GIOP

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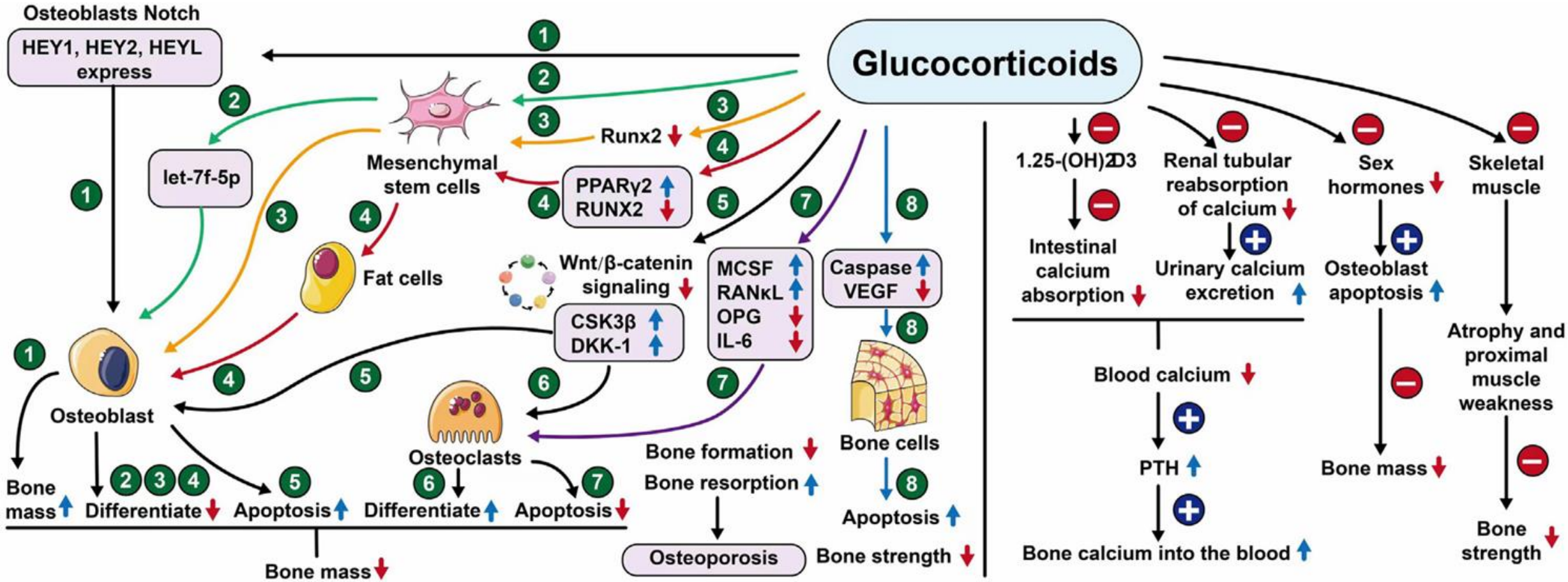
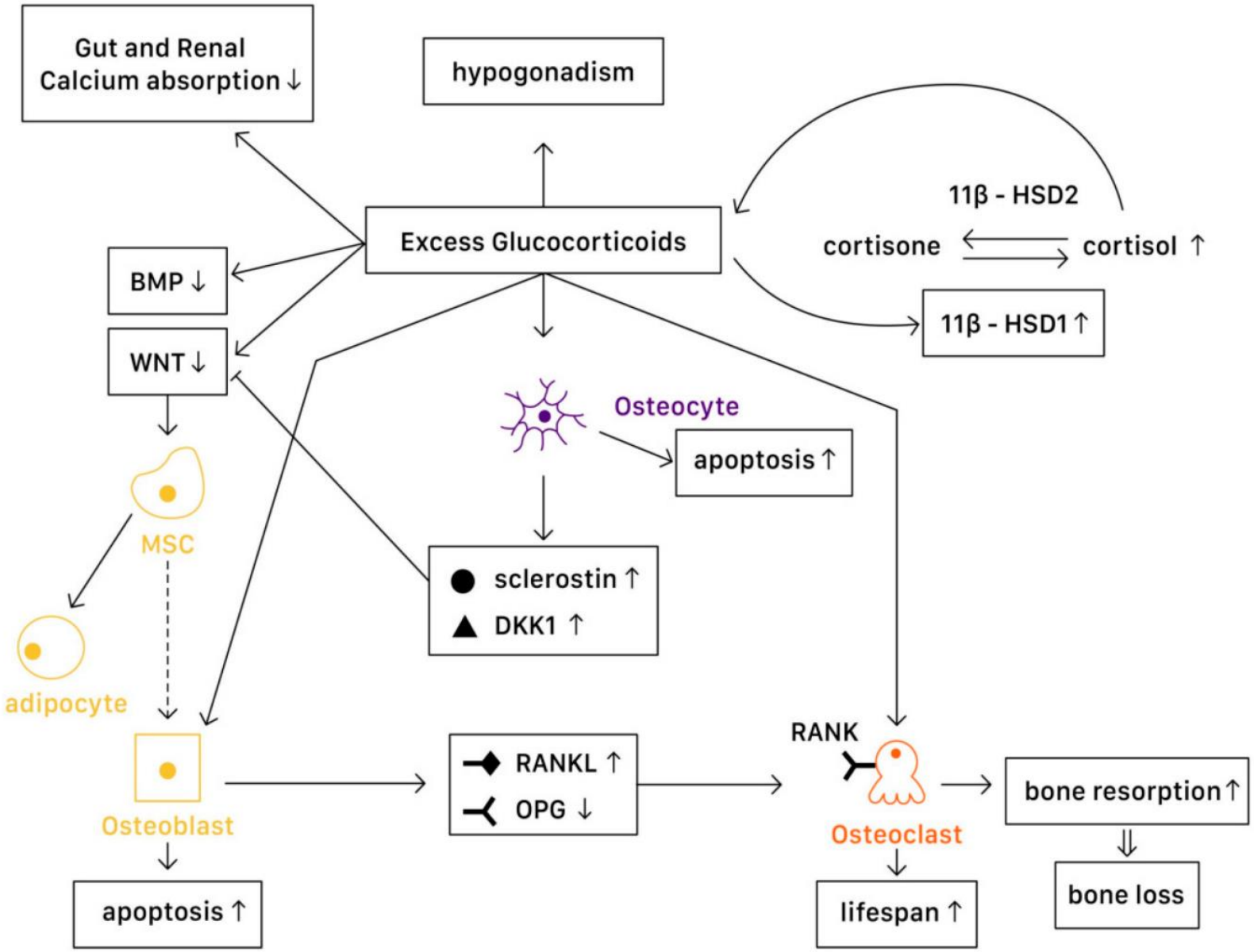
Key Points

