An increasing number of men with prostate cancer being treated with androgen-deprivation therapy (ADT) are at increased risk for developing osteoporosis. Osteoporosis often is overlooked in men and can have significant adverse economic effects and reduce quality of life, particularly if a fracture occurs. Nurses play a major role in identifying men who are at risk because of lifestyle factors and ADT. Men receiving ADT should undergo regular screening with bone densitometry to detect osteoporosis and monitor the effectiveness of therapy. Nurses also have a major role in administering medications to promote bone health. Many implications exist for patient education related to bone health in men.

Prostate cancer is a major public health issue. Advances in screening and treatment have resulted in a large population of men who must learn to live with and manage the side effects of therapy, particularly androgen-deprivation therapy (ADT). The National Cancer Institute reported that 2,177,975 men are alive with a history of prostate cancer (Horner et al., 2009). Bone loss is a significant issue among older men with prostate cancer receiving ADT. This article describes implications for nurses as they care for men with alterations in bone health caused by ADT.

Prostate cancer mainly affects men older than 40 years, with a median age at diagnosis of 68 years (Ries et al., 2008). An estimated 192,280 new cases of prostate cancer occur and 27,360 men die from the disease each year (American Cancer Society [ACS], 2009b). Incidence is higher among African American men than Caucasian men; an estimated 27,130 cases of prostate cancer were diagnosed in African American men in 2009, accounting for 34% of all cancers diagnosed in this population (ACS, 2009a). Prostate cancer is the second leading cause of cancer death in African American men, accounting for an estimated 3,690 deaths annually. The death rate for prostate cancer is 2.4 times higher in African American men than in Caucasian men (ACS, 2009b); the difference accounts for about 40% of the overall cancer mortality disparity between African American and Caucasian men.

Despite high mortality rates in some minority populations, epidemiologic evidence suggests that men with localized prostate cancer can expect relative survival rates of almost 100% at five years, 93% at 10 years, and 79% at 15 years (ACS, 2009a). The good survival rates are attributed largely to effective local treatment of the prostate with surgery or radiation and, in part, to the fact that hormonal therapy often can shrink a tumor or decrease its growth (Lu-Yao et al., 2008).

The prostate cancer trajectory and good long-term prognosis pose significant challenges for healthcare providers, particularly related to bone health in older men receiving ADT. Bone loss among men is largely under-reported and underassessed (National Osteoporosis Foundation [NOF], 2008). Men with localized prostate cancer receiving ADT experience a 5- to 10-fold higher rate of bone loss within the first year of ADT compared to the general population (Greenspan et al., 2005). The risk for developing osteoporosis among older men receiving ADT approaches 50% at four years and 80% at 10 years (Higano, 2008).

**At a Glance**
- Men with prostate cancer receiving androgen-deprivation therapy (ADT) are at high risk for developing osteoporosis.
- Men receiving ADT should undergo risk evaluation for osteoporosis and have regular screening with bone densitometry to evaluate the effectiveness of therapies.
- Nurses should educate men receiving ADT about osteoporosis, risk factors, prevention and screening strategies, and medications to promote bone health.

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Osteoporosis is defined as a metabolic disease in which bones lose density and become fragile and more likely to break (NOF, 2008). If not prevented or if left untreated, osteoporosis can progress without pain or noticeable symptoms until a fracture occurs. The broken bones, also known as fragility fractures, typically occur in the hip, spine, and wrist. A hip fracture, which almost always requires hospitalization and major surgery, can impair a person's ability to walk unassisted and may cause prolonged or permanent disability or even death, particularly in an older individual. Spinal or vertebral fractures also have serious consequences, including loss of height, severe back pain, and deformity.

In the United States, an estimated 8 million women and 2 million men are living with osteoporosis (NOF, 2008). During youth, bones grow in length and density. Maximum height is reached in the teenage years, but bones continue to grow denser until peak bone density is attained at about age 30. After age 30, bones slowly start to lose density or strength. Throughout life, bone density is affected by heredity, diet, sex hormones, physical activity, lifestyle choices, and use of certain medications. Men have larger, stronger bones than women, which explains, in part, why osteoporosis affects fewer men (NOF, 2008). Risk is lower in African Americans, but the large number of African American men being diagnosed with prostate cancer and receiving ADT is creating a population that is not routinely considered to be at risk for bone loss.

