RECOGNITION AND TREATMENT OF OSTEOPOROSIS WITH A STRATEGY FOR OPTIMIZATION



ALAN GREENWALD MD

OBJECTIVES

- 1. WHAT IS THE IMPACT OF OSTEOPOROSIS
- 2. DEFINE THE DISEASE
- 3. HOW DO WE MAKE THE DIAGNOSIS
- 4. WHAT ARE THE TREATMENT OPTIONS
- 5. CAN WE USE OUR KNOWLEDGE TO MAKE BETTER MEDICAL DECISIONS

OSTEOPOROSIS IS NOT CURABLE AND IS A LIFETIME DISEASE

- IT IS ASYMPTOMATIC UNTIL THERE IS A FRACTURE
- PREVENTION OF FRACTURES PREVENTS PAIN AND DISABILITY
- THEREFORE, EARLY RECONITION OF FRACTURE RISK IS PARAMOUNT

ALAN GREENWALD MD

DISCLOSURES

- I PRACTICED ORTHOPEDIC SURGERY FOR OVER 45 YEARS
- ORTHOPEDIC SURGEONS SEE FRAGILITY FRACTURES DAILY
- I NEVER STOPPED WORRYING ABOUT MY PATIENTS WITH FRAGILITY FRACTURES SINCE THEY WERE SEEN REPEATEDLY.

WHY?

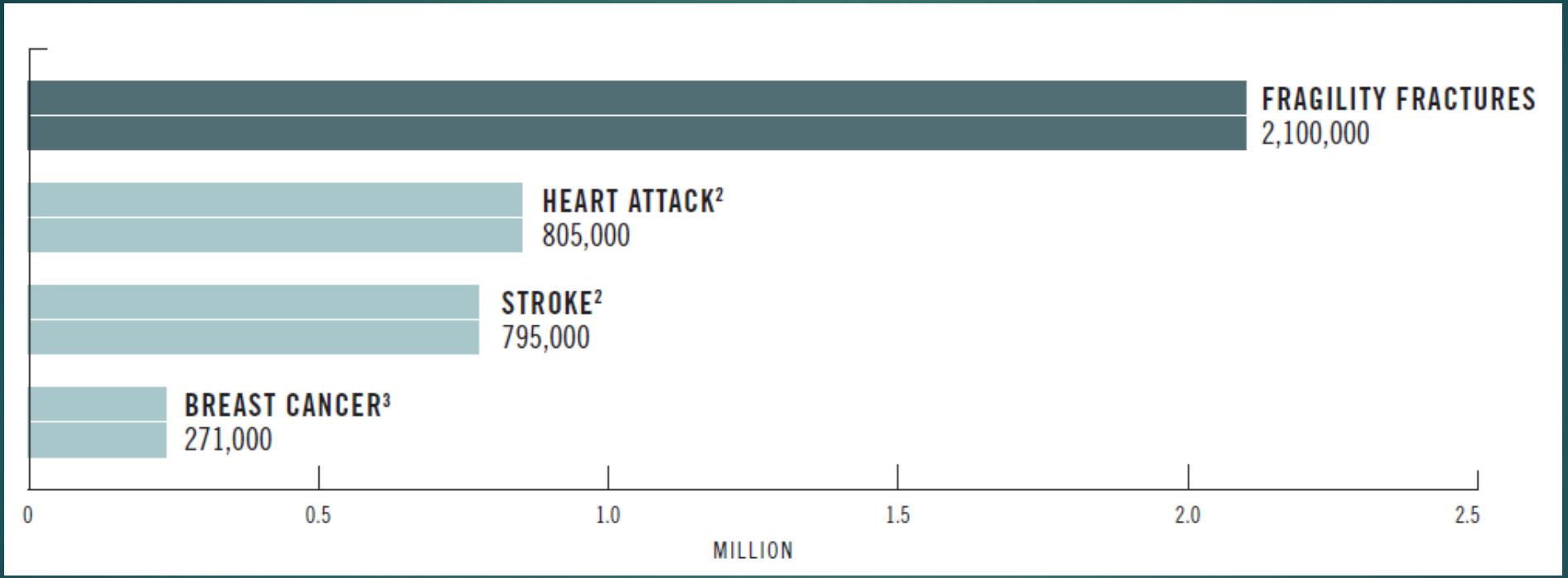
- THE GREATEST PREDICTOR OF A FRAGILITY FRACTURE IS A PREVIOUS ONE
- I SAW MANY HIP FRACTURE PATIENTS IN MY CAREER AS AN ORTHOPEDIC SURGEON WHO TOLD ME THAT THEY HAD A WRIST FRACTURE SOME YEARS EARLIER (RELATIVE RISK 1.43)

Risk of hip fracture following a wrist fracture-A meta-analysis Nick A Johnson, J Injury. 2017 Feb;48(2):399-405. doi: 10.1016

- WHY?
  - MORE THAN 200 MILLION PEOPLE IN THE WORLD HAVE OSTEOPOROSIS
  - ONE IN THREE WOMEN, AND ONE IN FIVE MEN WILL SUFFER AN OSTEOPOROTIC FRACTURE AFTER THE AGE OF 50
  - THESE FRACTURES RESULT IN A CHANGE IN LIFESTYLE, FUNCTION, AND SURVIVAL

- MEDICARE POPULATION
- 1 IN 20 BENEFICIARIES SUSTAIN AN OSTEOPOROTIC FRACTURE EACH YEAR
- 19% WILL DIE WITHIN A YEAR

OSTEOPOROSIS RISK



ALAN GREENWALD MD

- WHY?
  - HISTORICALLY ~20% OF PATIENTS WITH HIP FRACTURES DIE IN THE FIRST YEAR
  - PEOPLE RARELY RETURN TO THEIR PREVIOUS LEVEL OF ACTIVITY AND LIVING
  - THERE IS AN INCREASED RISK OF MENTAL ILLNESS, FRAILTY, DEPENDENCE, AND OTHER MEDICAL COMPLICATIONS

- WE ARE CURRENTLY RECEIVING AN "F" FOR TREATMENT
  - THERE IS A SIGNIFICANT "MISS RATE "IN RECOGNITION AND TREATMENT OF OSTEOPOROSIS
  - MANY FRACTURES ARE UNRECOGNIZED AS BEING RELATED TO BONE FRAGILITY
  - THERE IS > 80% GAP IN TREATMENT

IQVIA/AMGEN DATA

Over half of women over age 50 at the national level suffer from osteoporosis in this data set.

A large number of fractures occurred within the observed time frame.

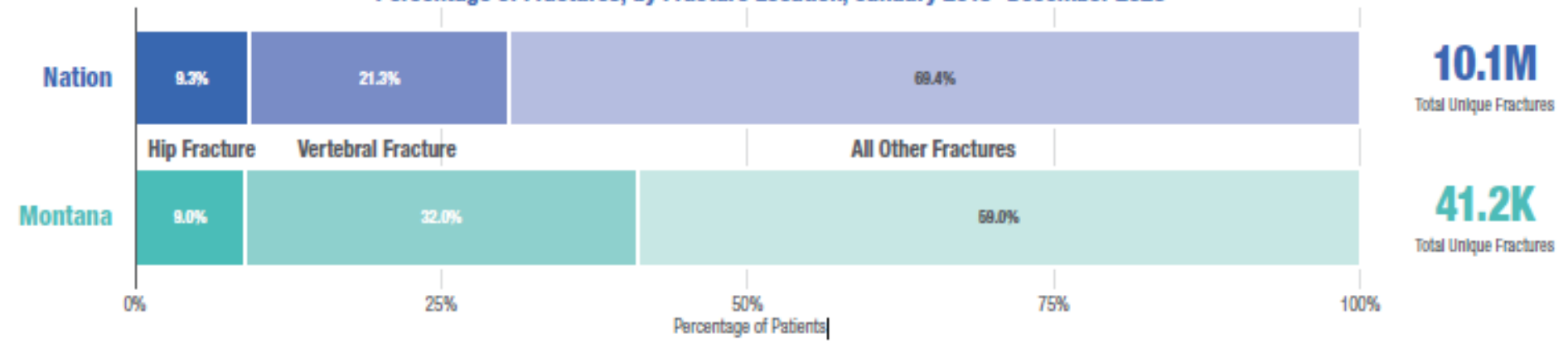
Number of Women in Claims Data January 2019–December 2023, by Inclusion Criteria:[1,*]

	Nation	Montana
Women over age 50	25.7M	85.5K
Unique osteoporosis patients based on composite inclusion criteria	13.7M	47.3K

Osteoporosis Composite Criteria:

- Diagnosis code for osteoporosis,
- Fracture diagnosis or procedure, OR
- Prescribed or administered osteoporosis treatment

Percentage of Fractures, by Fracture Location, January 2019–December 2023[1,*]



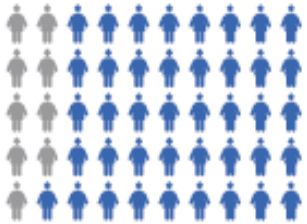
Note: Percentages include fractures that occurred January 2019–December 2023. The site of fractures occurring during that time period were reported as hip (left or right); vertebral; or all other fractures, which include fractures of the left or right femur, pelvis, humerus, radius/ulna, tibia/fibula, or clavicle. Data were calculated as the number of fractures at the specific site (hip, vertebral, or all other) divided by the total number of fractures. This includes unique site fractures seen within the full 2019–2023 time period.

IQVIA/AMGEN DATA

Osteoporosis diagnosis and follow-up evaluation are often lacking for women with fractures.

The majority of women do not receive a formal diagnosis for osteoporosis following a fracture.

Percentage of Women without a Diagnosis Code for Osteoporosis within 12 Months Post-Fracture, January 2019–December 2023[1,*]



83.1%
Without a Diagnosis Code for Osteoporosis

Nation



81.6%
Without a Diagnosis Code for Osteoporosis

Montana

Note: Percentages include patients with a fracture January 2019–December 2022. The patient's activity was then monitored for 12 months following the most recent fracture, and the number of patients without a subsequent diagnosis code for osteoporosis during that 12-month follow-up period is reported. Data were calculated as the number of women with a fracture with no evidence of a diagnosis code for osteoporosis within 12 months post-fracture, divided by the number of women with at least one fracture January 2019–December 2022.

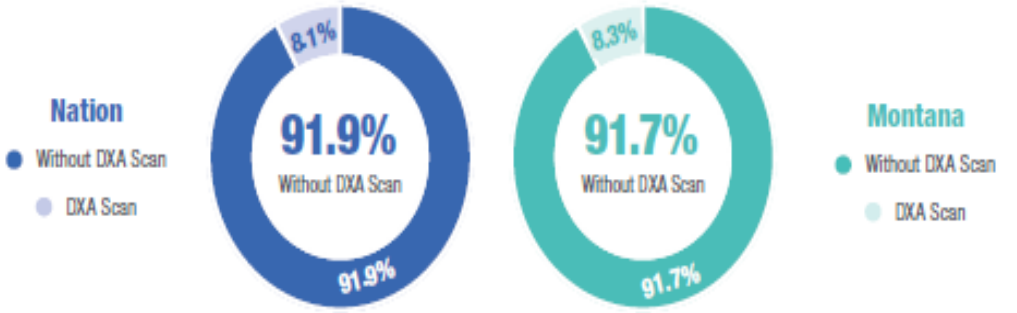
Most women do not have a follow-up visit or receive a DXA scan within 12 months of a fracture.

Percentage of Women with No Office/Clinic Visit within 12 Months Post-Fracture, January 2019–December 2023[1,*,†]

57.9%
n = 3,280,876
Nation

72.5%
n = 16,620
Montana

Percentage of Women without DXA Scan within 12 Months Post-Fracture, January 2019–December 2023[1,*]



Note: Percentages include patients with a fracture January 2019–December 2022. The patient's activity was then monitored for 12-months following the most recent fracture, and the number of patients without any services billed from a doctor's office or stand-alone clinic, outside of a hospital setting, (not only office/clinics that manage osteoporosis care) or a DXA scan during that 12-month follow-up period is reported. Data were calculated as the number of women with a fracture and with no evidence of an office/clinic visit or procedure code for a DXA scan, divided by the number of women with at least one fracture January 2019–December 2022

IQVIA/AMGEN DATA

Most women do not receive any osteoporosis treatment post-fracture.

Over 87% of women nationally do not receive any osteoporosis treatment within 12 months of a fracture.

Percentage of Women without Osteoporosis Treatment within 12 Months Post-Fracture, January 2019–December 2023[1,*]



Note: Percentages include patients with a fracture January 2019–December 2022. The patient's activity was then monitored for 12 months following the most recent fracture, and the number of patients with a subsequent treatment for osteoporosis during that 12-month follow-up period is reported. Data were calculated as the number of women who had a fracture with a prescription or procedure code for an osteoporosis treatment within 12 months post-fracture, divided by the number of women with at least one fracture January 2019–December 2022.

A very small percentage of patients receive anabolic or antiresorptive osteoporosis therapy within three, six, or 12 months of a fracture.

Percentage of Women with Osteoporosis Treatment within 12 Months Post-Fracture, by Timing and Treatment Type, January 2019–December 2023[1,*]

Population	Anabolic Therapy			Antiresorptive Therapy		
	0–3 Months	0–6 Months	0–12 Months	0–3 Months	0–6 Months	0–12 Months
Nation	0.4%	0.6%	0.8%	7.1%	9.6%	11.9%
Montana	0.4%	0.5%	0.7%	8.4%	11.2%	13.7%

Note: Percentages include patients with a fracture January 2019–December 2022. The patient's activity was then monitored for 12 months following the fracture, and the number of patients with a subsequent treatment for osteoporosis during the 3-, 6-, and 12-month follow-up periods are reported. Data were calculated as the number of women who had a fracture with a prescription or procedure code for the specified therapy class during the post-fracture time frames reported (0–3 months, 0–6 months, 0–12 months), divided by the number of women with at least one fracture January 2019–December 2022.

IQVIA/AMGEN DATA

Subsequent fractures are common and often occur soon after the initial fracture.

Over 747,000 women had subsequent fractures within 12 months of an index fracture nationally.