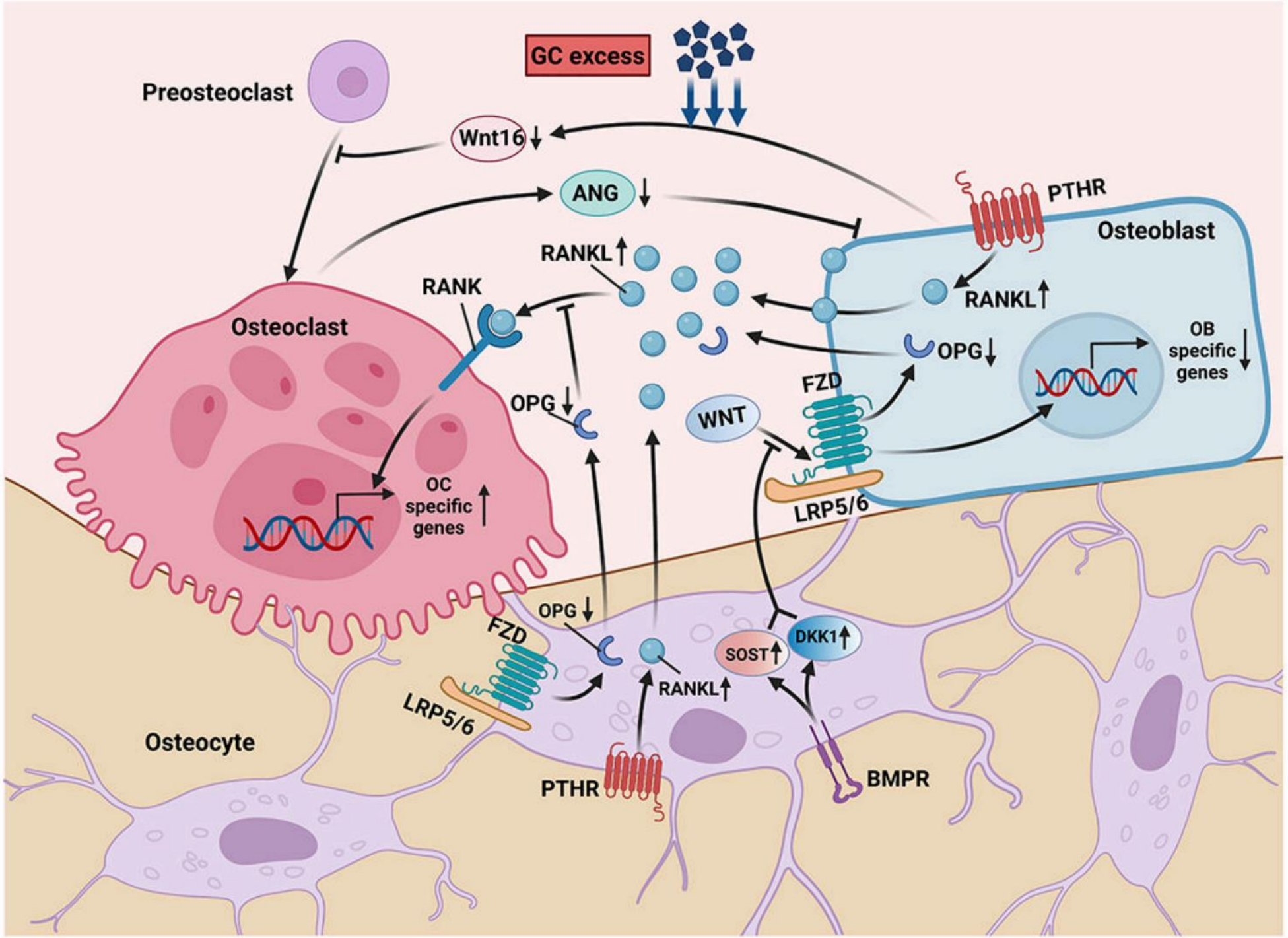
- **One-third of long-term glucocorticoid** (GC) users will develop **secondary osteoporosis**. **Fractures, which might be asymptomatic**, are the most serious consequence of glucocorticoid-induced osteoporosis (GIO), so quick diagnosis and prompt treatment are important. **No safety margin exists for dose-dependent bone loss even at low GC dosages; osteoporotic effects are inevitable.**
- While the risk of vertebral fractures is **increased by 55% even at a prednisolone-equivalent dose of <2.5 mg**, **the relative risk of vertebral fractures is increased by 14 folds in patients who are treated at a dose of ≥15 mg/day and have a cumulative exposure level of ≥5 g**.
- Since osteoporosis may develop even when **low-dose or short-term GC therapy** is used, each patient treated with corticosteroids, regardless of **sex, age, corticosteroid dosage, treatment duration, or administration method,** should be carefully assessed for the risk of fractures.
- The **first 3 months of GC treatment** are critical for deficiency and bone loss. Thus, adequate prevention of GIO should be immediately implemented (lifestyle modification and calcium and vitamin D supplementation). **Bisphosphonates** are the **first-line treatment for GIO**, but other drugs should also be considered.
- When it is necessary to administer drug therapy to **fertile women at moderate or very high risk of fractures**, **oral bisphosphonates and teriparatide are used as the first-line and second-line drugs, respectively.**

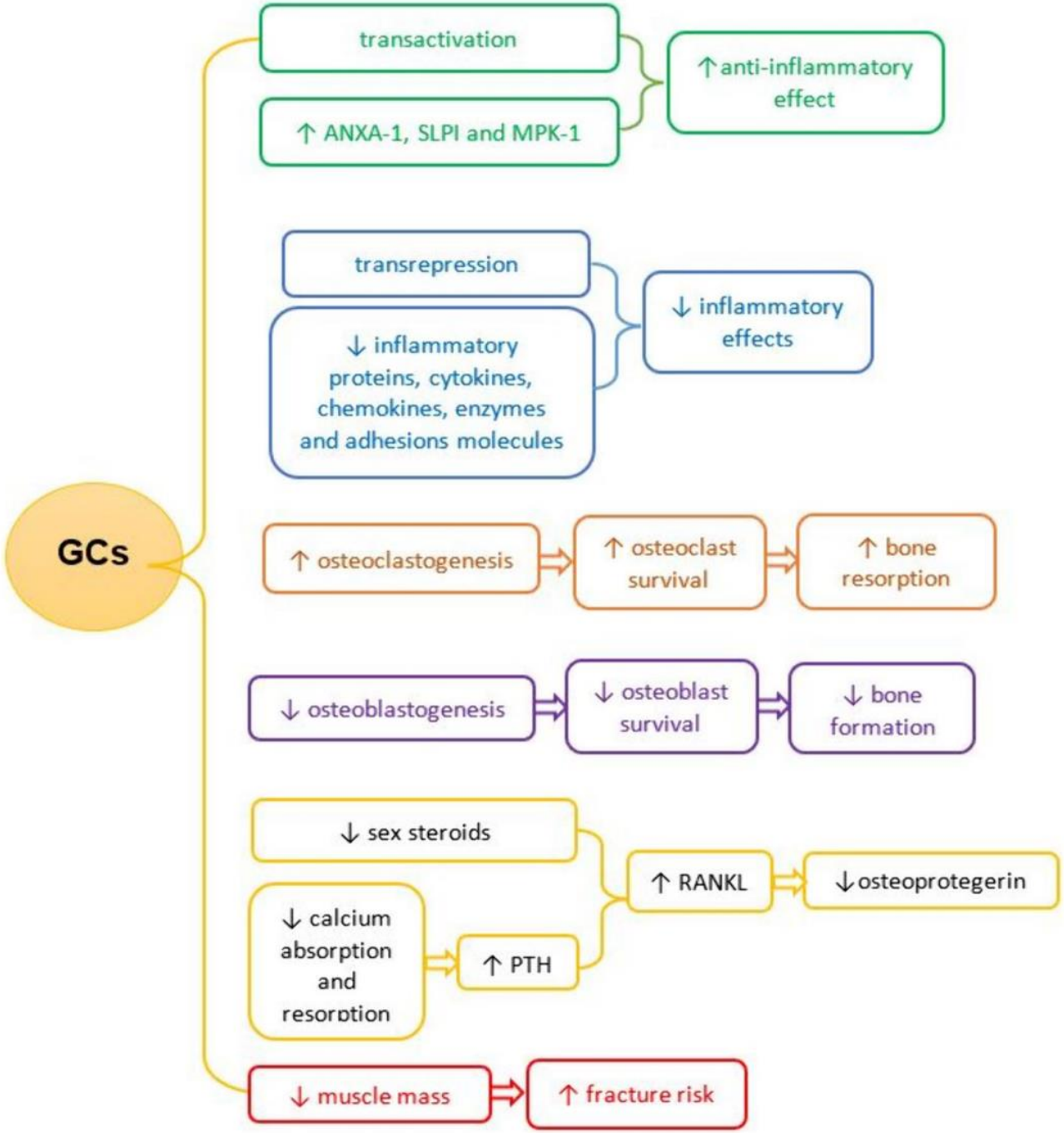
- The risk factors of GIOP include **advanced age, GC doses, low bone mineral density of the lumbar spine, presence of previous fractures, and no receipt of bisphosphonate therapy**.
- Although GIOP has **no specific symptoms**, **vertebral fractures** are useful for the diagnosis. It is recommended **to evaluate whether there are vertebral fractures soon after initiating GC therapy**. Also, **asymptomatic vertebral fractures** account for **two-thirds of all osteoporosis-related fractures**.
- Moreover, a **pre-existing fracture**, **with a score of 7 points**, carries the **greatest risk of a second fracture among the risk factors for fracture**.
- Based on **multiple network meta-analyses** comparing the usefulness of drugs in patients with GIOP, a **recombinant teriparatide** has been shown to be the **most effective drug for preventing vertebral fractures**. The usefulness of **abaloparatide** for the treatment of GIOP **cannot be determined** because of **the lack of studies**.
- **No studies on the efficacy** of an **antisclerostin antibody** for treating GIOP have yet been published. Thus, **no clear recommendations** can be made.
- **Recombinant teriparatide and an anti-RANKL antibody** are more effective than bisphosphonates for **preventing vertebral fractures**. The use of the former drugs is recommended. **Recombinant teriparatide is recommended for patients at high risk of fracture.**