<table>
<thead>
<tr>
<th>RISK FACTOR</th>
<th>POSSIBLE ETIOLOGIC FACTORS AND EPIDEMIOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive alcohol intake</td>
<td>Excessive alcohol intake can decrease testosterone levels, which increases risk for osteoporosis. In many cases, men who drink excessively do not get enough calcium. Drinking also may decrease the body's calcium supply. People with a history of excessive alcohol use are 1.7 times more likely to experience an osteoporotic fracture than people who do not consume alcohol regularly.</td>
</tr>
<tr>
<td>Gender</td>
<td>Two million people with osteoporosis (20%) are men. A man older than 50 years is more likely to break a bone because of osteoporosis than he is to get prostate cancer. Men have greater vertebral strength than women at all ages, largely because of their greater cross-sectional area of vertebrae, which is estimated to be 25% smaller in women.</td>
</tr>
<tr>
<td>Heredity</td>
<td>Heredity and genetics play a major role in osteoporosis. A family history of osteoporosis or a history of fracture increases risk for low bone mass and subsequent fracture. The genetic predisposition is not understood fully.</td>
</tr>
<tr>
<td>Inadequate exercise</td>
<td>Weight-bearing exercise such as walking and running as well as strength training with weights or resistance bands increase osteoblast activity and formation.</td>
</tr>
<tr>
<td>Increasing age</td>
<td>Aging is associated with decreased bone density because of a normal increase in the number of osteoclasts.</td>
</tr>
<tr>
<td>Low body weight</td>
<td>Men with small bones are more likely to have osteoporosis than larger people. Men who lose more than 5% of their baseline weight in a short period of time have about twice the rate of bone loss than men with stable weight. Men who gain weight tend to have very little or no bone loss. Increased muscle mass protects the bones.</td>
</tr>
<tr>
<td>Low calcium intake</td>
<td>Calcium, along with phosphate, is critical to the formation of hydroxyapatite, the crystal that gives bone its rigidity and strength. Recommended daily doses of calcium for adults range from 1,000–1,500 mg by diet or supplement, consumed in divided doses.</td>
</tr>
<tr>
<td>Magnesium deficiency</td>
<td>Magnesium deficiency causes a decrease in osteoblasts and an increase in osteoclasts.</td>
</tr>
<tr>
<td>Prolonged exposure to steroids, anticonvulsive medications, ADTs, and chemotherapy</td>
<td>These agents decrease the amount of calcium absorbed by the intestines from food and decrease the number of bone-forming cells. LHRH agonists generally result in the formation of resorption cavities beyond the capacity of osteoblasts to repair, resulting in a net loss of bone. Chemotherapy also promotes a hypogonadal state and has a direct toxic effect on bone that disturbs the balance between osteoclasts and osteoblasts.</td>
</tr>
<tr>
<td>Race</td>
<td>Osteoporosis affects all races and ethnicities. Caucasian and Asian Americans are at highest risk for osteoporosis. African Americans tend to have higher peak bone mass levels than Caucasian and Asian Americans. Hispanics tend to have peak bone mass levels lower than African Americans but higher than Caucasian or Asian Americans.</td>
</tr>
<tr>
<td>Smoking</td>
<td>The chemicals in cigarettes damage bone cells. Smoking might decrease osteoblasts' ability to absorb calcium. Certain smoking subgroups also may be at increased risk, particularly men with a history of smoking more than 20 packs per year and current smokers with a low body weight (less than 75 kg). Overall, smokers are 1.6 times more likely to experience an osteoporotic fracture than nonsmokers.</td>
</tr>
<tr>
<td>Testosterone</td>
<td>Testosterone protects bone in men. Estrogen levels in men also are important. Estrogen deficiency shifts the balance of bone remodeling toward increased bone resorption by activating osteoclasts, decreasing osteoclast apoptosis, and increasing osteoblast apoptosis. Low levels of the hormones can lead to bone loss. Men with the lowest levels of estradiol and highest levels of sex hormone-binding globulin are at highest risk for fracture, even when testosterone levels are considered.</td>
</tr>
<tr>
<td>Vitamin D deficiency</td>
<td>Vitamin D is important in the absorption and usage of calcium and is essential for skeletal maintenance. Vitamin D insufficiency has been linked to reduced muscle function and increased risk of falling, although the exact mechanisms are not well understood.</td>
</tr>
</tbody>
</table>