Women with a Subsequent Fracture within 12 Months of Index Fracture, January 2019–December 2023[1,*,†]

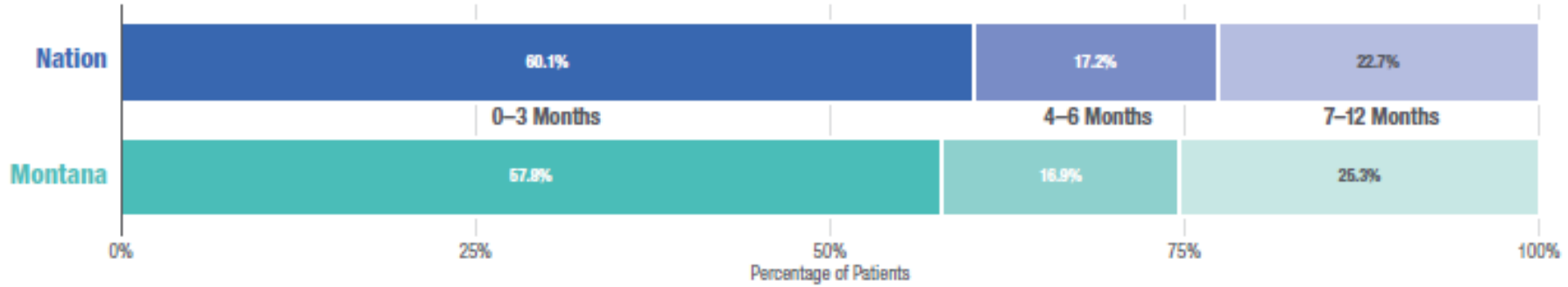
747,045
Women with Subsequent Fracture Nation

2,622
Women with Subsequent Fracture Montana

Note: Number of women were calculated as those with at least one subsequent fracture within 12 months of first fracture (Index).

Most women who experience a subsequent fracture within one year do so within six months of the initial fracture.

Timing of First Subsequent Fracture That Occurs within 12 Months of Index Fracture, January 2019–December 2023[1,*,†]

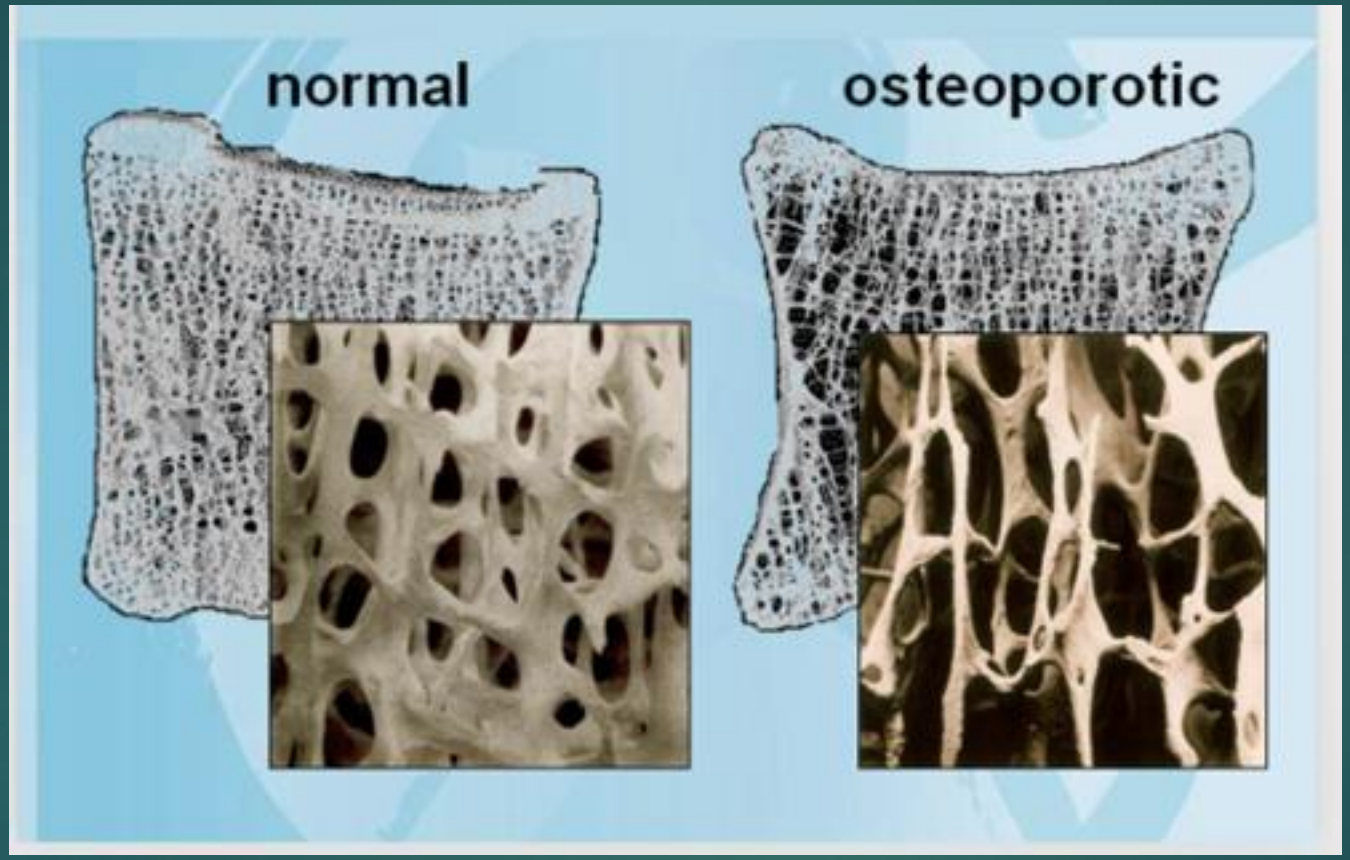


Note: Percentages include patients with a fracture January 2019–December 2022. The patient's activity was then monitored for 12 months following the index fracture, and the number of patients with a subsequent fracture during that 12-month follow-up period, and the timing of such fracture is reported. Data were calculated as the number of women with a subsequent fracture within the specified time frames post-index fracture (0–3 months, 4–6 months, 7–12 months), divided by the number of women with at least one fracture within 12 months post index fracture January 2019–December 2022.

- WHAT IS OSTEOPOROSIS
  - A DECREASE IN SKELETAL MINERAL CONTENT
  - A DEGRADATION OF BONE ARCHITECTURE MOST NOTABLE IN THE CANCELLOUS BONE

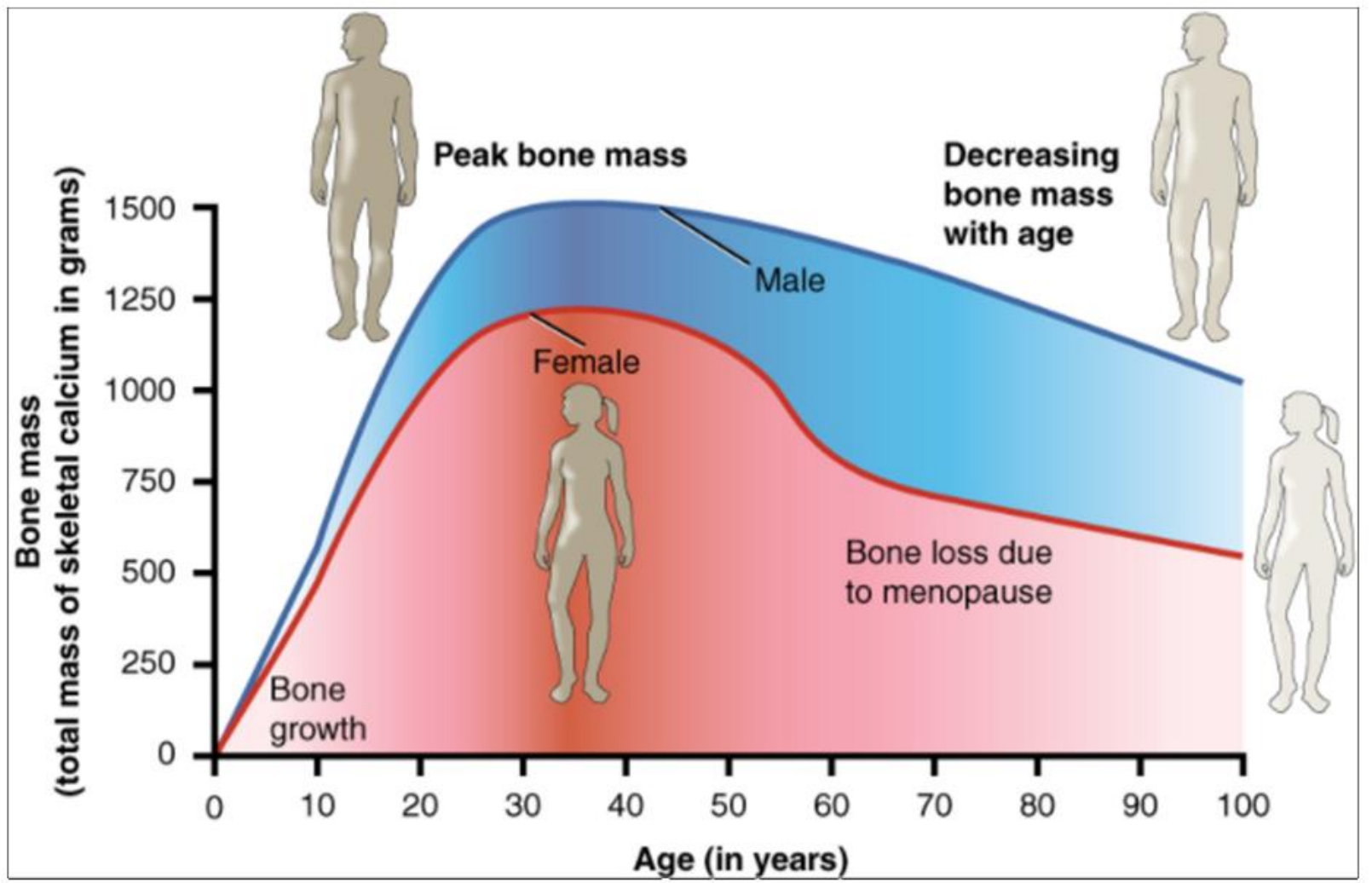
ALAN GREENWALD MD

OSTEOPOROSIS



ALAN GREENWALD MD

WE REACH PEAK BONE MASS BY OUR 20'S EVERYONE'S CURVE IS DIFFERENT

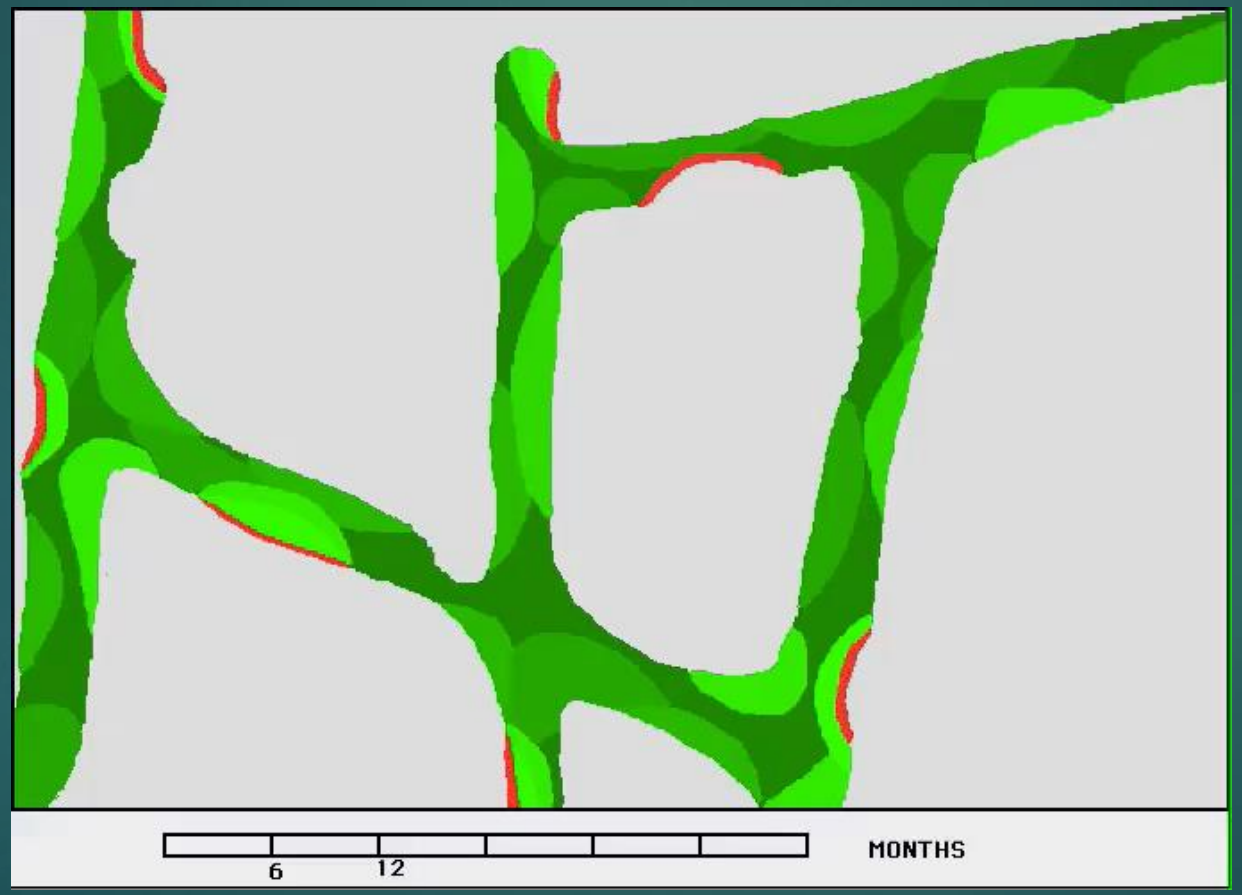




ALAN GREENWALD MD

WHAT IS OSTEOPOROSIS?