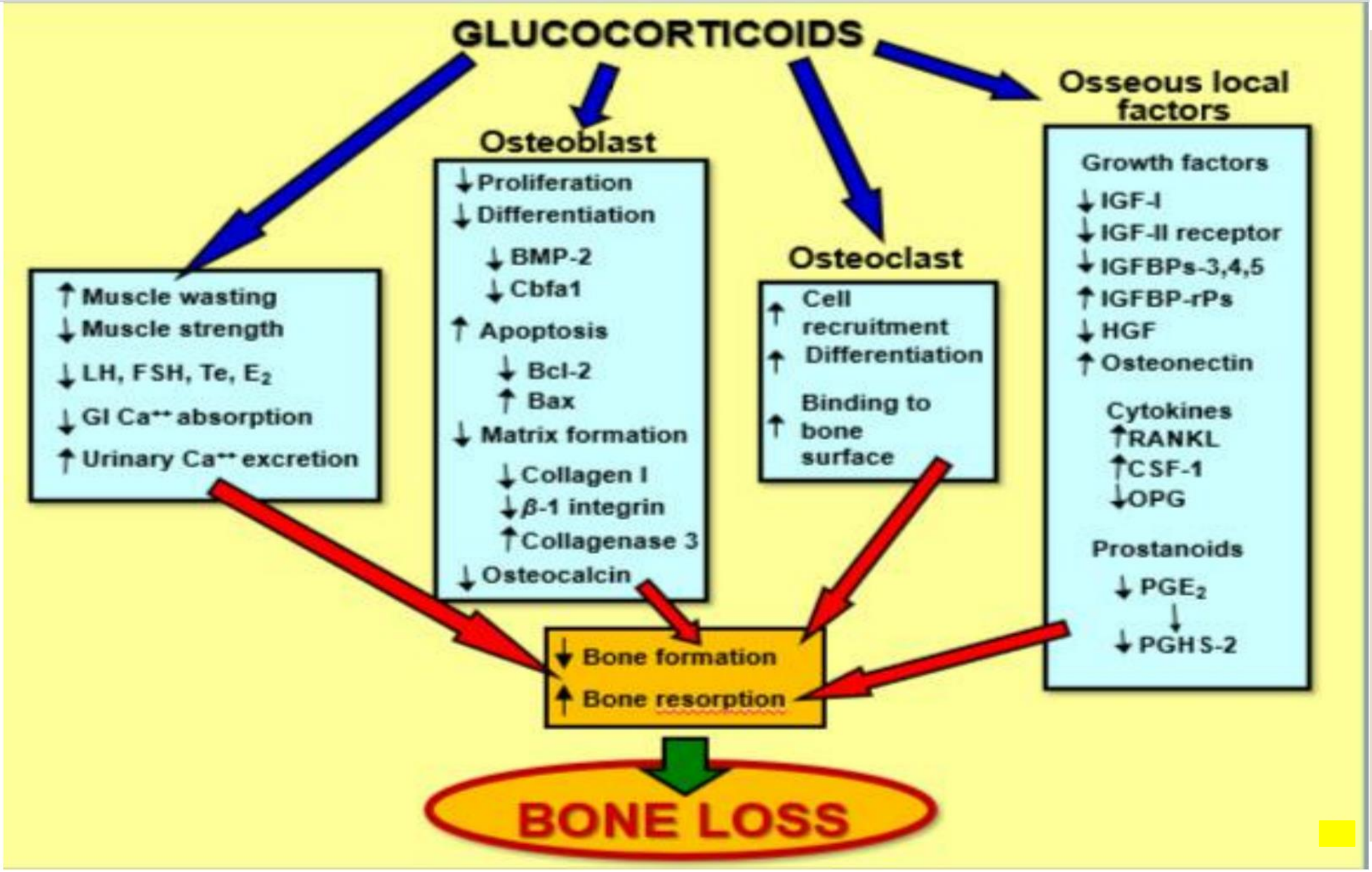

Osteoblasts Notch
HEY1, HEY2, HEYL express
Glucocorticoids
let-7f-5p
Mesenchymal stem cells
Runx2
PPARγ2
RUNX2
Fat cells
Wnt/β-catenin signaling
CSK3β
DKK-1
MCSF
RANκL
OPG
IL-6
Caspase
VEGF
Osteoblast
Osteoclasts
Bone cells
Bone mass
Differentiate
Apoptosis
Differentiate
Apoptosis
Bone mass
Bone formation
Bone resorption
Osteoporosis
Apoptosis
Bone strength
1.25-(OH)2D3
Intestinal calcium absorption
Renal tubular reabsorption of calcium
Urinary calcium excretion
Sex hormones
Osteoblast apoptosis
Bone mass
Skeletal muscle
Atrophy and proximal muscle weakness
Bone strength
Blood calcium
PTH
Bone calcium into the blood