ADT—androgen-deprivation therapy; LHRH—luteinizing hormone-releasing hormone

Note. Based on information from Israeli et al., 2008; National Osteoporosis Foundation, 2008; Papaioannou et al., 2009; Parton & Smith, 2008; Pietschmann et al., 2009; Reid, 2008; Rude et al., 2009; van Londen et al., 2008.
Although bone loss is a well-known public health issue in women, many do not realize that older men also are at risk for developing osteoporosis (see Table 1). Bone loss from long-term ADT can result in increased risk for developing fractures, frailty, and other skeletal complications. Many public health campaigns target bone loss in women, and women are routinely screened for osteoporosis; however, much less awareness exists regarding risk for osteoporosis in men.

**Economic Burden**

Economic burdens caused by bone loss and osteoporosis are significant (NOF, 2008). Room and board in the hospital after surgery accounts for 73% of the estimated $11,582 cost per patient associated with inpatient and outpatient care for hip fractures. Hip fractures tend to occur late in life; therefore, only about 23% of people who fracture their hips fully recover to prefracture status, 32% regain near normal functioning with minimal assistance, and 25% are injured more severely and require dependent care in a facility for at least one year. The remaining 20% die within one year. Among patients discharged to a skilled nursing facility, 51% require institutional care for at least one year, 10% die within six months, and 39% die within 6–12 months. Costs associated with rehabilitation and institutional care are estimated to be $5.1–$7.1 billion annually (NOF, 2008). Estimated total costs of osteoporosis-related fractures in the United States are at least $17 billion annually, of which men account for more than 25% of the burden (Burget et al., 2007).

The direct economic impact of ADT-related fractures has not been quantified. However, ADT can be inferred to contribute to fracture-related hospitalizations because ADT accelerates bone loss. Managing cancer treatment-induced bone loss is a significant issue that has emerged with the increased survival rate in men receiving ADT. The National Comprehensive Cancer Network (NCCN) has released guidelines on the assessment and management of bone loss in patients with cancer, particularly men receiving ADT (Gralow et al., 2009). Preventing complications may be the best way to decrease morbidity and financial costs associated with bone loss and improve quality of life in this population.

**Physiology of Bone Formation**

Bones are composed of three major components: collagen, calcium-phosphate mineral complexes, and living bone cells (NOF, 2008). Collagen is a protein that gives bones a flexible framework. Calcium-phosphate mineral complexes make bones hard and strong. Living bone cells known as osteoclasts and osteoblasts remove and replace weakened sections of bone (see Figure 1).

Throughout life, bone is continuously renewed through a two-part process called remodeling, which consists of resorption and formation (Hadjidakis & Androulakis, 2006). During resorption, old bone tissue is broken down and removed by osteoclasts. During bone formation, osteoblasts lay down new bone tissue to replace the old. Osteoclast and osteoblast function is regulated by several hormones including calcitonin, parathyroid hormone, vitamin D, estrogen (in women) and testosterone (in men).

Children and teenagers form new bone faster than they lose old bone. Even after they stop growing taller, young people continue to make more bone than they lose, meaning that their bones get denser until they reach their peak bone mass at about age 30 (Hadjidakis & Androulakis, 2006). After reaching peak bone mass, the balance between bone loss and bone formation begins to change. In midlife, bone loss usually speeds up in men and women. Osteoporosis occurs when an individual has too much bone loss, too little bone formation, or both. Greater peak bone mass leads to better protection against weak bones once bone loss begins (NOF, 2008). Figure 2 illustrates the difference between healthy bone and osteoporotic bone.