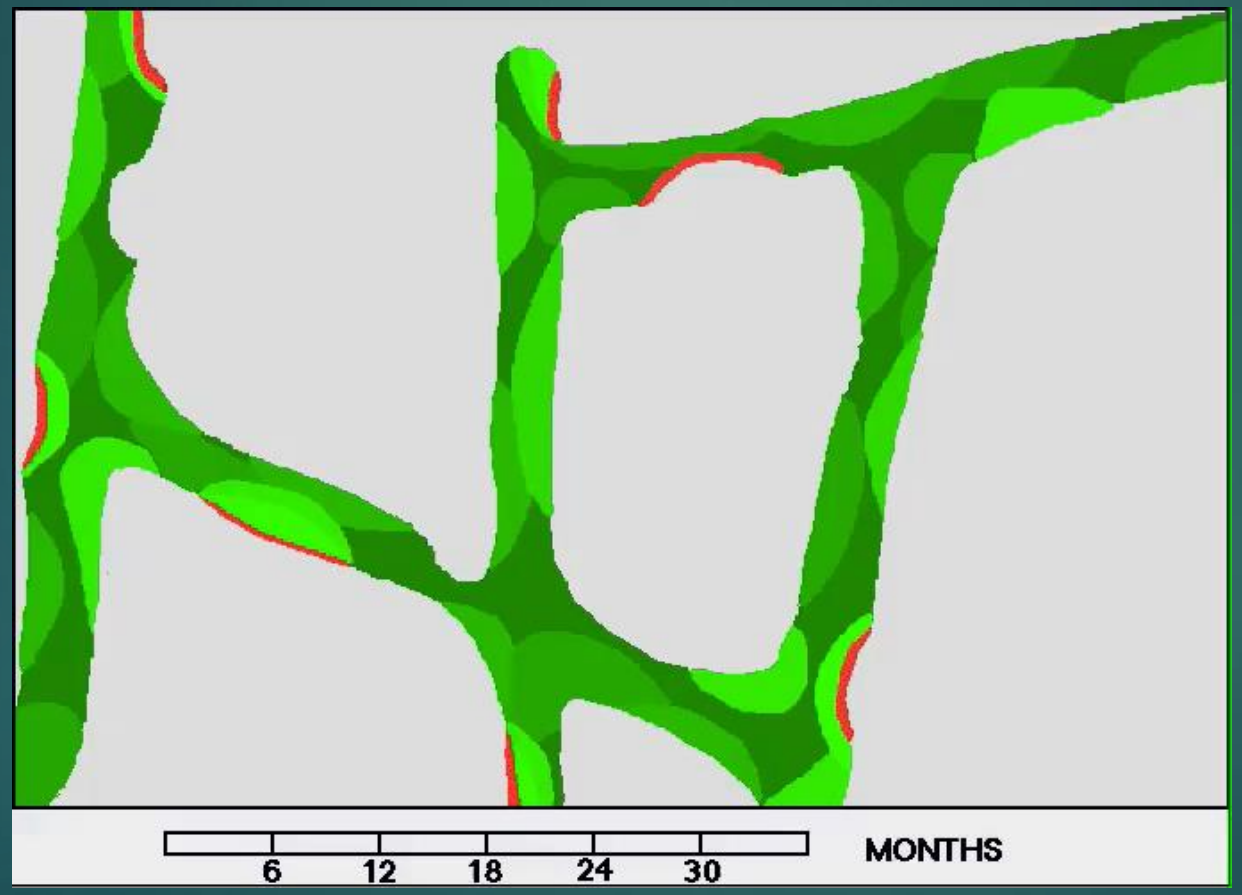
NORMAL BONE REMODELING



SUSAN OTT UW

ALAN GREENWALD MD

OSTEOPOROSIS BONE TURNOVER AFTER MENOPAUSE



SUSAN OTT UW

ALAN GREENWALD MD

- HOW DO YOU MAKE A DIAGNOSIS
  - 1. A HISTORY OF A FRAGILITY FRACTURE OF THE HIP WRIST, OR SPINE AND T SCORE -1 TO -2.4
  - 2. A DXA SCAN T SCORE < -2.5 IN ANY AREA
  - 3. A FRAX SCORE OF >20% RISK OF MAJOR OSTEOPOROTIC FRACTURE AND > 3% RISK OF HIP FRACTURE
  - OPPORTUNISTIC CT SCAN L1 VERTEBRAL BODY HOUNSFIELD UNITS <100

  - ISCD 2023

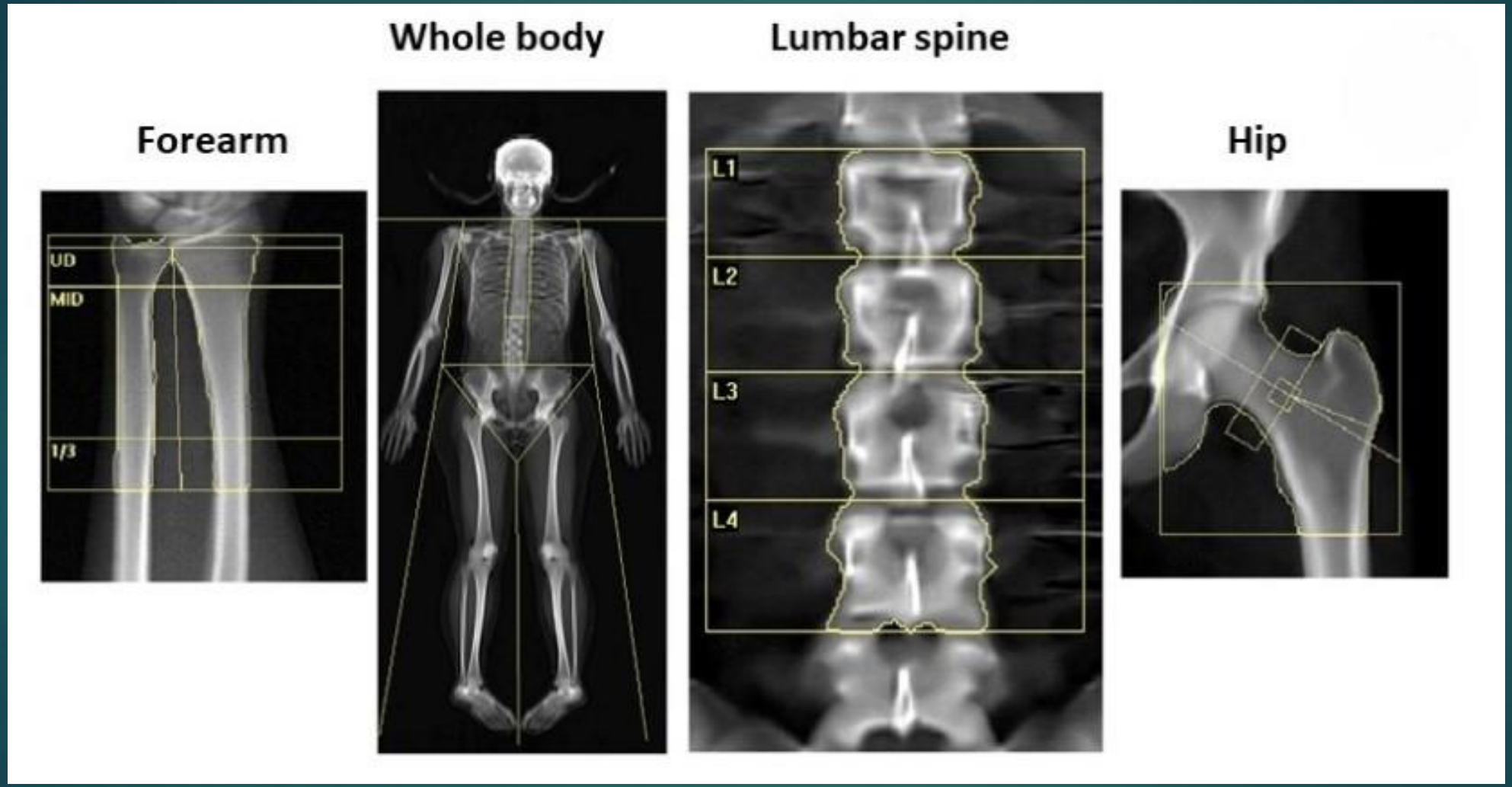
- HOW DO YOU MAKE A DIAGNOSIS
  - WHAT IS A DXA SCAN?
  - DUAL ENERGY SOURCE RAYS: HIGH AND LOW, ARE ABSORBED DIFFERENTLY BY HARD AND SOFT TISSUES AND MEASURES THE BLOCKAGE OF PHOTONS GIVING A DENSITY READING IN GM/CM^2
  - THE RADIATION DOSE IS LESS THAN WHAT IS RECEIVED BY FLYING ACROSS THE COUNTY IN A PLANE
  - THERE ARE TWO MAIN MANUFACTURERS AND READINGS ARE NOT COMPARABLE. MACHINES NEED TO BE CALLIBRATED YEARLY
  - THERE IS A HIGH ERROR RATE IN THE REPORTING AND TECHNIQUE
  - T SCORES ARE A CALCULATION THAT CAN BE USED TO COMPARE REPORTS