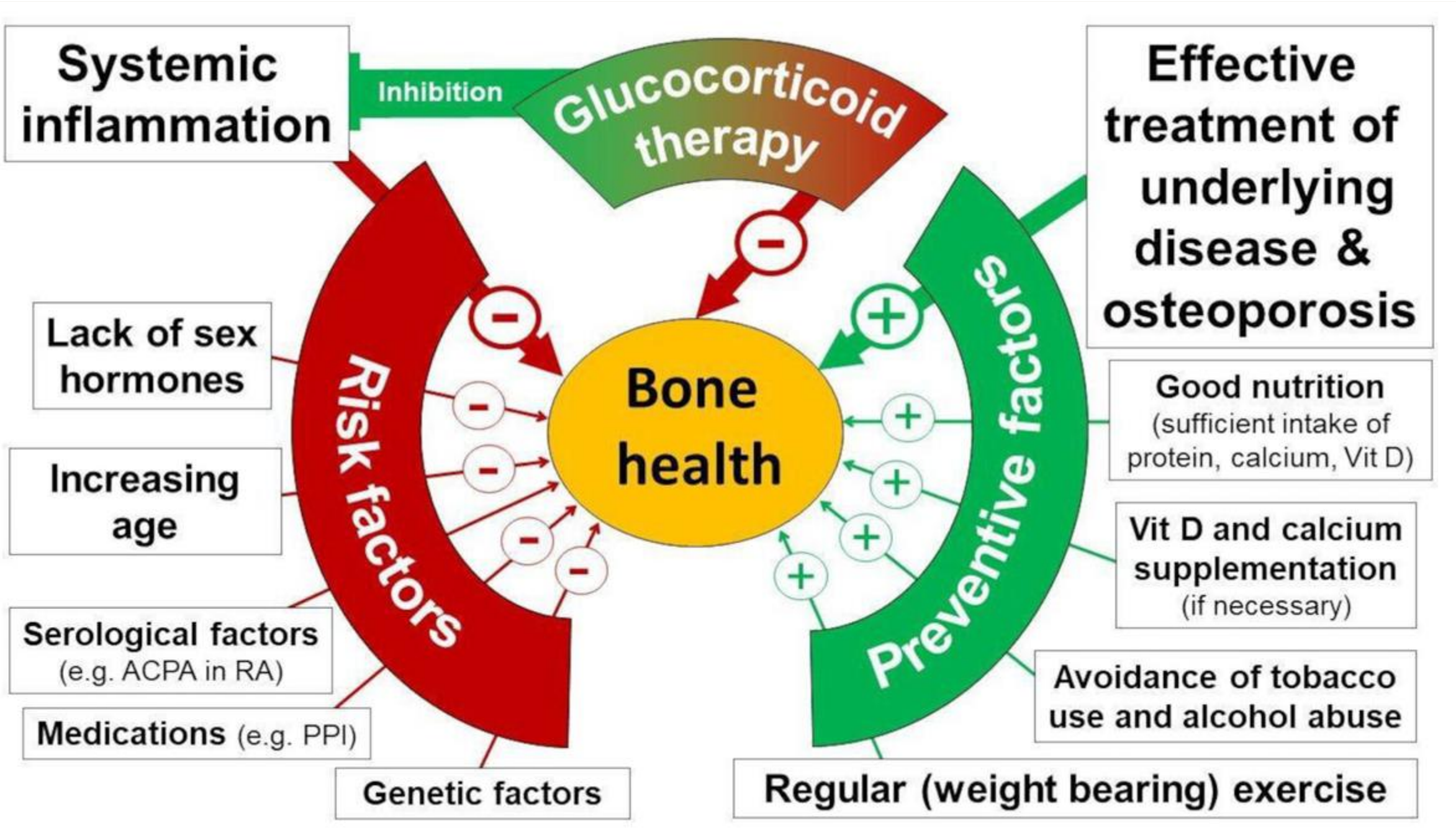


The mechanisms of glucocorticoid-induced osteoporosis (GIOP).


GC excess
Preosteoclast
Wnt16
ANG
PTHR
Osteoblast
RANKL
RANK
RANKL
Osteoclast
OPG
OB specific genes
OPG
FZD
WNT
OC specific genes
LRP5/6
OPG
FZD
DKK1
SOST
RANKL
LRP5/6
Osteocyte
PTHR
BMPR


GCs
transactivation
↑ ANXA-1, SLPI and MPK-1
↑anti-inflammatory effect
transrepression
↓ inflammatory proteins, cytokines, chemokines, enzymes and adhesions molecules
↓ inflammatory effects
↑ osteoclastogenesis
↑ osteoclast survival
↑ bone resorption
↓ osteoblastogenesis
↓ osteoblast survival
↓ bone formation
↓ sex steroids
↓ calcium absorption and resorption
↑ PTH
↑ RANKL
↓osteoprotegerin
↓ muscle mass
↑ fracture risk