**Androgen-Deprivation Therapy**

ADT is a common treatment among older men with prostate cancer. Androgen deprivation is achieved either by surgical intervention (bilateral orchietomy) or pharmacologic inhibition with a luteinizing hormone-releasing agonist, which can cause hypogonadism (Saad et al., 2004) (see Table 2). Hypogonadism increases bone resorption as well as bone formation. However, ADT increases bone resorption, resulting in decreased bone mass density and increased risk for fractures. The pathophysiology of bone loss from ADT is caused by excessive osteoclast-mediated bone resorption that cannot be repaired by the osteoblasts in bone remodeling (Guise & Eastham, 2004). In a study of 50,000 men with prostate cancer who had more than five years of survival, Shahinian, Kuo, Freeman, and Goodwin (2005) reported that fractures occurred among 19% who received ADT and 12% among those who did not (p < 0.0001). Among men with advanced prostate cancer who received ADT for more than 12 months, 38% had decreased bone mass density and 50% had vertebral fractures. The increase in skeletal morbidities in this population can adversely affect quality of life.

**Screening for Osteoporosis**

Age at diagnosis, preexisting bone loss, and osteoporosis prior to initiation of ADT can substantially increase the risk for skeletal morbidity in older men. According to World Health...
Organization ([WHO], 2007) criteria, osteoporosis is defined as a T score decrease in bone mineral density lower than 2.5 standard deviations (–2.5) (NOF, 2008). Osteopenia is considered a precursor of osteoporosis and is defined as a T score from –2.5 to –1 standard deviations (NOF, 2008; WHO, 2007). Bone mineral density is measured by dual-energy x-ray absorptiometry (DEXA). The American College of Preventive Medicine and NOF recommend DEXA for men older than 70 years (Lim, Hoeksema, Sherin, & ACPM Prevention Practice Committee, 2009; NOF, 2008). Figure 3 lists patient education points for DEXA.

Recommendations

Promoting bone health in older men with prostate cancer receiving ADT is an important aspect of comprehensive cancer care. An objective of the U.S. Department of Health and Human Services (2000) Healthy People 2010 goals directly related to bone loss and osteoporosis includes reducing the incidence of osteoporosis, reducing hospitalizations for spine fractures, reducing hip fractures, increasing calcium intake, and increasing physical activity. In addition, NOF (2008) recommends a vitamin D intake of 800–1,000 IU per day for adults 50 years and older. Vitamin D replacement can increase muscle strength and decrease the risk of falls (NOF, 2008). A vitamin D level of 30 ng/ml (75 nmol/l) is considered optimal (NOF, 2008).

NCCN (2008) guidelines for bone-loss prevention in older men receiving ADT include identification of risk factors for osteoporosis, establishing diagnoses, recommendations for pharmaceutical interventions, lifestyle changes, and prevention of clinical sequelae in this population. Recommended lifestyle changes include regular weight-bearing and muscle-strengthening exercises. Clinicians also should advise patients to avoid tobacco smoking and excessive alcohol intake to promote bone health (NOF, 2008).

Before guidelines for osteoporosis screening can be applied properly, the population at risk must be identified. Cancer-related causes of osteoporosis include hypogonadism from orchiectomy for prostate cancer, ADT, glucocorticoid therapy, and aromatase inhibitor therapy (Lim et al., 2009; NOF, 2008). Screening and early detection for osteoporosis in high-risk patients prior to initiation of ADT can promote bone health, earlier initiation of treatments, and the prevention of fractures and falls.

Osteoporosis risk-assessment tools are useful supplements to bone mass density assessments because they provide estimates of absolute fracture risk based on population cohort studies (Kanis, Johnell, Oden, Johansson, & McCloskey, 2008). Assessment tools can be used when bone mass density testing is not readily available or not feasible. In addition, the tools can help healthcare providers and patients make treatment decisions to reduce fracture risk. The FRAX® (Fractured Risk Assessment Tool) was developed by WHO to calculate the 10-year probability of a hip or major osteoporotic fracture (Kanis, 2008). Its algorithm is calibrated to different populations globally. The tool is available at www.nof.org and www.shef.ac.uk/FRAX.