DXA SCANNER



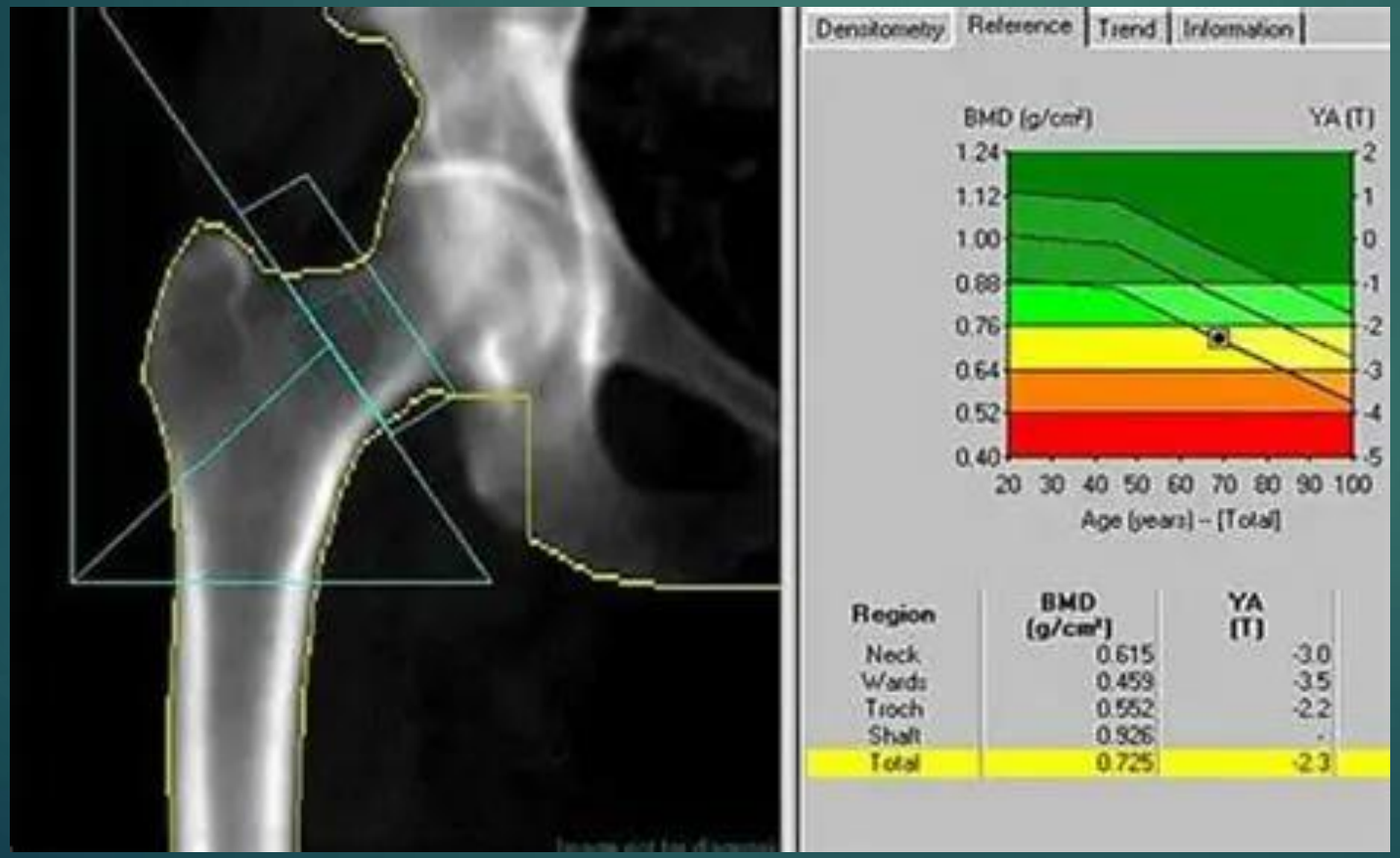
ALAN GREENWALD MD

DXA REPORT



DXA REPORT

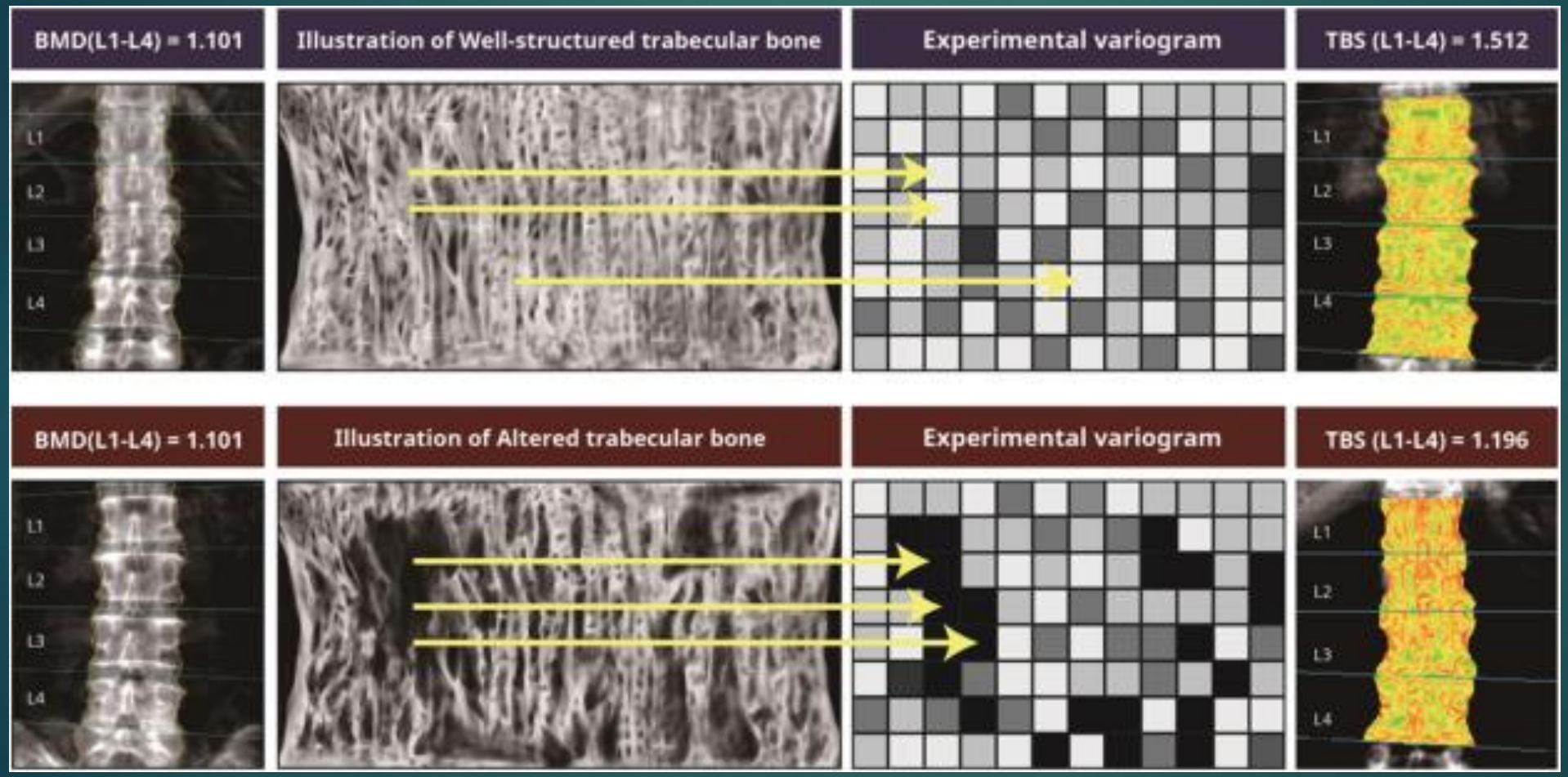
OSTEOPOROSIS IS ONLY A POSTMENOPAUSAL AGE DIAGNOSIS IN WOMEN
BEFORE THEN IT IS A LOW BONE DENSITY DIAGNOSIS



ALAN GREENWALD MD

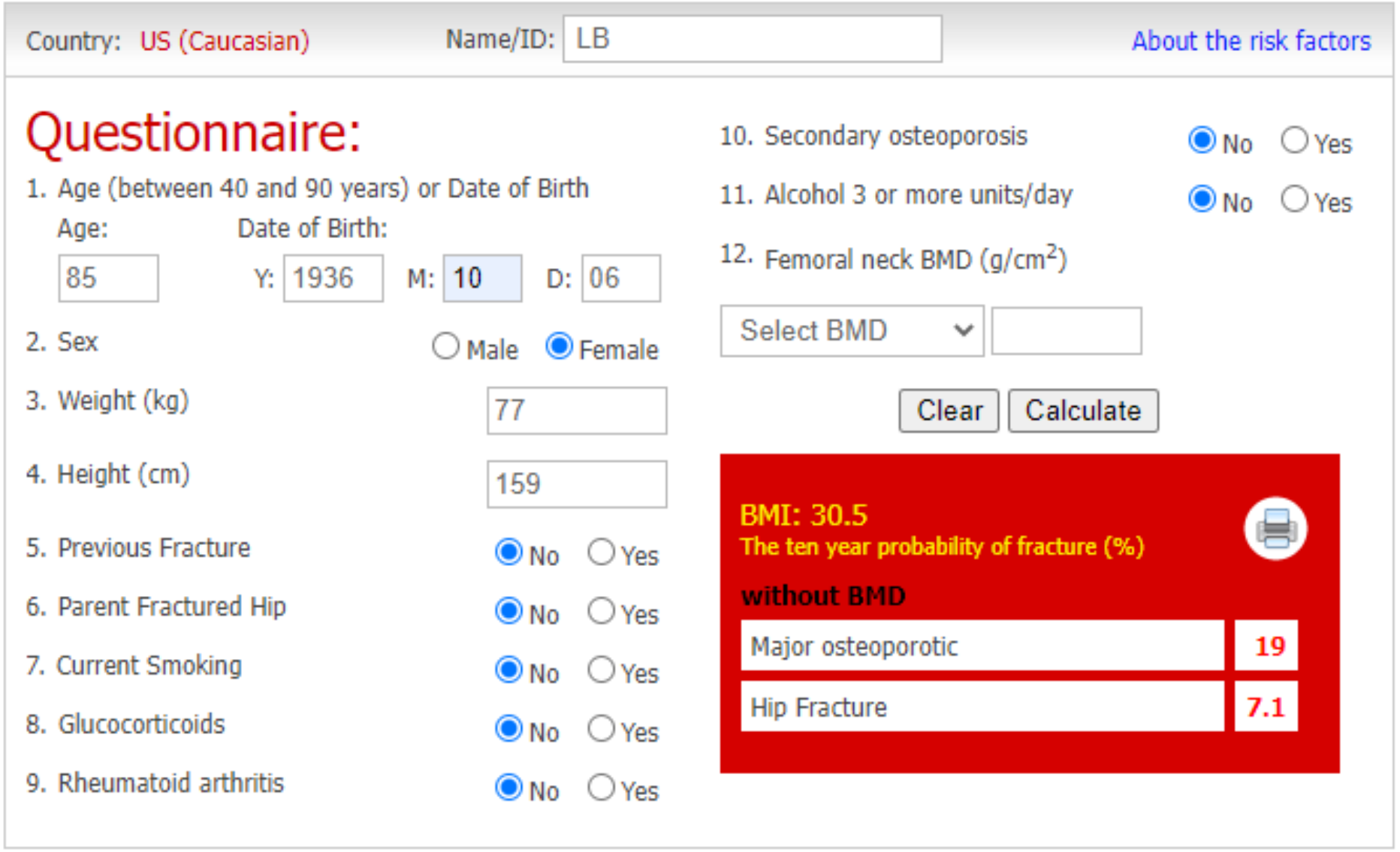
DXA REPORT

TBS TRABECULAR BONE SCORE



ALAN GREENWALD MD

FRAX CALCULATOR



- HOW DO YOU MAKE A DIAGNOSIS
  - HOWEVER, THESE DON'T ALWAYS PREDICT FRACTURE RISK……..
    - BONE SHAPE CAN BE A RISK SUCH AS BOWING AND ABNORMAL ARCHITECTURE
    - DXA AND CT SCANS ONLY LOOK AT LIMITED PARTS OF THE BODY SUCH AS SPINE, HIP, AND FOREARM
    - DXA SCANS LOOK AT AREA DENSITY, NOT 3 DIMENSIONS
    - THERE CAN BE ISOLATED DAMAGE FROM RADIATION OR PRIOR FRACTURE

- HOW DO YOU DECIDE WHO NEEDS A DXA?
  - 1. A WOMAN OVER 65 YEARS AGE
  - 2. A MALE OVER 70 YEARS OF AGE
  - 3. A FRAX SCORE OF >8.4% RISK OF MAJOR OSTEOPOROTIC FRACTURE
  - 4. ANYONE WITH A FRAGILITY FRACTURE WITHIN THE YEAR

PAUL ANDERSON ET AL SPINE 2023

ALAN GREENWALD MD

HOWEVER-------

- THE OPPORTUNITY TO GET A DXA EARLIER:
  - EARLY MENOPAUSE
  - POSITIVE FAMILY HISTORY OF OSTEOPOROSIS
  - HISTORY OF FRAGILITY FRACTURE
  - HISTORY OF IMMUNE THERAPY FOR CANCER AROMATASE INHIBITOR INCLUDING MEN
  - STEROID OR OTHER BONE TOXIC MEDICATION USE HISTORY
  - GASTRIC BYPASS SURGERY

OSTEOPOROSIS PREVENTION

WAITING UNTIL AGE 65 TO EVALUATE SKELETAL HEALTH IN POSTMENOPAUSAL WOMEN IS TOO LATE TO PREVENT OSTEOPOROSIS

ALAN GREENWALD MD

OSTEOPOROSIS PREVENTION

BONE LOSS ACROSS MENOPAUSE ~20%,

THEN 0.5% PER YEAR WITH AGING

FOR WOMEN WHO COME TO MENOPAUSE WITH A

T-SCORE = -1.0, THE AVERAGE AGE OF DEVELOPING OSTEOPOROSIS IS ~64 YEARS AFTER ALREADY LOSING 18% OF THEIE BONE MASS

NO ESTROGEN THERAPY LEADS TO T-score -2.5 AT 65

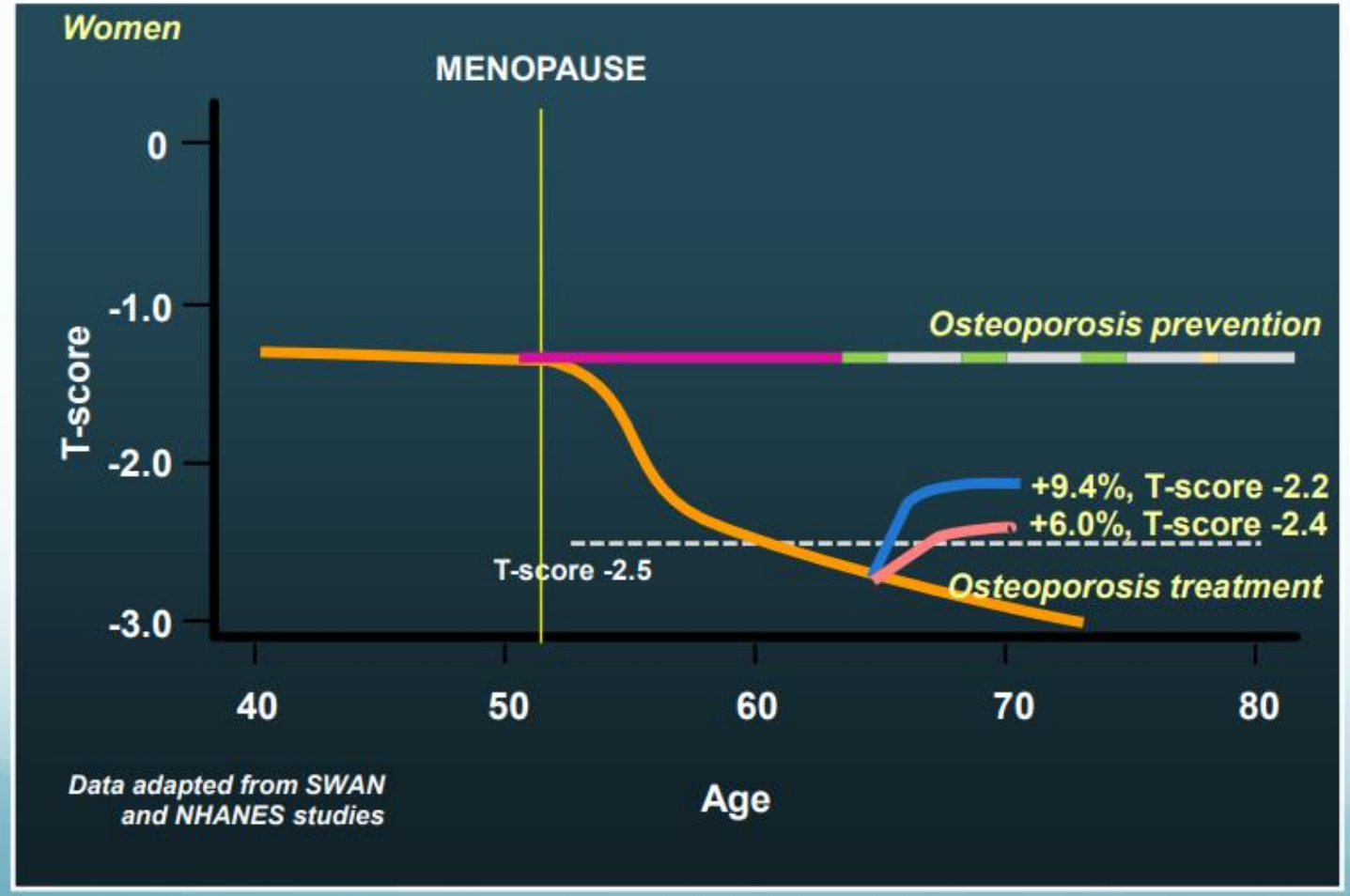
Sarafrazi N, et al. NCHS Data Brief No. 45 National Center for Health Statistics; 2021

THIS IS THE ORTHOPEDIC BERMUDA TRIANGLE



ALAN GREENWALD MD

OSTEOPOROSIS PREVENTION



Osteoporosis can be prevented – but therapy must begin at menopause and continue indefinitely

Treatment with an anabolic agent followed by an anti-remodeling drug can improve bone microarchitecture

Treating osteoporosis with a bisphosphonate will improve bone density but not the microarchitecture

OSTEOPOROSIS PREVENTION

- START HORMONE THERAPY WITH ESTROGEN/PROGESTERONE IN PERIMENOPAUSAL WOMEN
- DO “PULSED” ZOLENDRONATE OR ALENDRONATE EVERY 3-5 YEARS
- SERM-RELOXIFENE IN SELECTED PATIENTS