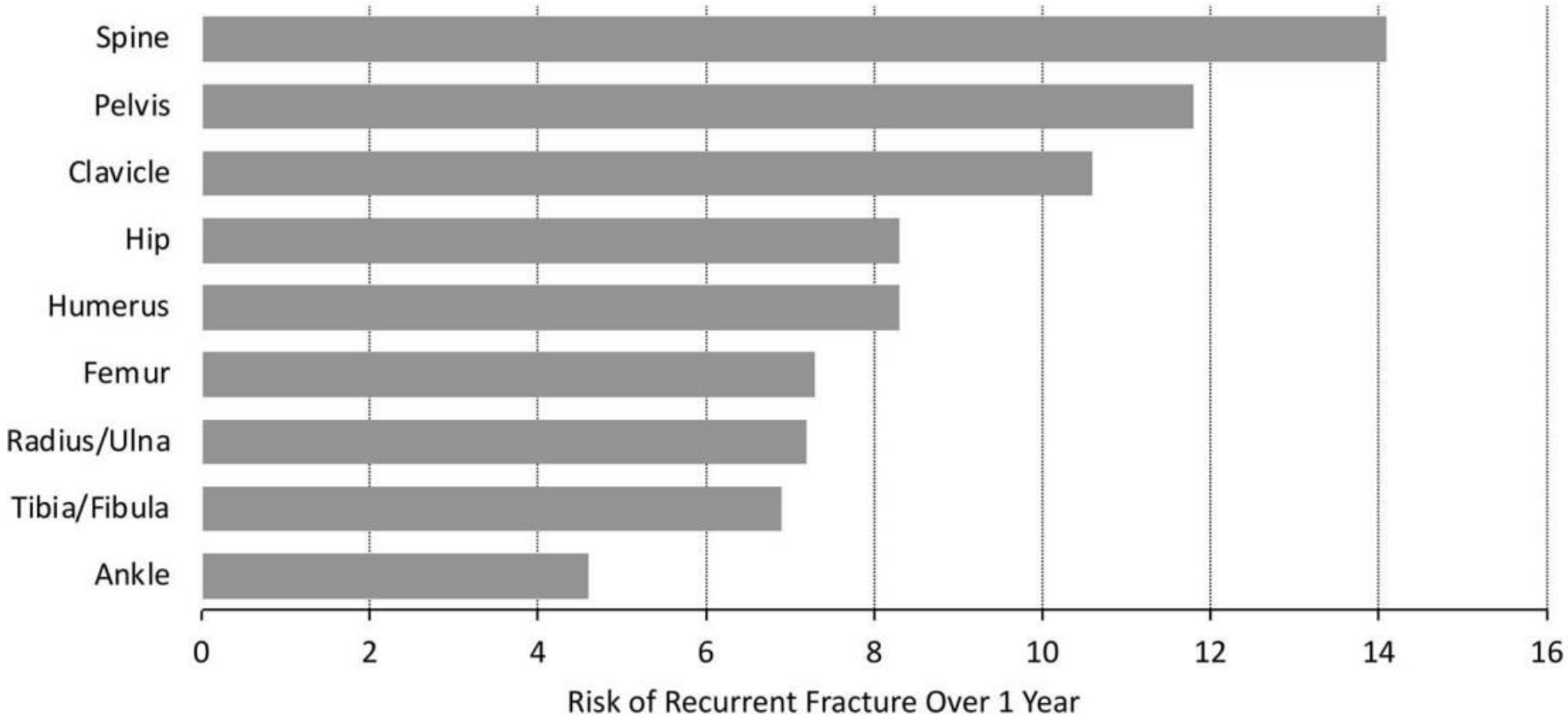

GLUCOCORTICOIDS
↑ Muscle wasting
↓ Muscle strength
↓ LH, FSH, Te, E_2
↓ GI Ca^{++} absorption
↑ Urinary Ca^{++} excretion
Osteoblast
↓ Proliferation
↓ Differentiation
↓ BMP-2
↓ Cbfa1
↑ Apoptosis
↓ Bcl-2
↑ Bax
↓ Matrix formation
↓ Collagen I
↓ β-1 integrin
↑ Collagenase 3
↓ Osteocalcin
Osteoclast
↑ Cell recruitment
↑ Differentiation
↑ Binding to bone surface
Osseous local factors
Growth factors
↓ IGF-I
↓ IGF-II receptor
↓ IGFBPs-3,4,5
↑ IGFBP-rPs
↓ HGF
↑ Osteonectin
Cytokines
↑ RANKL
↑ CSF-1
↓ OPG
Prostanoids
↓ PGE_2
↓ PGHS-2
↓ Bone formation
↑ Bone resorption
BONE LOSS


Systemic inflammation
Inhibition
Glucocorticoid therapy
Effective treatment of underlying disease & osteoporosis
Lack of sex hormones
Increasing age
Serological factors (e.g. ACPA in RA)
Medications (e.g. PPI)
Genetic factors
Risk factors
Bone health
Preventive factors
Good nutrition (sufficient intake of protein, calcium, Vit D)
Vit D and calcium supplementation (if necessary)
Avoidance of tobacco use and alcohol abuse
Regular (weight bearing) exercise

Glucocorticoid-induced osteoporosis caused by non-systemic GC administrations

GC administration and the risk of GIO			
Author [reference]	Characteristics of the study group	GC administration	Results
Loke et al.	Mean age 60–70 years old; > 50% male in every trial; *n* = 17,513	14 trials with inhaled fluticasone; 2 trials with inhaled budesonide	↑ relative risk of osteoporotic fractures (about 27%)
Egeberg et al.	Mean age 52.8 years old; 52.8% female; *n* = 723,251	> 200 g equivalent topical mometasone	↑ relative risk of osteoporosis (about 3%) and major fracture risk with every doubling topical GC dose
Thompson et al.	72-year-old female; *n* = 1	A single 80 mg triamcinolone acetonide intra-articular injection to the left hip	Left femoral head collapse and severe joint space narrowing 4 weeks after injection

n number of patients, *GC* glucocorticosteroid, ↓ decrease, ↑ increase



One-year risk of recurrent fracture in women > 65 years of age, based on site of initial fracture, from Medicare database of 377,561 women with first fracture. Adapted from reference 8.

The Stages of GIOP Based on Guidelines.

Stage	Description
Stage 0 (before starting GC therapy)	Recognition, agreement and infrastructure
Stage 1	Tailoring the GC regimen and dose
Stage 2	Implementing comprehensive strategies for bone health involves offering lifestyle guidance, conducting osteoporosis and fracture risk assessments, ensuring appropriate nutritional supplementation and prescribing preventive pharmacological interventions
Stage 3	Ensuring adherence to supplementation and preventive medication involves proactive efforts such as patient education, routine monitoring and personalised support to promote sustained health benefits
Stage 4	Evaluating GIOP data, reflecting on outcomes and seeking improvements

Do's and Don'ts in the management of glucocorticoids in patients with Systemic Lupus Erythematosus.

Do's

- ✓ Maintain long-term HCQ unless toxicity is confirmed.
- ✓ Adjust induction therapy to the severity of the disease.
- ✓ Restrict maintenance dose of prednisone to ≤5 mg/day (preferably ≤2.5 mg/day).
- ✓ Use MP (125-500 mg/day for 3 days) to treat moderate to severe flares.
- ✓ Use immunosuppressive drugs form the beginning to treat moderate to severe flares.
- ✓ Consider MP to treat mild flares that do not respond to prednisone up to 7.5-10 mg/day within one week.
- ✓ Use immunosuppressive drugs to treat mild flares that do not respond to antimalarials and prednisone up to 5 mg/day.
- ✓ Consider the discontinuation of prednisone after clinical remission for at least 3-5 years.
- ✓ Start prednisone withdrawal after immunosuppressive drugs discontinuation, and slowly taper for at least 3-6 months until definitive discontinuation.

Don’ts

- ✘ Ever start prednisone at doses higher than 30 mg/day.
- ✘ Ever use maintenance dose of prednisone >5 mg/day.
- ✘ Start biologics just as a steroid reduction strategy.
- ✘ Consider prednisone withdrawal before clinical remission has been achieved for at least 3-5 years.
- ✘ Taper prednisone to zero over periods shorter than 3 months.
- ✘ Stop HCQ unless toxicity is confirmed.

Similarities and differences in diagnosis, assessment, and pharmacologic intervention thresholds among glucocorticoid-induced osteoporosis recommendations and guidelines

	ACR 2022	Korean 2018	Belgian 2022	TOPF 2021	Malaysian 2015	Japan 2023
Dose definition of GIO (prednisolone equivalence)	≥ 2.5 mg/day	≥ 2.5 mg/day	≥ 5 mg/day	≥ 5 mg/day	≥ 7.5 mg/day (5 mg/day if FRAX > 20%)	Any
Pharmacologic intervention thresholds in patients aged ≥ 40–50 years if any of the following criteria are met						
T-score	< -1.0	≤ -2.5	≤ -1.5	≤ -2.5	NA	(Lumbar BMD) (%YAM)
FRAX	Hip > 1% MOF > 10%			Hip ≥ 3%	MOF > 10%	NA
Fracture	Osteoporotic fracture				NA	Osteoporotic fracture
Dose GC for start treatment	30 mg/day Cumulative dose > 5 gm/year		≥ 7.5 mg/day	x	≥ 7.5 mg/day	Any
Pharmacologic intervention thresholds in patients aged < 40–50 years if any of the following criteria are met.						
Z-score	Prednisolone > 7.5 mg/day Z-score < -3 Rapid bone loss ≥ 10% at Hip/spine			NA	NA	(Lumbar BMD) (%YAM)
Fracture	Osteoporotic fracture					
Dose GC for start treatment	30 mg/day Cumulative dose > 5 gm/year			NA	NA	any

BMD, Bone mineral density; GC, Glucocorticoids; GIO, Glucocorticoid-induced osteoporosis; NA, Not applicable

ACR 2022, the American College of Rheumatology Guideline for the Prevention and Treatment of GIO 2022; Korea 2018, Korean Guideline for the Prevention and Treatment of GIO 2018; Malaysia 2015, Update of the Malaysian clinical guideline on the management of GIO 2015; Belgian 2022, Prevention and Treatment of Glucocorticoid-Induced Osteoporosis in Adult: Consensus Recommendations from the Belgian Bone Club 2022; TOPF2021, Summary of the Thai Osteoporosis Foundation Clinical Practice Guideline on the diagnosis and management of osteoporosis 2021; Japan 2023, Guidelines on the management and treatment for GIO of the Japanese Society for Bone and Mineral Research 2023