Management of Osteoporosis in Men

Men must realize that they have a risk for osteoporosis. NCCN (2008) guidelines recommend that healthcare providers should inform patients that osteoporosis is an adverse effect of ADT.

Table 2. Advantages and Disadvantages of Androgen-Deprivation Therapies

<table>
<thead>
<tr>
<th>THERAPY</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiandrogens</td>
<td>Side effects can sometimes be managed by switching to a different drug.</td>
<td>Need to remember to take the pill every day</td>
</tr>
<tr>
<td></td>
<td>Erection may be possible because testosterone still is being produced.</td>
<td>Can cause breast swelling</td>
</tr>
<tr>
<td></td>
<td>May be less likely to cause osteoporosis than LHRH agonists</td>
<td>Can cause erectile dysfunction</td>
</tr>
<tr>
<td>LHRH agonists</td>
<td>Side effects can sometimes be managed by switching to a different drug.</td>
<td>Risk of tumor flare at the initiation of treatment</td>
</tr>
<tr>
<td></td>
<td>Equally effective as orchiectomy</td>
<td>Side effects include erectile dysfunction and hot flashes.</td>
</tr>
<tr>
<td></td>
<td>Less likely to cause breast swelling than antiandrogens</td>
<td>Must go to healthcare provider on a regular basis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Associated with bone loss</td>
</tr>
<tr>
<td>Orchiectomy</td>
<td>One-time treatment</td>
<td>Not reversible</td>
</tr>
<tr>
<td></td>
<td>Equally effective as LHRH agonists</td>
<td>Side effects include erectile dysfunction and hot flashes.</td>
</tr>
<tr>
<td></td>
<td>Less likely to cause breast swelling than antiandrogens</td>
<td>Requires local or general anesthesia and recovery</td>
</tr>
</tbody>
</table>

LHRH—luteinizing hormone-releasing hormone

Note. Based on information from Drake et al., 2008; National Comprehensive Cancer Network, 2008; Weingard, 2008.
What is a bone mineral density (BMD) test?
- A BMD test is the best way to determine bone health.
- BMD tests can identify osteoporosis, determine risk for fractures, and assess response to osteoporosis treatment.
- The most widely used test is the dual-energy x-ray absorptiometry (DEXA) test, which can measure bone density at the hip and spine.

What is measured with DEXA?
- A DEXA test measures BMD and compares it to an established norm.

What is a T score?
- DEXA test findings are compared to the ideal or peak BMD of a healthy 30-year-old adult. The result is reported as a T score.
- A T score of 0 means bone mineral density is equal to the norm for a healthy young adult. Differences between BMD and the norm are measured in standard deviations. Scores with more standard deviations below 0 (negative) indicate lower BMD and higher risk for fracture.
- A T score from –1 to +1 is considered normal or healthy.
- A T score from –2.5 to –1 indicates low bone mass (osteopenia).
- A T score of –2.5 or lower indicates osteoporosis. Lower negative numbers indicate more severe osteoporosis.

Who should get a DEXA test?
- The American College of Physicians recommends DEXA for men who have risk factors for osteoporosis and are willing and able to take drugs (bisphosphonates) for treatment.

**Figure 3. Patient Education Points for Bone Densitometry**
*Note. Based on information from National Osteoporosis Foundation, 2008; Qaseem et al., 2008.*

NCCN (2008) also recommends screening and treatment for osteoporosis in accordance with NOF guidelines. In particular, men receiving ADT should be screened with DEXA at baseline prior to initiating treatment. Depending on the outcome of the screening, men may need osteoporosis treatment. All men will benefit from preventive measures. Men may not be able to stop ADT in many cases, but they can engage in strategies to decrease bone loss (see Figure 4).

**Treatment**

Antiresorptives are medications that slow bone loss and are used to treat osteoporosis caused by ADT. The U.S. Food and Drug Administration has approved the following antiresorptive medications to treat osteoporosis in men: alendronate (Fosamax®), merck and Co., Inc.), zolendronic action (Reclast® and Zometa®, Novartis Pharmaceuticals) and risedronate (Actonel®, Procter and Gamble Pharmaceuticals). Antiresorptives are in a class of drugs called bisphosphonates. Table 3 outlines nursing education points regarding bisphosphonate therapy.