ALAN GREENWALD MD

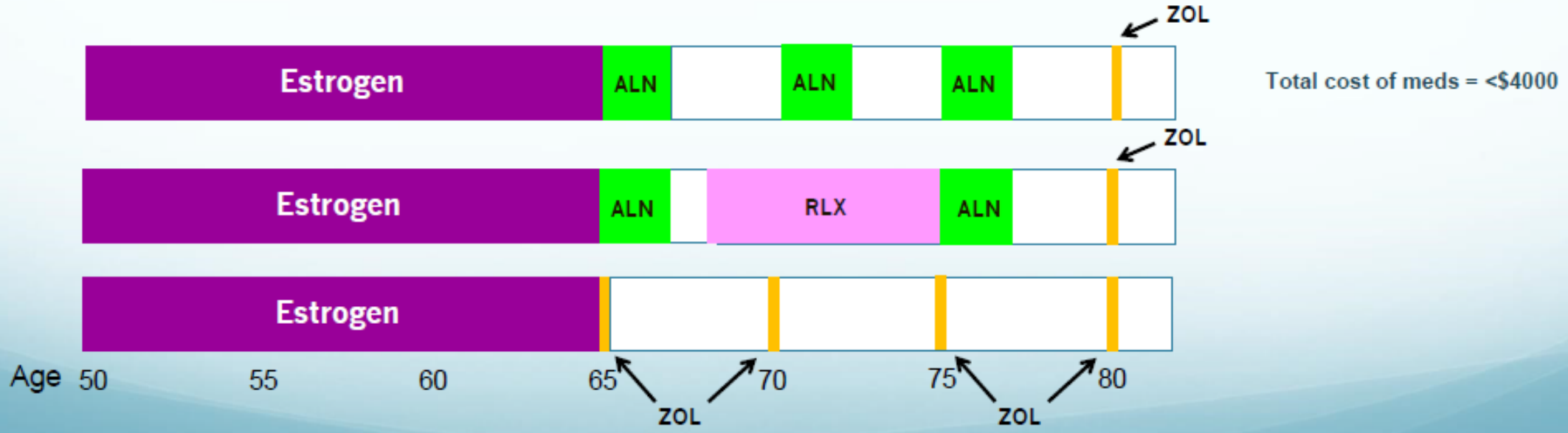
OSTEOPOROSIS PREVENTION

- ESTROGEN INHIBITS OSTEOCLASTS AND PROMOTES OSTEOBLASTS
- IT PREVENTS OSTEOPOROSIS BUT IS NOT AN EFFECTIVE TREATMENT
- THE WHI IN 1991 IMPACTED HORMONE THERAPY DUE TO THE INITIAL CONCERNS ABOUT CARDIAC AND CANCER RISKS
- THE FDA REMOVED THE "BLACK BOX" WARNING IN 2025 AS THESE RISKS WERE REASSESSED TO BE LOW AND FRACTURE RISK WAS NOTED TO BE IMPROVED WITH THERAPY WHEN TREATMENT WAS STARTED EARLIER

ALAN GREENWALD MD

Considering a lifetime plan for bone health
Management of Estrogen Discontinuation

- To maintain the skeletal benefit from the estrogen therapy, bisphosphonate therapy should be given if/when estrogen therapy is stopped
- After the initial course of bisphosphonate, a program of maintenance therapy could preserve BMD for the remainder of the patient's treatment lifetime



ALN = alendronate; RLX = raloxifene; ZOL = zoledronate

McClung M et al. *Menopause* 2021;28:973-97

HOW DO WE CONSIDER BONE HEALTH IN PATIENT CARE

ESTABLISHED RISK MANAGEMENT STRATEGIES IN ARTHROPLASTY:

- WEIGHT REDUCTION IN OBESITY
- SMOKING CESSATION
- CARDIAC EVALUATION
- GLUCOSE/ HEMAGLOBIN A1C MANAGEMENT
- DENTAL HYGIENE
- STAPH SCREENING
- NUTRITIONAL EVALUATION
- BONE HEALTH SCREENING

ALAN GREENWALD MD

BONE HEALTH OPTIMIZATION

- WHY DOES IT MATTER?
  - 50 % OF TOTAL JOINT PATIENTS HAVE OSTEOPOROSIS
  - 49-70% OF SPINE SURGERY PATIENTS HAVE LOW BONE DENSITY
  - IN SPINE FUSION PATIENTS OVER 50 YEARS OF AGE 14.5% OF MEN AND 51.3% OF WOMEN HAVE OSTEOPOROSIS
  - 50% OF SPINE PATIENTS HAVE LOW VIT D

THERE ARE ALWAYS RISKS TO TREATMENTS!

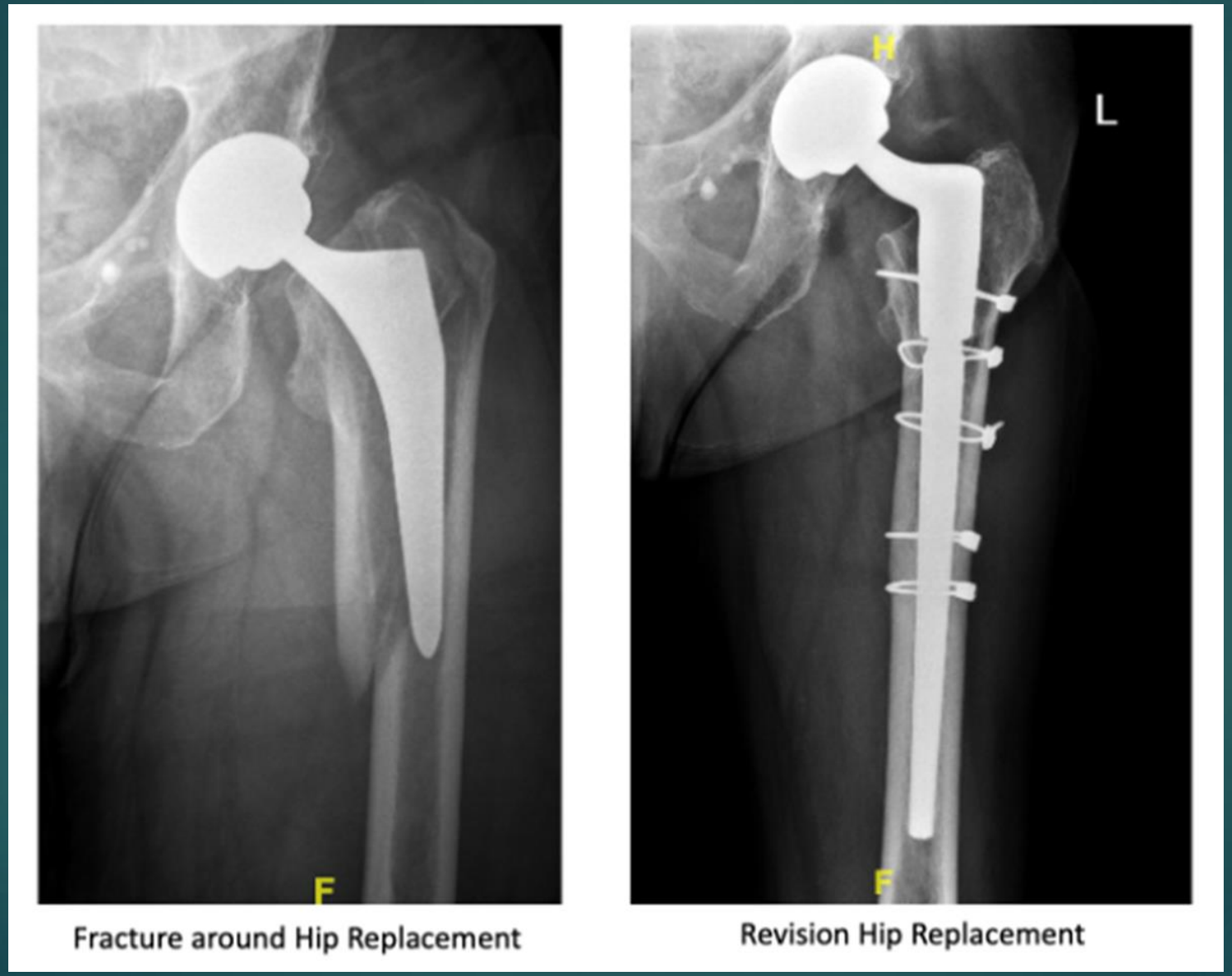


ALAN GREENWALD MD

- WHY DOES THE RISK OF PERIPROSTHETIC FRACTURE MATTER?
  - THE 1 YEAR MORTALITY IS up to 50%
  - 80% OF DEATHS ARE IN THE FIRST 3 MONTHS
  - THE RISK OF FAILURE OF REPAIR IS 12%
  - COSTS ARE HIGH $41,500 HIP STEM, $91,000 DISTAL FEMUR IN 2014
  - MOST INSTITUTIONS LOSE MONEY ON THESE CASES

SHIELDS ET AL, GERIATRIC ORTHOP SURGERY REHABIL 2014

BONE HEALTH OPTIMIZATION CLINIC



Fracture around Hip Replacement

Revision Hip Replacement

ALAN GREENWALD MD

WHEN TO CONSIDER BONE HEALTH IN ELECTIVE ORTHOPEDIC SURGERY



ALAN GREENWALD MD

- WHY DOES IT MATTER IN SPINE SURGERY?

  POOR BONE HEALTH CAN LEAD TO:

  - PSEUDOARTHROSIS-FUSION FAILURE
  - IMPLANT AND JUNCTIONAL FAILURE
  - ADJACENT VERTEBRAL COMPRESSION FRACTURE
  - SCREW PULLOUT RESULTING IN HIGHER INCIDENCE OF REOPERATION

- RISK STRATIFY PATIENTS:
  - VERY HIGH RISK-
    - T SCORE < 3.0 IN SPINE AND < -2.5 IN THE HIP
    - FRACTURE WHILE ON TREATMENT
    - PATIENTS ARE ON BONE HARMING DRUGS LIKE PREDNISONE, AROMATASE INHIBITORS, IMMUNE THERAPIES FOR CANCER, SEIZURE MEDS
    - HIGH RISK OF FALLS AND OSTEOPOROSIS
    - FRAX MOF >30% AND HIP> 4.5%

WHEN TO CONSIDER BONE HEALTH IN ELECTIVE ORTHOPEDIC SURGERY

- HOW DO WE DO THIS?

  SCREEN WITH DXA

  1.FEMALES >65

  2.MALES >70

  3.HISTORY OF FRAGILITY FRACTURE

  4.FRAX WITHOUT BMD >8.4% 10 YEAR FRACTURE RISK (MOF)

  HIP FRACTURE RISK ABOVE 4%

PAUL ANDERSON et al. Spine 2023

ALAN GREENWALD MD

WHEN TO CONSIDER BONE HEALTH IN ELECTIVE ORTHOPEDIC SURGERY

- HOW DO WE DO THIS?
  - 2. TEST BY IMAGING
  - DXA/TRABECULAR BONE SCORE
  - OPPORTUNISTIC CT SCAN FOR TRAUMA OR OTHER SCREENING CAN BE USED AS AN ALTERNATIVE REFERENCE USING HOUNSFIELD UNITS
  - LUMBAR VERTEBRAL BODY HU BETWEEN 160-110 IS EQUIVALENT TO T SCORES -2 TO -2.5
  - OPPORTUNISTIC MRI SCAN
  - AI APPLICATIONS MAY IMPROVE DIAGNOSTIC ACCURACY

WHEN TO CONSIDER BONE HEALTH IN ELECTIVE ORTHOPEDIC SURGERY

- HOW DO WE DO THIS?

  SCREEN

  PATIENTS AT HIGH RISK SHOULD HAVE PREOP:

  CBC, CMP, CALCIUM, PHOSPHORUS, 25 OH VITAMIN D LEVEL, PTH

Liu et al JBJS 2021

ALAN GREENWALD MD

BONE HEALTH OPTIMIZATION CLINIC

NORMAL	LOW FRAX, T SCORE, NO FRACTURE HISTORY
INTERMEDIATE	T SCORE ≥ -2.5, FRAX MOF<20, NO FRACTURE HX
HIGH RISK	T SCORE -2.5 TO -3.5, FRAX MOF <30
VERY HIGH RISK	T SCORE < -3.5, FRAX >30 MOF RECENT FRACTURE

ALAN GREENWALD MD

BONE HEALTH OPTIMIZATION CLINIC

NORMAL	OPTIMIZE VITAMIN D/ CALCIUM,LIFESTYLE CHANGES. PROCEED WITH SURGERY
INTERMEDIATE	OPTIMIZE VITAMIN D/ CALCIUM,LIFESTYLE CHANGES. PROCEED WITH SURGERY
HIGH RISK	OPTIMIZE VITAMIN D/CALCIUM, LIFESTYLE CHANGES, POSSIBLE FDA APPROVED THERAPY. PROCEED WITH SURGERY WITH CAUTION
VERY HIGH RISK	OPTIMIZE VITAMIN D/CALCIUM, LIFESTYLE CHANGES, PHARMACOTHERAPY/ METABOLIC CONSULTATION, DELAY FOR 3 MONTHS

ALAN GREENWALD MD

- MODIFIABLE TREATMENTS:
  - LIFESTYLE CHANGES LIKE REDUCING CAFFIENE AND ALCOHOL
  - STRENGTHENING EXERCISES, BALANCE TRAINING, FALL PREVENTION, HOME SAFETY
  - IMPROVING DIET FOR VITAMIN D AND CALCIUM
  - SUPPLEMENTATIONS OF THESE IF NEEDED
  - WEIGHT BEARING EXERCISES
  - FDA APPROVED MEDICATIONS

WHEN TO CONSIDER BONE HEALTH IN ELECTIVE ORTHOPEDIC SURGERY

- VITAMIN D IS NECESSARY FOR NORMAL MACROPHAGE ACTIVITY AND INFLAMATORY RESPONSE
- IT MAY REDUCE RISK OF INFECTION
- THERE MAY BE IMPROVED BALANCE AND STRENGTH WITH HIGHER LEVELS

