The Continuum of Women's Health: From Menopause to Osteoporosis

The Oklahoma City Area Annual Pharmacy Seminar
Katherine O'Neal, PharmD, MBA, BCACP, CDE, BC-ADM, AE-C, CLS
Associate Professor
University of Oklahoma College of Pharmacy
Member Harold Hamm Diabetes Center
Katherine-ONeal@ouhsc.edu
June 30, 2019

Disclosure

- Under guidelines established by the Accreditation Council for Pharmacy Education, disclosure must be made regarding financial relationships with commercial interests within the last 12 months.
- I have no relevant financial relationships or affiliations with commercial interests to disclose.

Learning Objectives

At the completion of this activity, pharmacists will be able to:

1. List health screenings recommended for adult women
2. Describe the efficacy and place in therapy for osteoporosis prevention and treatment options
3. Identify pros and cons for postmenopausal treatment options

3

Pre-Assessment Question 1

At which age should all women be screened for osteoporosis, regardless of risk?

A. 55
B. 60
C. 65
D. 75

4

Pre-Assessment Question 2

Which therapy option listed below provides benefit in reducing risk of vertebral, non-vertebral and hip fractures and is an oral therapy option?

A. Alendronate
B. Calcitonin
C. Denosumab
D. Zoledronic acid

5

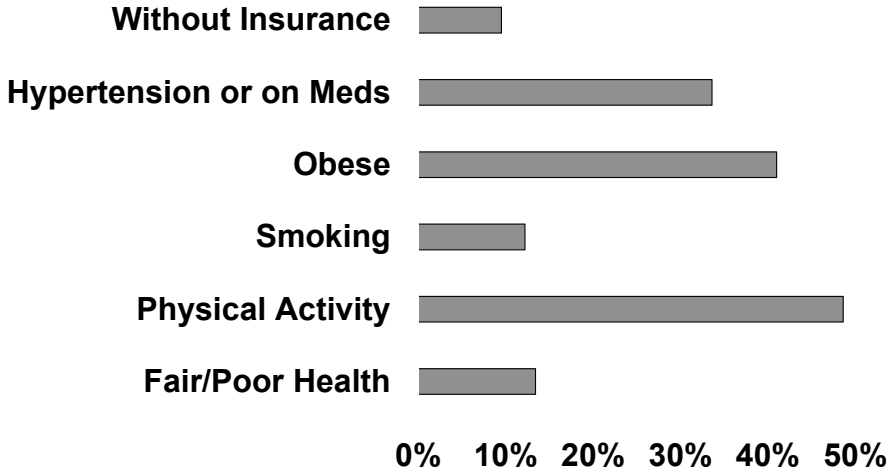
Pre-Assessment Question 3

A 68 year old female complaining of vasomotor symptoms with a significant history of CVD and breast cancer (on tamoxifen) would best be treated with which option?

A. Black cohosh
B. Hormone replacement therapy (transdermal)
C. Gabapentin
D. Paroxetine

6

Current Landscape



Heart disease is leading cause of death

CDC National Center for Health Statistics: FastStats – Women's Health.

7

Health Screening Recommendations

Updated USPSTF A and B Recommendations

Screen	Description	Evidence Grade	Date
Cervical Cancer	Screen every 3 years with cervical cytology alone in women aged 21-29. Age 30-65, screen cervical cytology alone, every 5 years with high-risk human papillomavirus (hrHPV) testing alone, or every 5 years with hrHPV testing in combination with cytology (cotesting)	A	Aug 2018
Syphilis	Screen early for syphilis infection in all pregnant women	A	Sep 2018
Fall Prevention	Exercise interventions to prevent falls in community-dwelling adults 65 years and older who are at increased risk of falls	B	April 2018
Osteoporosis	Screen postmenopausal women <65 who are at increased risk as determined by a formal clinical risk assessment tool and screen all women ≥65	B	June 2018

Campos-Outcalt D. USPSTF Update. 2018;67(5):294;USPSTF A and B Recommendations. US Preventive Services Task Force. February 2019