**Outcomes**

Patient-centered outcomes promoting safety, timeliness, efficiency, effectiveness, and equity are among the most important criteria for improving quality of care in this population. Quality care outcomes can be at the clinical level or population level. Outcomes related to bone health can be measured by reduced falls, fractures, hospitalizations, and improved quality of life.

**Clinical-level outcomes:** The availability of quality care (prevention, screening, and treatment) to patients who are at risk for or who have bone fractures is critical for obtaining positive patient outcomes. Outcomes can be measured by the functional capacity achieved after a fracture. Other outcome measures include survival, prevention of complications, decreased hospitalization days, and prevention of disability. Determinants of health outcomes at the clinical level are related to social, economic, and environmental factors; health disparities; access to care; payer system; insurance affiliations; and compliance with treatment.

The cost of the examination and some geographic localities may limit the availability of DEXA machines when indicated. Evidence-based clinical practice guidelines and healthcare providers’ knowledge can contribute to negative or positive clinical outcomes. Clinical effectiveness is achieved by improving the health status of the individual through preventive medical care services (Aday, Begley, Lairson, & Balkrishnan, 2004). Efficiency is achieved by combining inputs to produce services at the lowest cost, and procedural equity is achieved by optimizing the availability of services across groups (Aday et al., 2004). All factors, clinical outcomes, clinical efficiency, and procedural equity should be considered when evaluating the effectiveness of bone health care in men with prostate cancer receiving ADT.

**Population-level outcomes:** Population-level measurements specifically for cancer treatment-induced osteoporosis and falls need additional research. However, quality indicators from the vulnerable older adult population for management of osteoporosis can be applied to bone health among older men with prostate cancer receiving ADT.

Healthcare providers in primary care should screen patients with prostate cancer for risk factors and implement prevention and early detection measures. Evidence suggests the importance of identifying secondary osteoporosis among patients with cancer and patients receiving ADT. In men with a history of smoking and alcohol use, cessation should be promoted and screening should be emphasized because both have been linked to increased fractures of the hips, spine, and wrists (Hollenbach, Barrett-Connor, Edelstein, & Holbrook, 1993; National Institutes of Health, 1993).

- Eliminate unhealthy habits (e.g., smoking, excessive alcohol intake).
- Ensure adequate calcium intake. Men younger than 50 years need 1,000 mg of calcium daily; men 50 years or older need 1,200 mg of calcium daily.
- Ensure adequate vitamin D intake. Men younger than 50 years need 400–800 IU of vitamin D daily; men 50 years or older need 800–1,000 IU of vitamin D daily. Both types of vitamin D supplements (D2 and D3) are necessary for bone health.
- Reduce inactivity and engage in a regular regimen of weight-bearing exercises in which bone and muscles work against gravity. Exercises can include walking, jogging, racquet sports, stair climbing, and team sports. In addition, lifting weights or using resistance machines appears to help preserve bone density. Exercise also improves balance and muscle tone and imparts a sense of well-being.

**Figure 4. Primary Prevention Strategies for Osteoporosis**
*Note. Based on information from National Osteoporosis Foundation, 2008; Weingard, 2008.*
of Health, 2009). NOF and the American College of Physicians recommend taking a history of medication and alcohol use (NOF, 2008; Qaseem et al., 2008). Other outcome measurements and quality indicators related to bone health in men include prevention of osteoporosis through education, use of calcium and vitamin D supplements, physical activity and exercise, and other lifestyle changes. Adherence to lifestyle modification and nutritional recommendations are key to prevention. Monitoring for bone loss and prevention of fractures in this population are crucial and measurable clinical outcomes.