ALAN GREENWALD MD

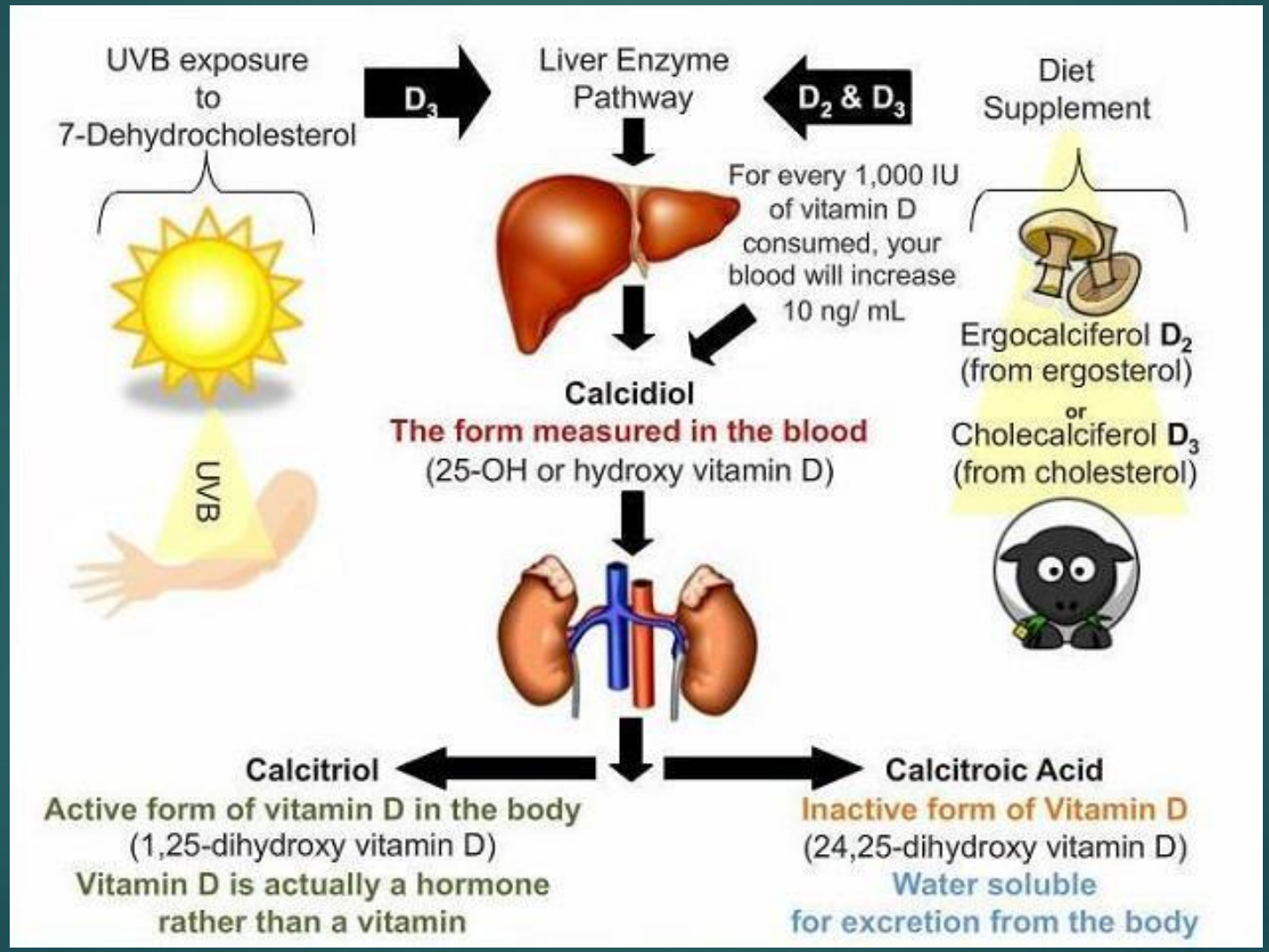
VITAMIN D SUPPLEMENTATION

VITAMIN D IS NECESSARY FOR CALCIUM HOMEOSTASIS

- VITAMIN D DEFICIENCY IS COMMON IN THE US (<20ng/ml)
- 20-40% OF JOINT REPLACEMENT PATIENTS ARE DEFICIENT

ALAN GREENWALD MD

VITAMIN D METABOLISM



ALAN GREENWALD MD

VITAMIN D IS IMPORTANT

1400 THR AND TKA PATIENTS

700 GIVEN A SINGLE PREOP ORAL 300,000 IU VITAMIN D vs CONTROL

IN THE VITAMIN D GROUP THERE WAS A LOWER RISK OF CELLULITIS, WOUND DRAINAGE, PULMONARY EDEMA, AND ALL COMPLICATIONS 4.3% vs 8.6%

THERE WAS NO DIFFERENCE IN PJI

Effect of Vitamin D Deficiency on Periprosthetic Joint Infection and Complications After Primary Total Joint Arthroplasty Murat Birinci, MD et al J Arthroplasty 2023

ALAN GREENWALD MD

VITAMIN D3 SUPPLEMENTATION

- VITAMIN K ADDITION
  - COFACTOR FOR CARBOXYLATION OF OSTEOCALCIN WHICH BINDS CALCIUM INTO THE MATRIX IMPROVING MINERALIZATION
  - COFACTOR FOR MATRIX GLA PROTEIN WHICH PREVENTS VASCULAR CALCIFICATION

ALAN GREENWALD MD

CALCIUM SUPPLEMENTATION

- IT WILL AFFECT PEAK BONE MASS UNTIL MATURITY
- CALCIUM ABSORPTION DIMINISHES WITH AGE
- CALCIUM AND VITAMIN D SUPPLEMENTATION ALONE WILL NOT CHANGE THE BONE MASS CURVE
- ON A DAILY BASIS APPROX 150-200MG OF CA LOSS FROM KIDNEYS, 150MG FROM GUT, AND 300MG GI ABSORPTION.

SUPPLEMENTAL CALCIUM

Age	Calcium Recommended daily Intake (mg/day)	
Infancy to Adolescence	0-6 months	200
	6-12 months	260
	1-3 years	700
	4-8 years	1000
	9-13 years	1300
	14-18 years	1300
Adulthood	19-50 years	1000
	51-70 years	Females 1200 Males 1000
	Over 70 years	1200

ALAN GREENWALD MD

WHEN TO CONSIDER BONE HEALTH IN ELECTIVE ORTHOPEDIC SURGERY

- LOW CALCIUM IS AN INDEPENDENT PREDICTOR OF A 79% HIGHER COMPLICATION RATE IN PATIENTS OVER 60 HAVING ELECTIVE ORTHO SURGERY

Preoperative hypocalcemia predicts postoperative complications in older orthopedic patients: A multicenter cohort study
Doudou Li1, Ting Zhang1, Yanmei Ning2, Jiacong Miao3, Jiana Shi1, Ying Hu 1*PLOS One | https://doi.org/10.1371/journal.pone.0340876 March 4, 2026

ALAN GREENWALD MD

NUTRITIONAL CALCIUM

- DIETARY CALCIUM IN FOOD HAS THE BEST ABSORPTION
  - NUT MILK 1 CUP 400MG
  - YOGURT 8 OZ 415MG
  - NON FAT MILK 1 CUP 299MG
  - SOY MILK 1 CUP 299 MG
  - SPINACH 1 CUP 123 MG
  - KALE 1 CUP 24 MG

ALAN GREENWALD MD

CALCIUM SUPPLEMENTATION

- ABSORPTION IS 30-40%
- CALCIUM CARBONATE IS 40% ELEMENTAL
  - CHEAPEST
  - MOST CONCENTRATED
  - BEST TAKEN WITH FOOD
  - CAUSES CONSTIPATION

ALAN GREENWALD MD

CALCIUM SUPPLEMENTATION

- CALCIUM CITRATE IS 21% ELEMENTAL
  - MORE EXPENSIVE
  - BETTER ABSORPTION
- CALCIUM GLUCONATE IS 9-13% ELEMENTAL
  - MAY BE BETTER FOR GI INTOLERANCE

NON-PHARMACOLOGIC THERAPY

- ONERO PROGRAM
- LIFTMOR EXERCISE TRIAL
  - WEIGHT BEARING IMPACT LOADING
  - HIGH INTENSITY PROGRESSIVE RESISTANCE
  - VALIDATED TO INCREASE BONE DENSITY

PHARMACOTHERAPY OPTIONS:

ANTIRESORPTIVES=ANTIREMODELING DRUGS:

BISPHOSPHONATES- OSTEOCLAST APOPTOSIS

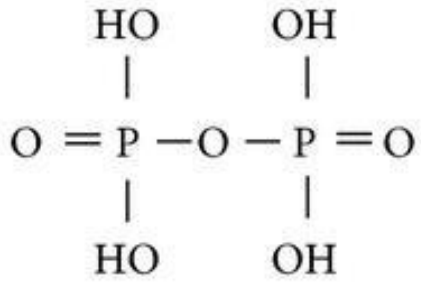
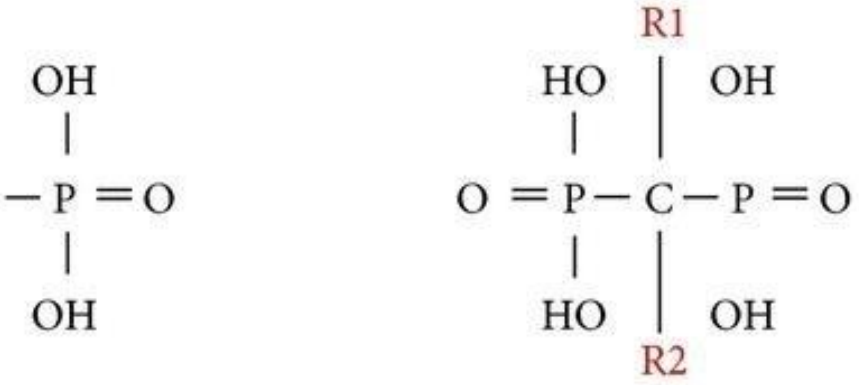
- ALENDRONATE 70mg ORAL WEEKLY
- RISEDRONATE
- IBANDRONATE
- ZOLEDRONATE 5mg IV YEARLY

DENOSUMAB A MONCLONAL ANTIBODY AGAINST RANK L- INHIBITS OSTEOCLASTS

RELOXIFENE

ALAN GREENWALD MD

PHARMACOTHERAPY OPTIONS:

Pyrophosphate	Bisphosphonate
	

PHARMACOTHERAPY OPTIONS:

ANTIRESORPTIVES=ANTIREMODELING DRUGS:

DENOSUMAB A MONCLONAL ANTIBODY AGAINST RANK LIGAND GIVEN 60MG SQ EVERY 6 MONTHS

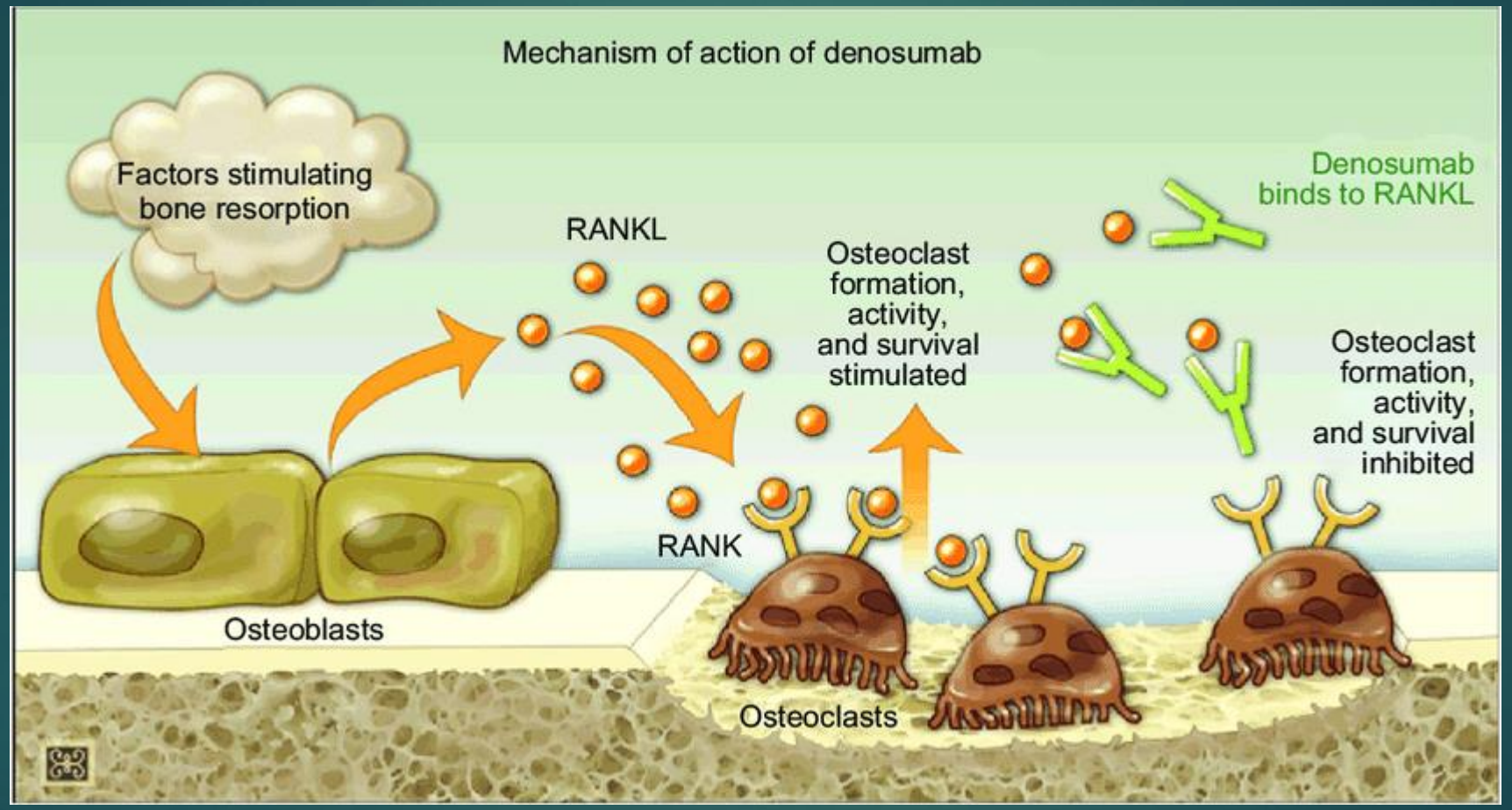
IT "STUNS" OSTEOCLASTS THAT WILL REBOUND BACK TO WORK IF STOPPED WITHOUT MANAGEMENT NO DRUG HOLIDAY!!!!!