9

Updated USPSTF A and B Recommendations

Screen	Description	Evidence Grade	Date
Obesity	Offer or refer adults with a BMI ≥30 kg/m2 to intensive, multicomponent behavioral interventions	B	Sep 2018
Intimate Partner Violence	Screen for intimate partner violence in women of reproductive age and provide or refer women who screen positive to ongoing support services	B	Oct 2018
Unhealthy Alcohol Use	Screen for unhealthy alcohol use in primary care settings in adults ≥18, including pregnant women, and providing persons engaged in risky or hazardous drinking with brief behavioral counseling interventions to reduce unhealthy alcohol use	B	Nov 2018
Perinatal Depression	Provide or refer pregnant and postpartum persons who are increased risk of perinatal depression to counseling interventions	B	Feb 2019

Campos-Outcalt D. USPSTF Update. 2018;67(5):294;USPSTF A and B Recommendations. US Preventive Services Task Force. February 2019

10

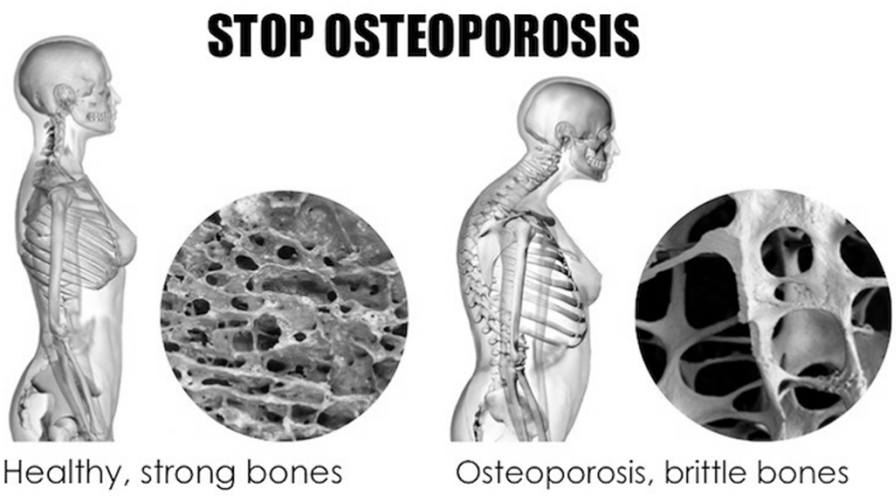
Screening Recommendations

- Pelvic/Breast Exam
- Blood Pressure
- Depression
- Cholesterol
- Mammography
- Genetic Risk Assessment and BRCA Mutation Testing
- Diabetes
- Papanicolaou Test
- Colorectal Cancer
- Lung Cancer
- Statin Use
- Hep C
- Obstructive Sleep Apnea

Campos-Outcalt D. USPSTF Update. 2018;67(5):294;USPSTF A and B Recommendations. US Preventive Services Task Force. February 2019

11

Osteoporosis



Available Guidelines

- US Preventive Services Task Force
- National Osteoporosis Foundation
- American College of Rheumatology
- National Institute for Health and Care Excellence
- American College of Physicians
- American Association of Clinical Endocrinologists and American College of Endocrinology

National Statistics

- Estimated 10 million people in US have osteoporosis
- 40% regain prefracture independence
- 10-20% increased mortality at one year
- 500,000 hospitalizations/year
- 800,000 emergency department visits/year
- 2.5 million office visits/year
- Total healthcare costs expected to increase to $25 billion by 2025 ($18 billion in 2002)

NCHS Data Brief No. 187, Feb 2015; CDC National Center for Statistics; Jeremiah MP. Diagnosis and Management of Osteoporosis. Am Fam Physician. 2015;92(4):261