Recommendations based on expert opinion for bone health in patients with prostate cancer receiving ADT include investigations of skeletal fractures in patients with a history of fractures using x-rays and DEXA (Cummings et al., 2006; Higano, 2008; Siris et al., 2004). An osteoporosis diagnosis is highly predictive of fracture risk (Greenspan, 2008); however, no clinical trials to date have demonstrated a direct correlation between ADT and osteoporosis diagnosis (Qaseem et al., 2008). Monitoring bone mineral density in patients receiving ADT also is important for determining other treatments. Biochemical markers of bone turnover, such as N-telopeptide and bone alkaline phosphatase, have been used to measure the effectiveness of treatments in clinical trials but have not been used at the population level.

Gender and age disparity in screening guidelines are evident in recommendations from the American Association of Clinical Endocrinologists, the United States Preventive Services Task Force, and the NOF to routinely screen women 65 years and older (NOF, 2008; Qaseem et al., 2008). The public health threat and burden of osteoporosis in the general population of men should not be ignored, as ADT for prostate cancer increases risk for osteoporosis, fractures, mortality, morbidity, and quality of life.

### Table 3. Bisphosphonates to Treat Osteoporosis

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>ALENDRONATE SODIUM OR ALENDRONATE SODIUM PLUS VITAMIN D</th>
<th>RISEDRONATE SODIUM OR RISEDRONATE SODIUM WITH CALCIUM CARBONATE</th>
<th>ZOLEDRONIC ACID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication</td>
<td>FDA approved for the prevention and treatment of osteoporosis in postmenopausal women and for treatment of osteoporosis in men. FDA approved for the treatment of glucocorticoid-induced osteoporosis in men and women caused by long-term use of steroid medications.</td>
<td>FDA approved for the prevention and treatment of osteoporosis in postmenopausal women. FDA approved in 2006 for the treatment of osteoporosis in men. FDA approved for the prevention and treatment of glucocorticoid-induced osteoporosis in men and women caused by long-term use of steroid medications.</td>
<td>FDA approved in 2007 for the treatment of osteoporosis in postmenopausal women. The drug is the first and only once-a-year osteoporosis medication available. The medication was available as Zometa&lt;sup&gt;a&lt;/sup&gt; (Novartis Pharmaceuticals) for use in patients with cancer with certain bone conditions in 2001.</td>
</tr>
<tr>
<td>Mechanism of action</td>
<td>Alendronate reduces bone loss, increases bone density, and reduces the risk for spine, hip, and other fractures by about 50% over two to four years.</td>
<td>Risedronate slows bone loss, increases bone density, and reduces the risk for spine and nonspine fractures by 35%–45% over three years.</td>
<td>Zoledronic acid increases bone strength and reduces fractures in the hip, spine, and nonspine areas (e.g., wrists, arms). Zoledronic acid reduces risk for spine fractures by 70% and hip fractures by 41%.</td>
</tr>
<tr>
<td>Dosage</td>
<td>For prevention, alendronate is taken daily as a 5 mg tablet or weekly as a 35 mg tablet. For treatment, alendronate is taken daily as a 10 mg tablet or weekly as a 70 mg tablet with or without vitamin D.&lt;sup&gt;b&lt;/sup&gt; The weekly dose with vitamin D contains either 2,800 IU or 5,600 IU of vitamin D.</td>
<td>For both prevention and treatment, risedronate is taken daily as a 5 mg tablet, weekly as a 35 mg tablet that is available with or without separate calcium carbonate tablets, twice monthly as a 75 mg tablet (on two consecutive days), or monthly as a 150 mg tablet.</td>
<td>Zoledronic acid is administered as an IV dose of 5 mg in the outpatient setting. The yearly infusion takes 15 minutes.</td>
</tr>
<tr>
<td>Administration</td>
<td>The tablet is taken on an empty stomach first thing in the morning after waking. The tablet is swallowed whole with 6–8 oz. of plain water (no other liquid) at least 30 minutes before having anything to eat or drink. Patients must remain upright (sitting, standing, or walking) during the 30-minute period.</td>
<td>The tablet is taken on an empty stomach first thing in the morning after waking. The tablet is swallowed whole with 6–8 oz. of plain water (no other liquid) at least 30 minutes before having anything to eat or drink. Patients must remain upright (sitting, standing, or walking) during the 30-minute period.</td>
<td>Patients need to have two blood tests prior to each IV dose. The first is a test for creatinine to confirm that kidney function is normal. The other is a test for calcium to confirm that the blood calcium level is normal.</td>
</tr>
<tr>
<td>Side effects</td>
<td>Bone, joint, or muscle pain Side effects of oral tablets may include nausea, difficulty swallowing, heartburn, esophageal irritation, and gastric ulcer.</td>
<td>Bone, joint, or muscle pain Side effects of oral tablets may include nausea, difficulty swallowing, heartburn, esophageal irritation, and gastric ulcer.</td>
<td>Bone, joint, or muscle pain Flu-like symptoms Headache Osteonecrosis of the jaw</td>
</tr>
</tbody>
</table>