The performance of intervention thresholds for treating glucocorticoid-induced osteoporosis based on different guidelines against actual fragility fractures. Result reported in number (95% confidence interval)

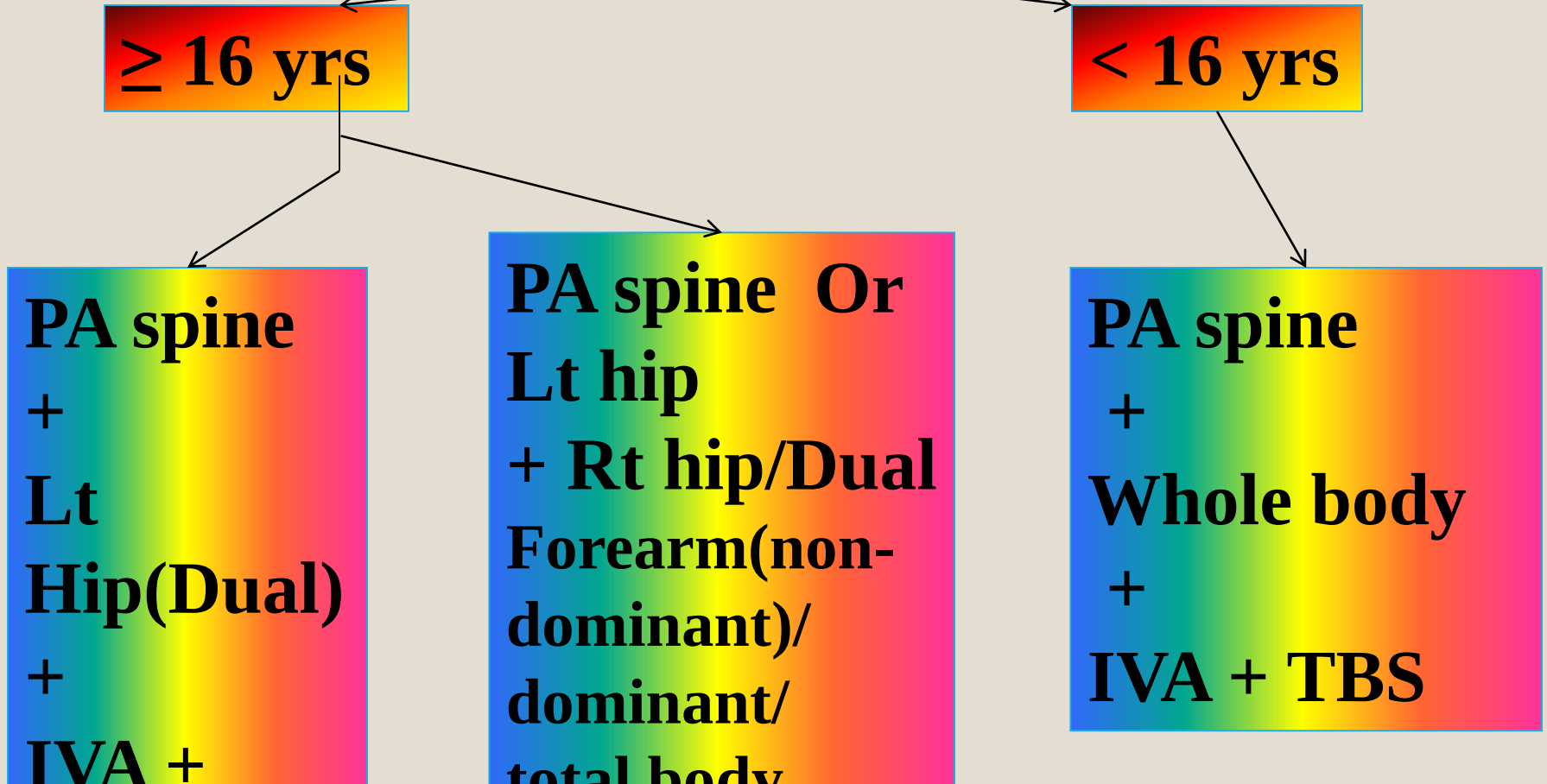
Guidelines	Sensitivity	Specificity	PPV	NPV	Accuracy	AUC
ACR 2022	100 (89.1–100)	3.1 (1.14–6.61)	14.6 (10.2–19.9)	100 (54.1–100)	16.8* (12.2–22.3)	0.590 (0.494–0.685)
Korean 2018	100 (89.1–100)	17.5 (12.5–23.6)	16.7 (11.7–22.7)	100 (89.7–100)	29.2* (23.4–35.6)	0.587 (0.491–0.683)
Malaysia 2015	78.1 (60–90.7)	62.9 (55.7–69.7)	25.8 (17.4–35.7)	94.6 (89.1–97.8)	65 (58.4–71.2)	0.719 (0.627–0.810)
Belgian 2022	93.8 (79.2–99.2)	14.4 (9.8–20.2)	15.3 (10.6–21.1)	93.3 (77.9–99.2)	25.7* (20.1–31.9)	0.558 (0.457–0.559)
TOPF2021	93.8 (79.2–99.2)	43.8 (36.7–51.1)	21.6 (15.1–29.4)	97.7 (91.9–99.7)	50.9 (44.2–57.6)	0.704 (0.625–0.784)
Japan 2023	100 (89.1–100)	24.2 (18.4–30.9)	17.9 (12.6–24.3)	100 (92.5–100)	35* (28.8–41.6)	0.621 (0.530–0.711)

PPV: Positive predictive value, NPV: Negative predictive value, AUC: Area under the curve. CI: Confidence interval *Significant difference from Malaysian 2015 ($p < 0.05$)