14

Statistics for Women

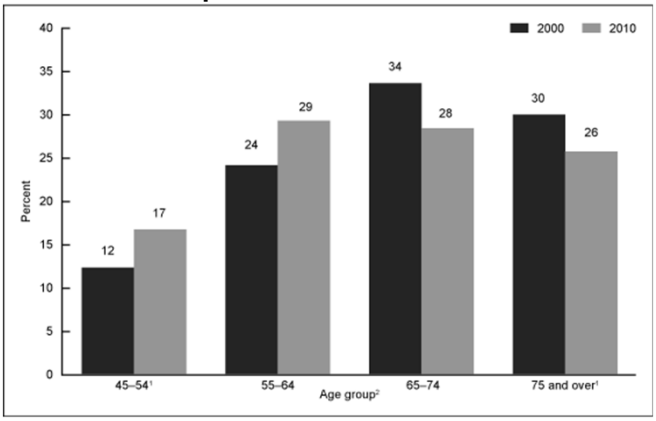
- Affects 25% of women (1 in 4) aged ≥65
- 24.5% of women ≥65 have osteoporosis of the femur neck or lumbar spine
- Half of all postmenopausal women have an osteoporosis related fracture during their lifetime
- 25% of women develop a vertebral deformity

NCHS Data Brief No. 187, Feb 2015; CDC National Center for Statistics

15

Hip Fractures

- Women fall more often than men, three quarters of all falls
- In 2010, there were 310,800 total hip replacements performed in adults ≥45



NCHS Data Brief No. 187, Feb 2015; CDC National Center for Statistics

16

Osteoporosis Pathophysiology

- Characterized by low bone mass and structural deterioration of bone tissue, “porous bone”
- Bone resorption > bone formation as we age
- Key components in bone health
  - Calcitonin: inhibits bone resorption
  - RANKL: stimulates hematopoietic stem cell differentiation for development of mature osteoclasts
  - Estrogen: helps to maintain normal bone resorption rate
  - Calcium: chief mineral component and essential to development of bone
  - Vitamin D: modulates calcium and phosphate homeostasis

RANKL = receptor activator of nuclear factor kappa B ligand

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016 17

Osteoporosis Diagnosis

- Fragility fracture
- Bone Mineral Density (BMD) measurements
- T-score is a measure of an individual’s BMD in standard deviation relative to the normal young adult mean BMD (with DXA)
- Every standard deviation decrease in BMD represents a 10-12% decrease in bone mass and a 1.5-2.6 fold increase in fracture risk
  - Normal bone mass: T-score -1 or higher
  - Osteopenia: T-score of -1 to -2.5
  - Osteoporosis: T-score -2.5 or lower

DXA = dual energy x-ray absorptiometry assessment

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016 18

Osteoporosis Risk Factors

- Increase in age
  - Women >65
  - Men >70
- Gender – Women
- Hormone deficiency
  - Women – estrogen
  - Men – androgen
- Race – Caucasian and Asian
- Bone structure and body weight <127 lbs
- Family history
- Social history (smoking, alcohol, caffeine)

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016 19

Medication Related Risks

- Anticonvulsants
- Lithium
- Proton pump inhibitors
- Systemic corticosteroids (>5mg daily prednisone or equivalent for ≥3 months)
- Selective serotonin reuptake inhibitors
- Excessive thyroid supplementation
- Tricyclic antidepressants
- Warfarin
- Thiazolidinediones
- Methotrexate

Cosman F. Clinician's Guide to Prevention and Treatment of Osteoporosis. Osteoporosis. 2014;25:2359 20

Treatment Considerations

- Osteoporosis = treatment
- Osteopenia
  - Calculate FRAX WHO Fracture Risk Assessment (http://www.shef.ac.uk/FRAX/)
  - FRAX 10-year probability risk hip fracture ≥3% or major fracture ≥20%, consider treatment

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10)

21

Treatment Options

- Lifestyle
- Medication Classes
  - Bisphosphonates
  - RANKL antagonists
  - Parathyroid hormone
  - Calcitonin
  - Estrogen
  - Selective estrogen receptor modifier (SERM)

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10)

22

Lifestyle

- Weight-bearing and balance exercises
- Calcium and Vitamin D supplementation
  - Meta-analysis demonstrates 15% reduced risk of total fractures and 30% hip fractures
- Limit alcohol intake (≤4 drinks/day M and ≤2 drinks/day W)
- Smoking cessation
- Fall risk assessment/prevention
- Limit caffeine intake (≤2.5 cups coffee/day)

Age	Calcium	Vitamin D
19-50	1000mg	400-800 IU
M 51-70	1000mg	800-1000 IU
W >51; M>70	1200mg	800-1000 IU