THERE IS A 10% RISK OF ATRAUMATIC VERTEBRAL COMPRESSION FRACTURES AFTER MISSING A DOSE

NEED TO SWITCH TO BISPHOSPHONATE

ALAN GREENWALD MD

PHARMACOTHERAPY OPTIONS:



ALAN GREENWALD MD

PHAROMACOTHERAPY SIDE EFFECTS:

- RISKS OF ANTIRESORPTIVE TREATMENT:
- 1. LIMITED MUSCLE OR BONE ACHING ACUTE PHASE REACTION
- 2. INFLAMATORY JOINT PAINS OR UVEITIS<1%
- 3. ATRIAL FIBRILLATION<1%
- 4. ATYPICAL FEMUR FRACTURE
- 5. RARE MRONJ
  - REQUIERS INFLAMATION OR INFECTION TO OCCUR
  - 1/100,000 FREQUENCY IN OSTEOPOROSIS DOSES

AM ASSN OF ORAL AND MAXILOFACIAL SURGERY POSITION PAPER ON MRONJ 2022 RUGGIERO ET AL , JOMS VOL80,P920-43

ALAN GREENWALD MD

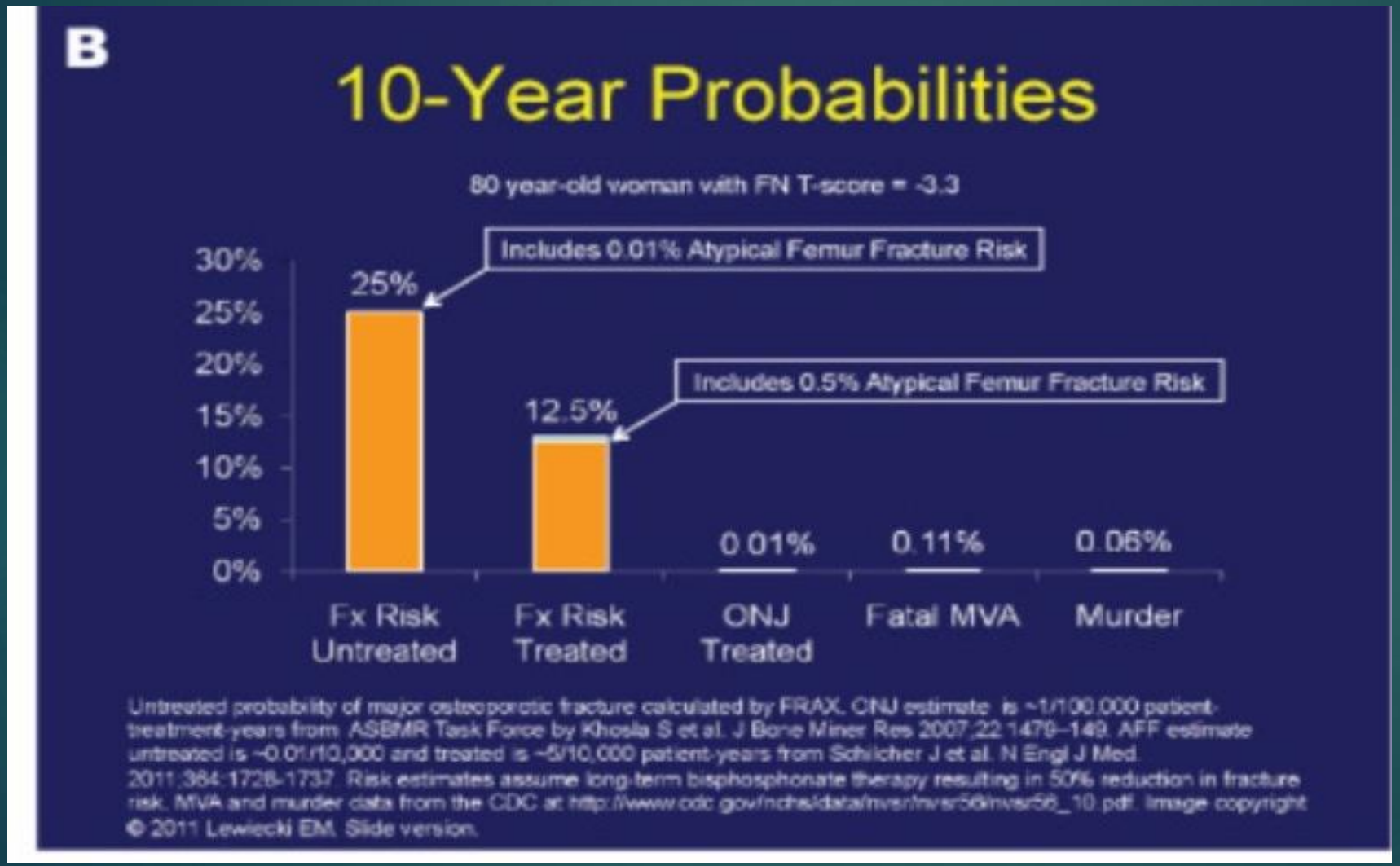
MEDICATION RELATED OSTEONECROSIS OF THE JAW MRONJ

- INHIBITION OF BONE REMODELING IS CENTRAL TO MRONJ MECHANISM
- SEEN WITH BISPHOSPHONATES AND DMAB
- NOT SO MUCH WITH PTH ANALOGS AND ROMOSOZUMAB
- THE RISK IS 0.02-0.05% AND GREATER IN CANCER DOSES
- THIS RISK IS MUCH LOWER THAN THE RISK OF OSTEOPOROSIS FRACTURES AND TREATMENT SHOULD NOT BE STOPPED

AM ASSN OF ORAL AND MAXILOFACIAL SURGERY POSITION PAPER ON MRONJ 2022 RUGGIERO ET AL , JOMS VOL80,P920-43

ALAN GREENWALD MD

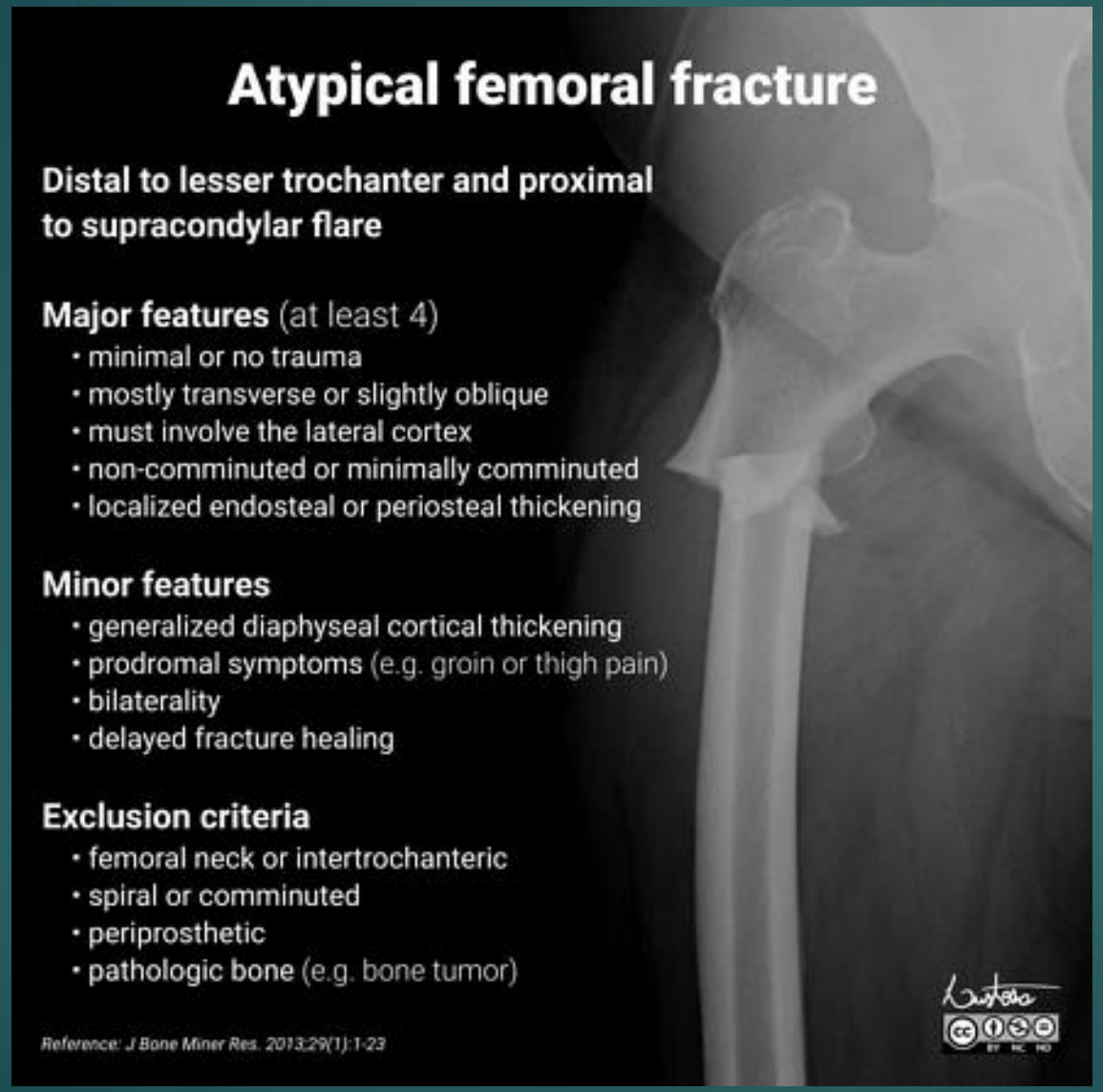
MEDICATION RELATED OSTEONECROSIS OF THE JAW
MRONJ



ALAN GREENWALD MD

KHOSLA ET AL, J BONE AND MINERAL RES VOL 22,10 1479

ATYPICAL FEMUR FRACTURES



ALAN GREENWALD MD

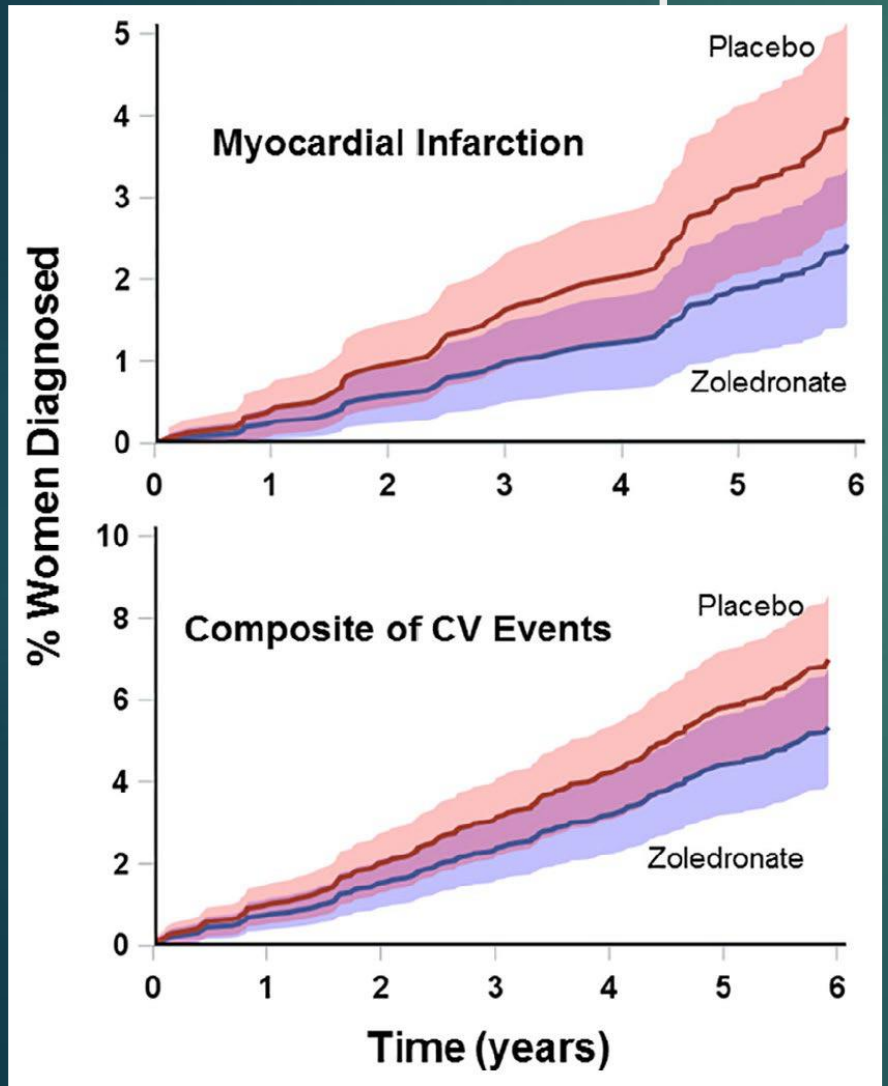
UNMANAGED DISCONTINUATION OF ANTIRESORPTIVES

- THE INCIDENCE OF HIP FRACTURES INCREASED IN THE EARLY 2000'S WHEN TREATMENTS WERE SUSPENDED DUE TO RISK CONCERNS.
- SPONTANEOUS SPINE FRACTURES OCCUR AS EARLY AS 8 MONTHS FOLLOWING MISSED PROLIA DOSES IN 5% CASES DUE TO RAPID REBOUND BONE LOSS

WARNING OF INCREASED VERTEBRAL COMPRESSION FRACTURES AFTER STOPPING DENOSUMAB, SYMONDS CMAJ 2018

ALAN GREENWALD MD

ZOL Reduces CV Events in Women with Osteopenia



6-year RCT of 2000 women age ≥ 65 with osteopenia received ZOL or PBO Q18M x 4 doses