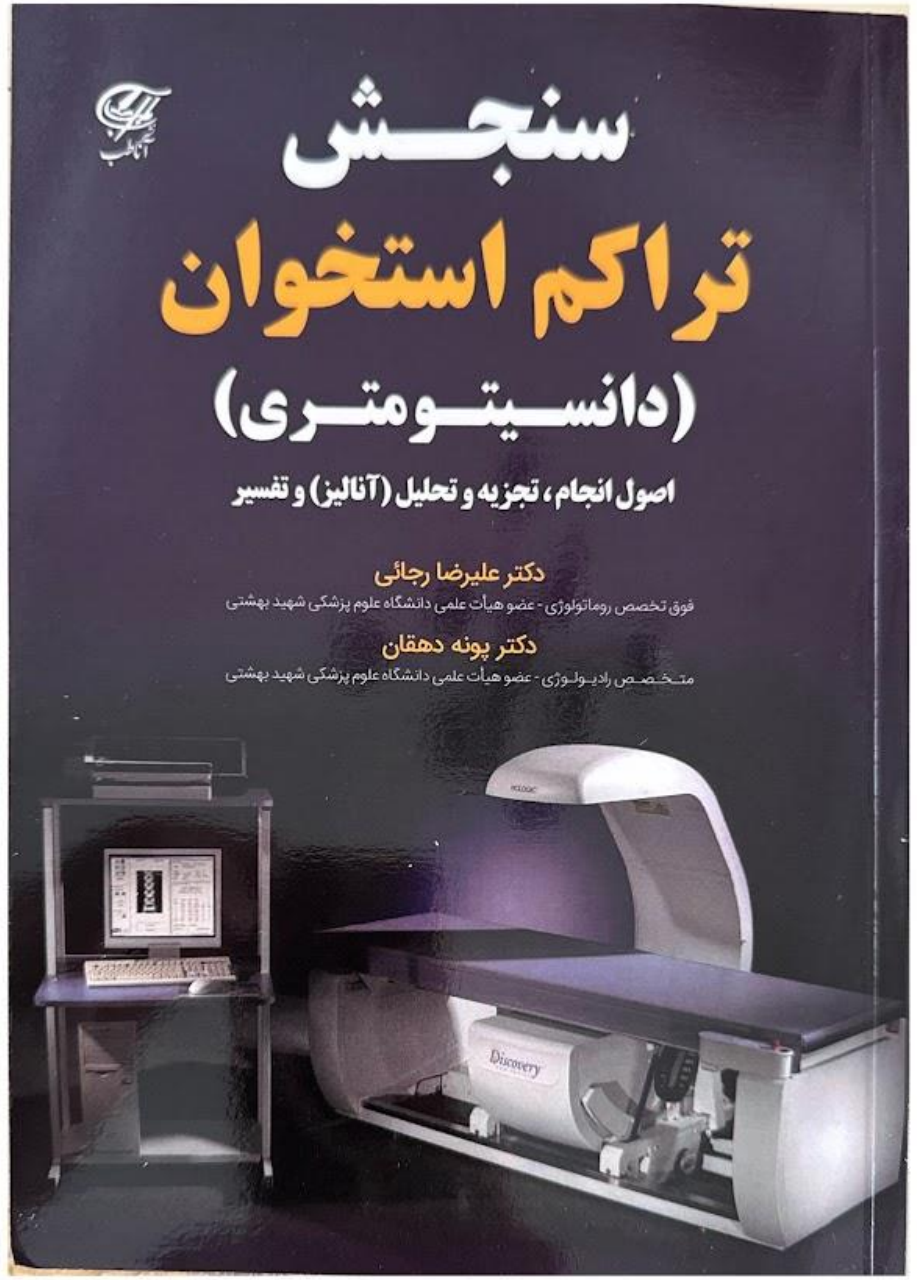
ACR2022, the American College of Rheumatology Guideline for the Prevention and Treatment of GIO 2022; Korea2018, Korean Guideline for the Prevention and Treatment of GIO 2018; Malaysia2015, Update of the Malaysian clinical guideline on the management of GIO 2015; Belgian2022, Prevention and Treatment of Glucocorticoid-Induced Osteoporosis in Adult: Consensus Recommendations from the Belgian Bone Club 2022; TOPF2021, Summary of the Thai Osteoporosis Foundation Clinical Practice Guideline on the diagnosis and management of osteoporosis 2021; Japan2023, Guidelines on the management and treatment for GIO of the Japanese Society for Bone and Mineral Research 2023

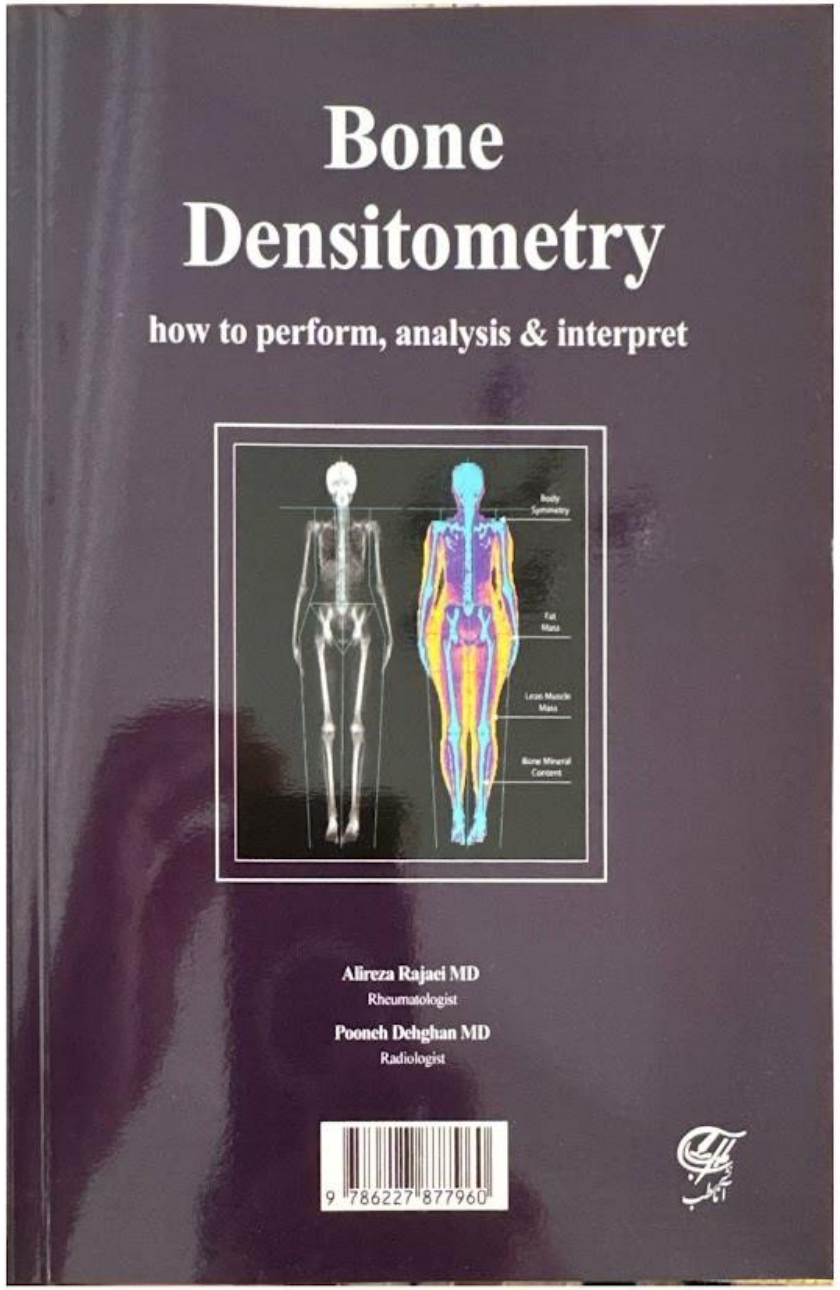
2	What are the risk factors for GIOP?	The risk factors of GIOP include advanced age, GC doses, low bone mineral density of the lumbar spine, presence of previous fractures, and no receipt of bisphosphonate therapy. It is recommended to implement appropriate management and treatment of GIOP without delay while attention is paid to these risk factors	D	1	9.0

How request BMD for GIOP



A.R.Rajaei MD


سنجش
تراکم استخوان
(دانسیتومتری)
اصول انجام، تجزیه و تحلیل (آنالیز) و تفسیر
دکتر علیرضا رجائی
فوق تخصص روماتولوژی - عضو هیأت علمی دانشگاه علوم پزشکی شهید بهشتی
دکتر پونه دهقان
متخصص رادیولوژی - عضو هیأت علمی دانشگاه علوم پزشکی شهید بهشتی
Discovery


Bone
Densitometry
how to perform, analysis & interpret
Body Symmetry
Fat Mass
Lean Muscle Mass
Bone Mineral Content
Alireza Rajaei MD
Rheumatologist
Pooneh Dehghan MD
Radiologist
9 786227 877960