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10); NOF

23

Bisphosphonates

Drugs	• **Alendronate (Fosamax, Fosamax Plus D, Binosto)** • **Ibandronate (Boniva)** • **Risedronate (Actonel, Atelvia)** • **Zoledronic Acid (Reclast)**
MOA	• Binds to hydroxyapatite, inhibiting osteoclastic activity leading to decrease in bone turnover
Adverse Effects	• GI symptoms (OR 1.6-3.3) • Atypical subtrochanteric fractures (100/100,000 people) • Osteonecrosis of the jaw (primarily with zoledronic acid and with long-term use)
Evidence	• All bisphosphonates have evidence to support use for preventing vertebral fractures 40-70% • Alendronate, risedronate, and zoledronic acid have evidence to support prevention of non-vertebral fractures and hip fractures

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10); Lexi-Comp

24

Bisphosphonates

Dosing	• Caution in patients with impaired renal function or low serum calcium concentration • Frequency options: once daily, once weekly, once monthly, quarterly, and yearly infusions Alendronate: P 5mg/day or 35mg/week; T 10mg/day or 70mg/week Risedronate: P and T 5mg/day, 35mg/week, 150mg/month Ibandronate: P 150mg/month; T 150mg/month, 3mg/IV quarterly Zoledronic acid: P 5mg every 2 years; T 5mg every year
Clinical Pearls	• If patient is unable to tolerate one, try another • Moderate to high fracture risk duration of therapy 5-10 years with consideration of restarting in 2-3 years (may consider teriparatide or denosumab treatment during drug holiday) • Cost efficacy analysis show alendronate and risedronate as most cost-effective

P = Prevention; T = Treatment; Underlined = Male dosing

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10); Lexi-Comp; Tu K. Osteoporosis A Review of Treatment Options. P&T. 2018;43(2):92

25

RANKL Antagonist

Drugs	• **Denosumab (Prolia)**
MOA	• Inhibits formation and activity of osteoclasts by blocking receptor activator of nuclear factor kappa B ligand (RANKL)
Adverse Effects	• GI symptoms, infection, cellulitis
Evidence	• Decreased incidence of vertebral 68%, non-vertebral 20% and hip 40% fractures • Increased BMD in hip 6% and lumbar spine 9.2%
Dosing	• 60mg subcutaneous injection every 6 months (men and women)
Clinical Pearls	• Comparable efficacy to bisphosphonates • Drug holiday not recommended • Treatment of choice in renal insufficiency

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10); Lexi-Comp

26

Parathyroid Hormone

Drugs	• **Teriparatide (Forteo)** • **Abaloparatide (Tymlos)**
MOA	• Stimulates osteoblasts activity
Adverse Effects	• Orthostatic hypotension, Hypercalcemia
Evidence	• Increases vertebral BMD • Decreased incidence of new or worsening vertebral 35-65% and non-vertebral 47-53% fractures • Prevents BMD loss and vertebral fractures in patients receiving chronic systemic corticosteroid therapy
Dosing	• 20mcg subq once daily for 2 years (M and W) • 80mcg subq once daily for 2 years
Clinical Pearls	• Initiate anti-resorptive therapy upon discontinuation

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10); Lexi-Comp

27

Calcitonin

Drugs	• **Calcitonin (Miacalcin)**
MOA	• Directly inhibits osteoclastic activity
Adverse Effects	• GI symptoms, Flushing, Rhinitis, Nasal congestion
Evidence	• Reduced incidence of recurrent vertebral fractures by 33% • Beneficial effects on BMD in spine
Dosing	• 100 units injected subcutaneously or intramuscularly or 1 spray in one nostril daily
Clinical Pearls	• Limited comparative efficacy; not preferred • Short-term treatment may provide analgesic effects in patients with acute painful vertebral fractures

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10); Lexi-Comp

28

Estrogen Replacement

Drugs	• Estrogen
Adverse Effects	• GI symptoms, Breast discomfort, Vaginal bleeding, Risk of venous thromboembolism, stroke, coronary heart disease
Evidence	• Reduced risk of vertebral fractures 33-40% • Reduced risk of non-vertebral fractures
Dosing	• Once daily oral dosing
Clinical Pearls	• Women's Health Initiative, risk of A/E exceeds benefit of therapy for fracture prevention