•Primary endpoint: time to first VF or NVFZOL decreased risk of VFs and NVFs

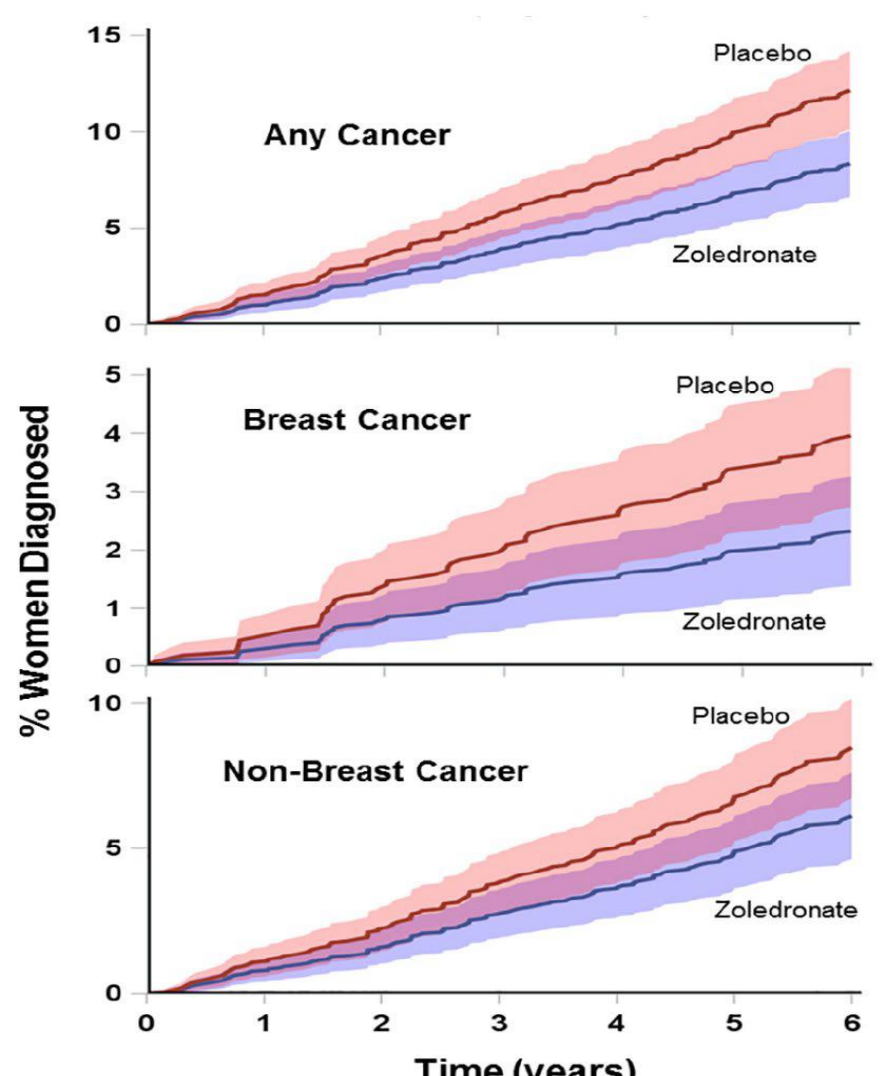
•Myocardial Infarction –Hazard Ratio, Rate Ratio HR 0.60 (CI 0.36-1.00)
RR 0.58 (CI 0.35 to 0.94)

•CV Events -sudden death, MI, stroke, or coronary artery revascularization HR 0.76 (CI 0.53-1.08)
RR 0.72 (CI 0.53-0.98)

Reid IR et al. J Bone Miner Res. 2020;35:20-27.

ALAN GREENWALD MD

ZOL Reduces Cancer Events in Women with Osteopenia



- Any Cancer –Hazard Ratio, Rate Ratio HR 0.67 (CI 0.51-0.89)
- RR 0.68 (CI 0.52-0.89)

- Breast Cancer HR 0.58 (CI 0.35-0.97)
- RR 0.59 (CI 0.35-0.98)

- Non-breast Cancer HR 0.72 (CI 0.52-1.00)
- RR 0.72 (CI 0.52-0.995)

- Reid IR et al. J Bone Miner Res. 2020;35:20-27.

ALAN GREENWALD MD

PHARMOCOTHERAPY OPTIONS

- PHARMACOTHERAPY OPTIONS: ANABOLICS

  PARATHYROID HORMONE DRUGS
- 1. TARIPARATIDE (FORTEO) RECOMBINANT HUMAN PARATHYROID HORMONE (N TERMINAL 1-34)
- 2. ABALOPARATIDE (TYMLOS) RECOMBINANT PTHrP MAY NOT HAVE AS MUCH ANTIRESORPTIVE EFFECT
- 3. ROMOSOZUMAB MONOCLONAL SCLEROSTIN INHIBITOR, WHICH THEN STIMULATES OSTEOBLASTS

PHARMOCOTHERAPY OPTIONS

- PHARMACOTHERAPY OPTIONS: ANABOLICS

- PARATHYROID HORMONE REGULATES CALCIUM AND PHOSPHORUS METABOLISM BY STIMULATING OSTEOCLASTS TO BREAK DOWN MINERALIZED BONE AND COLLAGEN.
- CONTINUOUSE PTH IS CATABOLIC AND BREAKS DOWN BONE

- PULSED INJECTIONS OF PTH LIKE DRUGS HAVE A BONE BUILDING EFFECT BUT THERE IS REMODELING AS WELL

PHARMOCOTHERAPY OPTIONS

- PHARMACOTHERAPY OPTIONS: ANABOLICS

  PARATHYROID HORMONE DRUGS
- TARIPARATIDE IS SELF ADMINISTERED 20 MCG/DAY BY SQ INJECTION FOR 2 YEARS
- ABALOPARATIDE IS SELF ADMINISTERED 80 MCG/DAY FOR 2 YEARS

- THERE IS USUALLY AN ANABOLIC PLATEAU
- BONE STRENGTH INCREASES 10-14% AND FRACTURE RISK IS REDUCED BY 50%

PHARMOCOTHERAPY OPTIONS

- PHARMACOTHERAPY OPTIONS: ANABOLICS

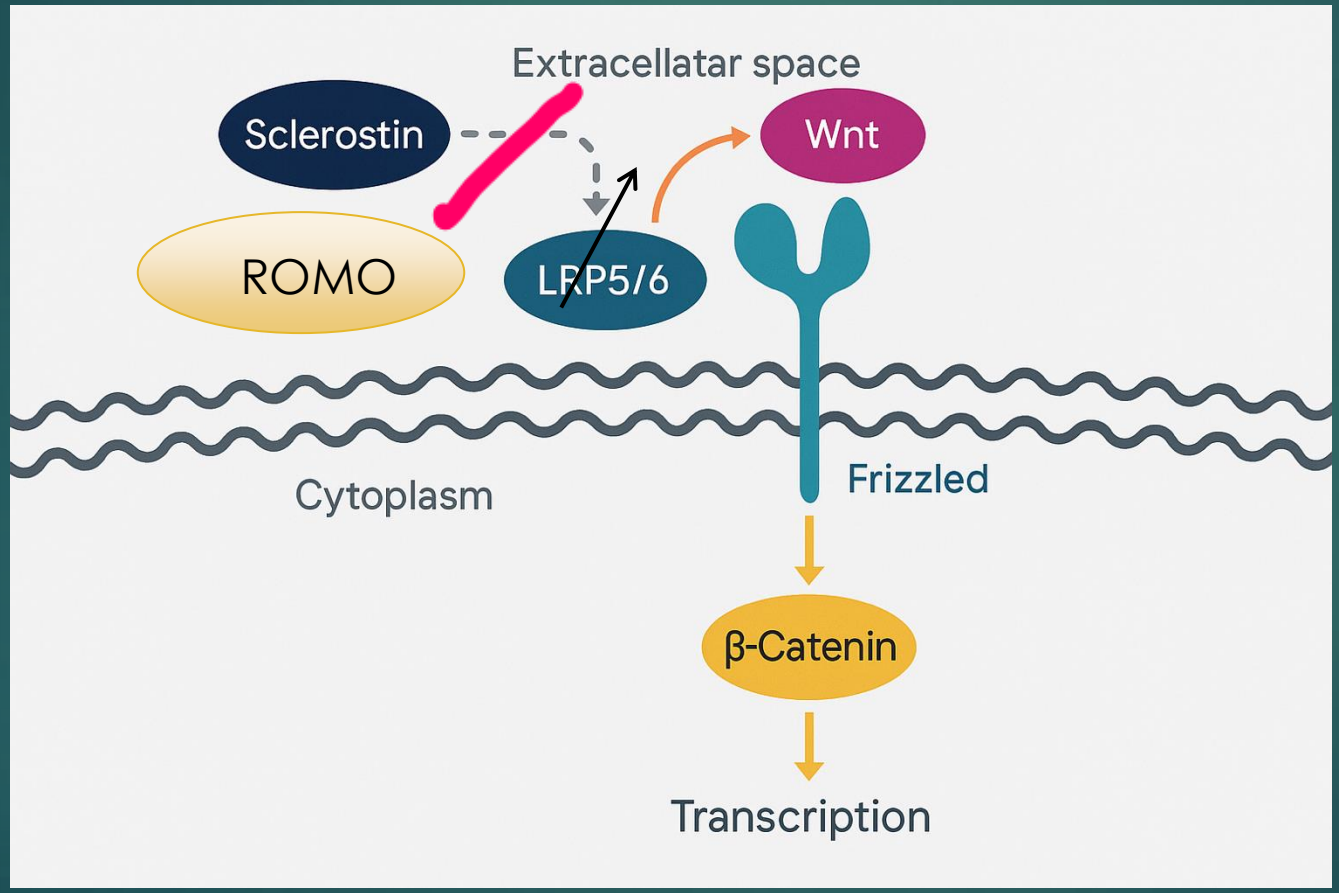
ROMOSOZUMAB (EVENITY) IS ADMINISTERED 210 MG MONTHLY IN 2 SYRINGES FOR 12 MONTHS

MONOCLONAL ANTIBODY THAT BLOCKS SCLEROSTIN WHICH IS A Wnt PATHWAY INHIBITOR

BONE DENSITY IS INCREASED BY 10% IN HIP AND SPINE

FDA APPROVED FOR WOMEN BUT CAN BE GIVEN TO MEN

THE GLYCOPROTEIN Wnt ATTACHES TO LRP5/6 AND FRIZZLED RECEPTORS ON OSTEOBLAST SURFACE TO SIGNAL TRANSCRIPTION OF PROTEINS TO PRODUCE BONE



ALAN GREENWALD MD

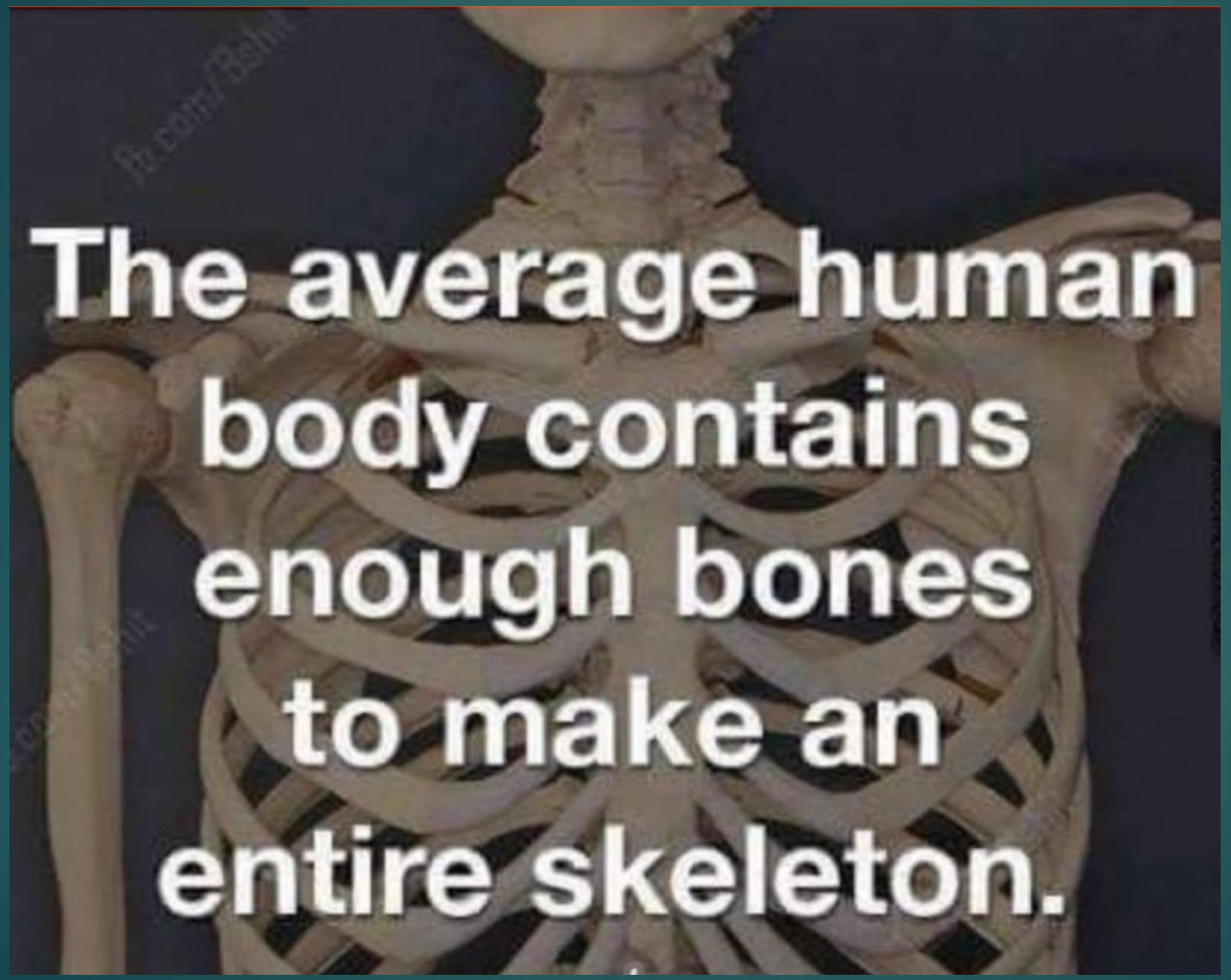
- ASBMR GUIDELINES 2024
  - SEQUENCE FIRST WITH OSTEOANABOLIC MEDS ROMOSOZUMAB, TERIPARATIDE, ABALOPARATIDE
  - THEN “SEAL” THE BMD GAINS WITH AN ANTIRESORPTIVE LIKE ZOLEDRONATE OR DENOSUMAB

- ASBMR/BHOF 2024 GUIDELINES:
  - TREAT TO TARGET T SCORES > -2.5 IN 3 YEARS
  - IT MAY BE POSSIBLE TO ACHIEVE WITH ANTIRESORPTIVES, BUT MORE SUCCESSFUL WITH OSTEOANABOLICS FIRST, THEN ANTIRESORPTIVES
  - SEQUENCING IS CRUCIAL IN THAT THE RESPONSE IS BLUNTED OR NEGATIVE WHEN DONE IN THE REVERSE

Goal-directed osteoporosis treatment: ASBMR/BHOF task force position statement 2024 Open Access
Felicia Cosman, E Michael Lewiecki , Journal of Bone and Mineral Research, Volume 39, Issue 10, October 2024

ALAN GREENWALD MD

THANK YOU FOR YOUR ATTENTION



ALAN GREENWALD MD