in Older Adults

#### Dietary Intervention

- Enhance diet with dairy products, bakery products made with enriched white flour, dark green vegetables, salmon and sardines including tiny bones, and addition of nonfat dried milk to solid foods
- Oral vitamin D therapy (400 IU daily)
- Oral calcium supplements (1500 mg daily for postmenopausal women)

#### Environmental Intervention

- Outdoor activities
- Ultraviolet lighting
- Outdoor recreation and exercise
- Outdoor patio for physical and psychological benefits

## THE CASE OF MARY COOKE

Mary Cooke, an 80-year-old single Caucasian woman went to the Geriatric Assessment Center for an evaluation. She had had a Billroth II operative procedure years before and a history of bilateral chronic stasis leg ulcers, osteoarthritis of the hips that limited her functioning, osteoporosis, swelling of her legs and feet, decreased appetite, loneliness, and vague complaints of muscle weakness, bone pain, and fatigue.

Mary could not stand long enough to do any cooking; therefore, she had toast and tea each morning for breakfast and received daily meals-on-wheels for lunch and dinner. Mary's dietary history revealed that her intake of vitamin D was less than 200 IU daily. She never ate liver, kidneys, oily fish, or eggs and, when able to cook, would use only corn oil, which contains no vitamin D.

A home health aide assisted Mary 2 to 3 hours each day. She only went outside when she had medical appointments. Mary was afraid to go outdoors because of her inability to walk and her decreased self-confidence, thus depriving herself of exposure to sunlight.

A physical examination revealed a thin, slim, small-framed, soft-spoken, severely kyphotic woman who was barely able to walk with the assistance of two people. She had pronounced pedal edema and draining stasis ulcers on both legs. Marked tenderness was elicited from deep pressure over the thigh and chest bones. Hip movement was painful.

Laboratory data included a hemoglobin level of 10.1, hematocrit of 31.1, and other hemogram indices normal. Serum calcium level was low (7.9) and dropped to 6.9 over a two-week period. Alkaline phosphatase level was elevated at 177. Creatinine was 2.0 and rose to a high of 2.2 before falling to a low 1.7 over the same two-week period. Mary's total serum protein was 6.7, and her serum carotene level was below normal at 39.

Chest x-rays showed diffuse osteoporosis. Her laboratory tests indicated that she had a low serum calcium level even with calcium replacement. In addition, it was noted that she had an anion gap acidosis with an elevated chloride.

The most likely explanation for these findings was the malabsorption of vitamin D secondary to her Billroth II operative procedure. A 72-hour collection of Mary's stool was obtained and tested. It showed an increased quantity of fat indicating fat malabsorption. On a trial basis, she was given a dosage of 50,000 IU PO of vitamin D every day to overcome the malabsorption and slow the loss of calcium from the bone.

A medical diagnosis of osteomalacia was then made based on the findings. Her medical treatment consisted of calcium carbonate, 1,950 mg PO three times a day; Ergocalciferol (vitamin D), 60,000 IU PO every day; and a multivitamin daily.

Based upon the total assessment of Mary Cooke's clinical and physical status, the nurse who worked with Mary helped obtain visiting nurse services for care of her leg ulcers, arranged for increased homemaker services, and provided Mary with information and instruction on diet, use of a walker, and need for exercise and outside activity. Instructions concerning the nature and dosage of the prescribed medications were also given. Follow-up care was provided by the visiting nurse and the nurse from the assessment center to ensure proper medication administration.

After a two-week period, Mary's alkaline phosphatase level started dropping and became normal after three months. Bone pains disappeared. She became more independent in her daily activities and only needed help two to three times per week. Her stasis ulcers healed, and she was able to walk with the assistance of a walker.

adequate intestinal absorption of vitamins. Therefore, caution must be taken to avoid vitamin overdose, which can lead to toxicity in the older adult. Consequently, providing UV lighting or sunshine appears to be an easier, less expensive, and safer alternative(16).

From the nursing viewpoint, the most effective focus for the nurse is to prevent these problems through health education. This includes teaching patients about appropriate diet, medications, and exposure to sunlight. Screening patients for those that are at risk can be an effective means for decreasing the amount of immobile patients suffering from bone diseases. The preferred laboratory tests for vitamin D deficiencies employ serum 25-hydroxycholecalciferol and serum alkaline phosphatase. An alternative test would be to

use serum calcium and phosphorus.

Since much research remains to be done about UV lighting for older adults in institutions, exposure to the outdoors on warm, sunny days may still be the best therapy for decreasing the incidence of vitamin D deficiency in older adults.

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