**FDA**—U.S. Food and Drug Administration

Note. Based on information from "Alendronate (Fosamax) and risedronate (Actonel) revisited," 2005; MacLean et al., 2008; National Osteoporosis Foundation, 2008.
Nursing Implications

Nurses play a major role in promoting bone health in older men with prostate cancer receiving ADT. Patient education on ADT’s implications for bone health and fracture risk is important prior to initiating ADT. Nurses are critical in identifying patients who are at risk for bone loss prior to receiving ADT. The administration of calcium, vitamin D, and bisphosphonates as measures to promote bone health should be considered in patients prior to receiving ADT as well as in long-term survivors. Nurses also should ensure that patients receive DEXA annually to screen for bone loss and monitor the effectiveness of therapy.

Nurses should monitor the effectiveness of interventions on outcome. Some possible outcome measures throughout the cancer continuum are shown in Figure 5. Nurses can make a significant impact by educating patients, healthcare providers, and third-party payers about bone loss and osteoporosis in men, particularly those receiving ADT.

Nurses also play important roles in interprofessional collaboration and teamwork to promote bone health in this population. Teamwork is necessary in clinical management, multidisciplinary roles, assessment, diagnosis, development of preventive fall strategies at bedside, safety and mobility programs, and quality improvement initiatives. Interprofessional collaboration among nurses and other disciplines can be reflected in increased clinical research, policy changes to effect practice change patterns, and the development of guidelines, treatment protocols, and surveillance programs. Nurses will have opportunities to conduct future research studies and evaluate clinical practice patterns related to bone health in older men with prostate cancer receiving ADT.

Conclusion

The change in the prostate cancer trajectory poses challenges in the long-term survival of older men receiving ADT. Bone loss is a significant side effect of ADT that can affect men’s quality of life. However, a need exists to identify men at risk for osteoporosis and implement strategies to prevent and treat complications from bone density loss. Osteoporosis, bone density loss, and fracture risk should be assessed in men with prostate cancer prior to starting ADT. Bone health management should be emphasized in the prevention and treatment of cancer treatment-induced bone loss. Interprofessional collaboration and teamwork approaches among nurses are necessary to improve outcomes. The roles of nurses in research, clinical management, education, quality improvement, and advocacy for high-quality care related to bone health management throughout the cancer care continuum are critical.

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Prevention
- Adherence to preventive strategies such as taking vitamin D and calcium supplements or physical activities
- Elimination of unhealthy behaviors (e.g., excessive alcohol intake)

Screening and Early Detection
- Identification of men at risk for bone loss
- Testing baseline bone mass density in men who are at high risk

Diagnosis and Treatment
- Increased adherence to treatment guidelines
- Reduction in bone loss and osteoporosis
- Reduction in falls
- Reduction in fractures
- Reduction in mortality and morbidity

Surveillance and Education
- Bone health management education, follow-up, and monitoring
- Long-term surveillance for falls and fractures
- Skeletal morbidity reduction while on androgen-deprivation therapy
- Providers’ adherence to guidelines for androgen-deprivation therapy and bone loss management

Policy Development and System Changes
- Change Medicare reimbursement for routine screening to include men.
- Increase bone health education and awareness initiatives.

Figure 5. Potential Outcome Measures of Bone Health in Patients With Prostate Cancer

Note. Based on information from Lim et al., 2009; National Osteoporosis Foundation, 2008; Qaseem et al., 2008; World Health Organization, 2007.

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