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10); Lexi-Comp

29

SERM

Drugs	• Raloxifene (Evista) • Estrogen/Bazedoxifine (Duavee)
MOA	• Estrogenic agonists decreasing bone resorption and turnover
Adverse Effects	• Athralgias, Hot flashes/flushes, Peripheral edema, Increased risk of stroke and venous thromboembolism
Evidence	• Increases BMD of spine (2.6%) • Reduced incidence of clinical vertebral fractures 30-68%
Dosing	• 60mg once daily (Evista) • 20mg/0.45mg daily (Duavee)
Clinical Pearls	• Rates of venous thromboembolism similar to rates of preventing clinical vertebral fractures

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10); Lexi-Comp

30

Treatment Algorithm

- First line for individuals with no prior fragility fracture or at moderate risk
  - Alendronate, risedronate, zoledronic acid, and denosumab
- First line for individuals requiring risk reduction in spine fracture
  - SERM
- Last line for high risk individuals
  - Estrogen, calcitonin
- Combination therapy is not recommended

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10)

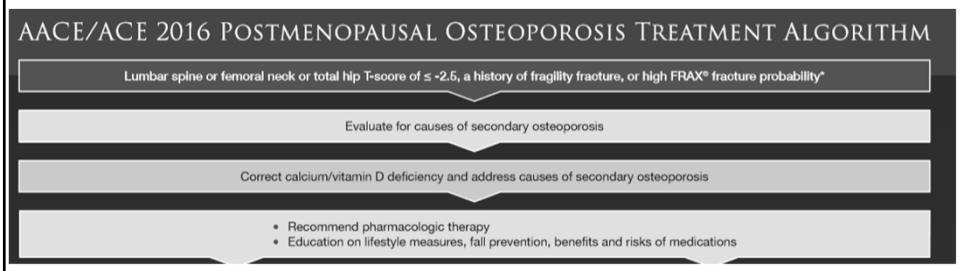
31

Summary of Treatment Principles

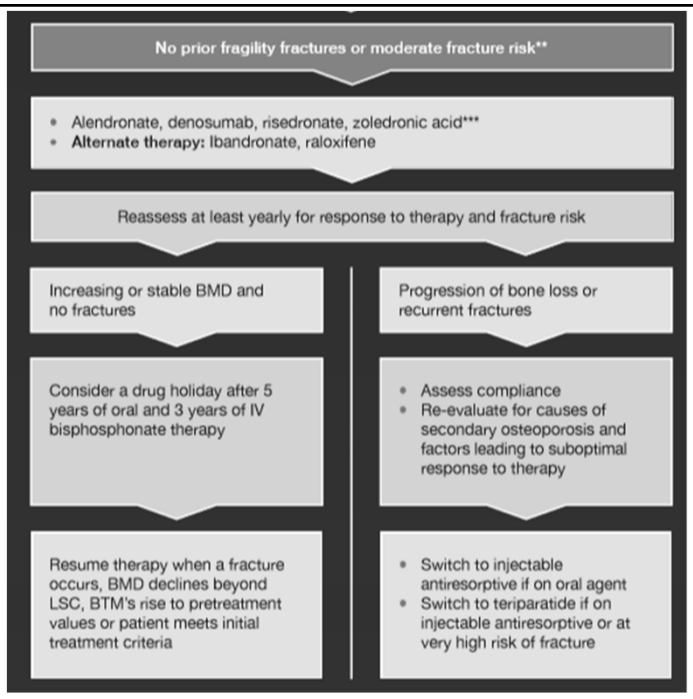
- Treatment with bisphosphonates should be continued for 5 years then drug holiday if low risk
- Individuals on treatment, BMD testing every 1 to 2 years is appropriate; once stable longer intervals may be appropriate
- Patients not on therapy, can recheck DXA every 5 years
- Bisphosphonates, denosumab, and teriparatide are recommended treatments to reduce the risk of hip and vertebral fractures
- Estrogenic treatment options are associated with increased risk of cerebrovascular accident and venous thromboembolism

AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016; Gullapalli K. Treatment of Osteoporosis Clinical Guideline Synopsis. JAMA. 2018;319(10)

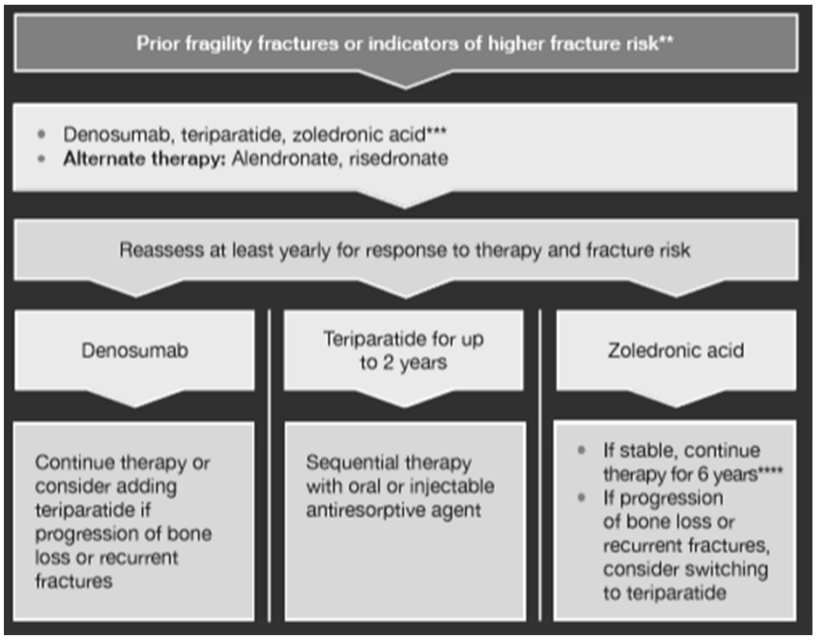
32



AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016 33



AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016 34



AACE and ACE Clinical Practice Guidelines for the Diagnosis and Treatment of Postmenopausal Osteoporosis, 2016

35

Menopause

Available Guidelines

- American College of Obstetricians and Gynecologists
- North American Menopause Society
- Endocrine Society

37

Overview of Symptoms

- 75% of women experience vasomotor symptoms (hot flashes, chills, perspiration, and palpitations)
- 10-40% of women experience vaginal atrophy (vulvar pain, burning, itching, vaginal dryness, vaginal discharge, dyspareunia, and spotting or bleeding after intercourse)
- Psychological symptoms include mood changes, insomnia, memory loss, depression, and anxiety
- Osteoporosis risk increases

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

38

Guideline Updates

- No previous 2011 recommendations were reversed or changed
- Use of hormone therapy should be based on all risk factors for CVD, age and time from menopause
- Use of transdermal route (vs oral) may be less likely to produce thrombotic risks and perhaps the risk of stroke and CAD
- When progesterone is needed, use micronized
- High risk women should use non-hormonal therapy for symptom management
- Bioidentical hormone therapy not supported

SSRI = selective serotonin reuptake inhibitor

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

39

Treatment Options

- Hormonal replacement therapy (HRT)
- Bioidentical hormones
- Combination selective estrogen receptor modifier (SERM) and conjugated equine estrogen (CEE)
- Selective serotonin re-uptake inhibitors (SSRIs)
- Anticonvulsants
- Black Cohosh

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

40

Hormone Replacement Therapy

Recommendation	Most effective therapy; treatment individualized (all equally effective); clearest benefit in women <60 yoa or within 10 years of menopause
Evidence	Evidence for vasomotor symptom relief and atrophic vaginal symptoms
	If only vaginal symptoms, use local therapy (premarin vaginal, vagifem, estring, or femring) in lower doses
	KEEPS trial had 728 women treated to oral estrogen (premarin 0.45mg), transdermal estradiol (Climara 50mcg) or placebo for 12 days/month. No difference in breast cancer, MI, TIA, stroke, or VTE
Adverse Effects	Breast tenderness, bloating, headaches, VTE, stroke, breast cancer

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

41

Compounded Bioidentical Hormones

Recommendation	Not recommended due to lack of evidence to support superior safety and lack of consistency between products
Evidence	No controlled trials to support efficacy or safety

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

42

Combination SERM/CEE

Recommendation	Limited data; weigh risk/benefits (breast cancer risk in humans unknown)
Dose	Estrogen/bazedoxifene: 0.45mg/20mg daily
Evidence	Decreases the incidence of hot flashes and improves vaginal dryness compared to SERM alone
	Risk of deep vein thrombosis remains

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

43

SSRI

Recommendation	In symptomatic women at risk from using HRT, this may offer significant relief
MOA	Increases serotonin and reduces leutinizing hormone
Dose	Venlafaxine: 37.5 – 75 mg/day Citalopram: 10-20 mg/day Escitalopram: 10-20 mg/day Paroxetine: 10-20 mg/day; 12.5-25 mg/day (avoid in women on tamoxifen)
Evidence	Pooled data from 3 RCT with 899 women with 14 bothersome vasomotor symptoms per week compared 0.5 mg estradiol with 75 mg venlafaxine or 10-20 mg escitalopram. Significant reductions in hot flashes were seen: 54% escitalopram, 48% estradiol, and 49% venlafaxine
Adverse Effects	Headache, insomnia, GI, drowsiness

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

44

Anticonvulsants

Recommendation	In symptomatic women at risk from using HRT, this may offer significant relief
MOA	Modifies serotonergic and adrenergic pathways of the pituitary hypothalamic region impacting thermoregulatory process
Dose	Gabapentin: Initial 300-400 mg once daily at bedtime; titrate based on response to 300-2400 mg/day divided in 2-3 doses Pregabalin: 50 – 150 mg/day
Evidence	RCT of 600 women with 7 or more moderate to severe hot flashes per day over 6 months, 1800 mg/day gabapentin, reported improvements in hot flashes and sleep
Adverse Effects	Dizziness, headache, somnolence, peripheral edema

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

45

Black Cohosh

Recommendation	Advise against the use in women who have a history of breast cancer; limited data
MOA	Weak estrogenic activity and some serotonergic effects
Dose	40-80 mg/day
Evidence	Meta analysis with 14 RCT, 7 uncontrolled trials, and 5 observational studies concluded beneficial effect compared to baseline but not to placebo
	2 observational studies showed significant reduction in risk of primary breast cancer (OR 0.47, 95% CI 0.27-0.82) and risk of recurrence (OR 0.75, 95% CI 0.63-0.89)

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

46

Summary of Treatment Principles

- Hormonal therapy is most effective and dosage and route of administration should be tailored to individual (start low and titrate to response)
  - Topical avoids first-pass metabolism
  - Progestin decreases risk of endometrial hyperplasia in women with intact uterus taking estrogen
- If symptoms are specific to genitourinary symptoms, choose local therapy
- If significant cardiovascular risk, nonhormonal therapy options should be considered; consider comorbidities
- For moderate cardiovascular risk, consider transdermal route of hormonal therapy

Cobin RH. American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement on Menopause-2017 Update. 2017;23(7):869

47

Post-Assessment Question 1

At which age should all women be screened for osteoporosis, regardless of risk?

A. 55
B. 60
C. 65
D. 75

48

Post-Assessment Question 2

Which therapy option listed below provides benefit in reducing risk of vertebral, non-vertebral and hip fractures and is an oral therapy option?

A. Alendronate
B. Calcitonin
C. Denosumab
D. Zoledronic acid

49

Post-Assessment Question 3

A 68 year old female complaining of vasomotor symptoms with a significant history of CVD and breast cancer (on tamoxifen) would best be treated with which option?

A. Black cohosh
B. Hormone replacement therapy (transdermal)
C. Gabapentin
D. Paroxetine

50

The Continuum of Women's Health: From Menopause to Osteoporosis

The Oklahoma City Area Annual Pharmacy Seminar
Katherine O'Neal, PharmD, MBA, BCACP, CDE, BC-ADM, AE-C, CLS
Associate Professor
University of Oklahoma College of Pharmacy
Member Harold Hamm Diabetes Center
Katherine-ONeal@ouhsc.edu
June 30, 2019