Spine

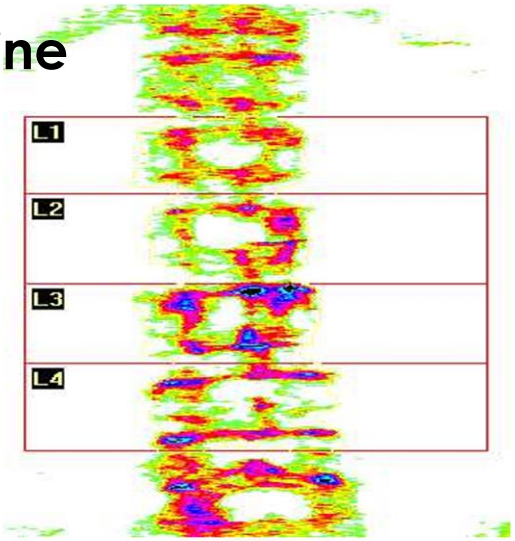
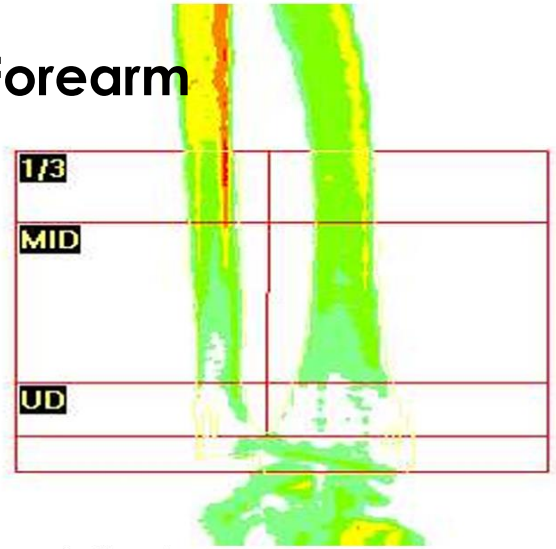


Image not for diagnostic use

Forearm



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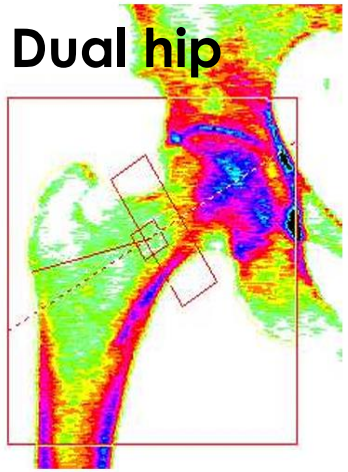
GIOP updates

f Right Hip 03.01.2022

f Left Hip 03.01.2022

Dual hip



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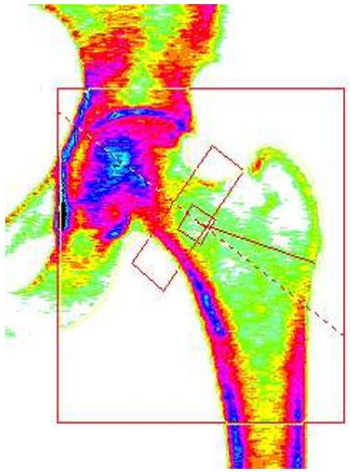

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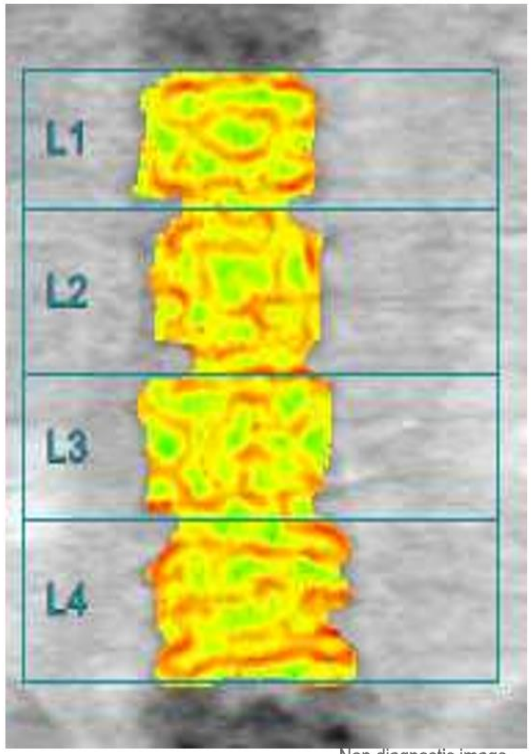
TBS Mapping



Non diagnostic image

TBS Values High

TBS Values Low

Lt hip

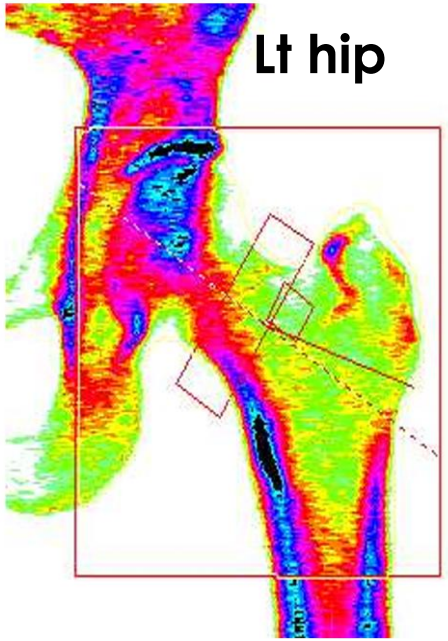
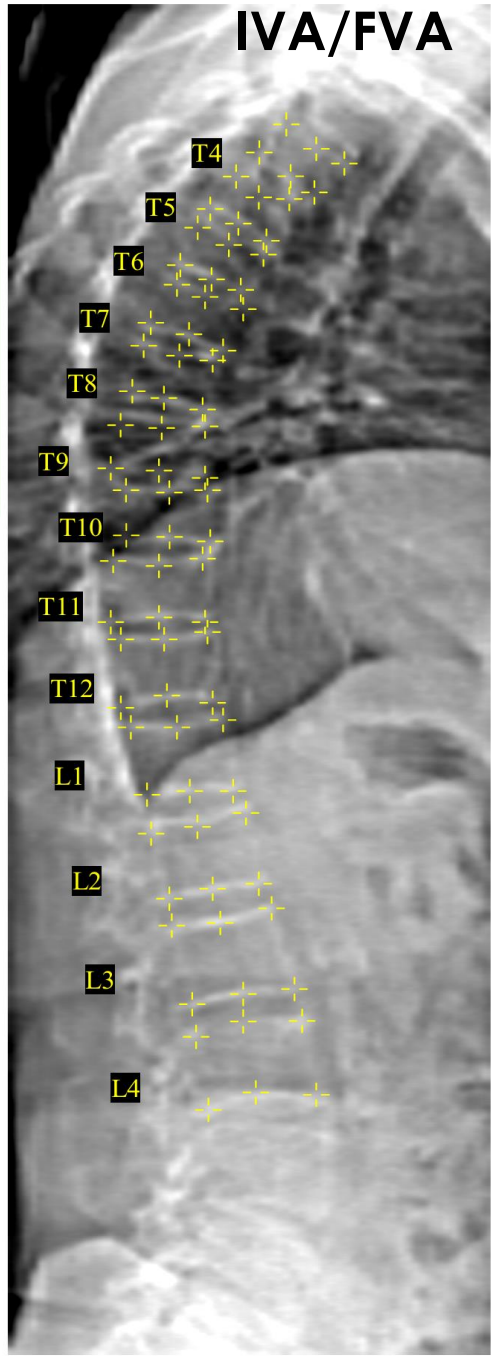
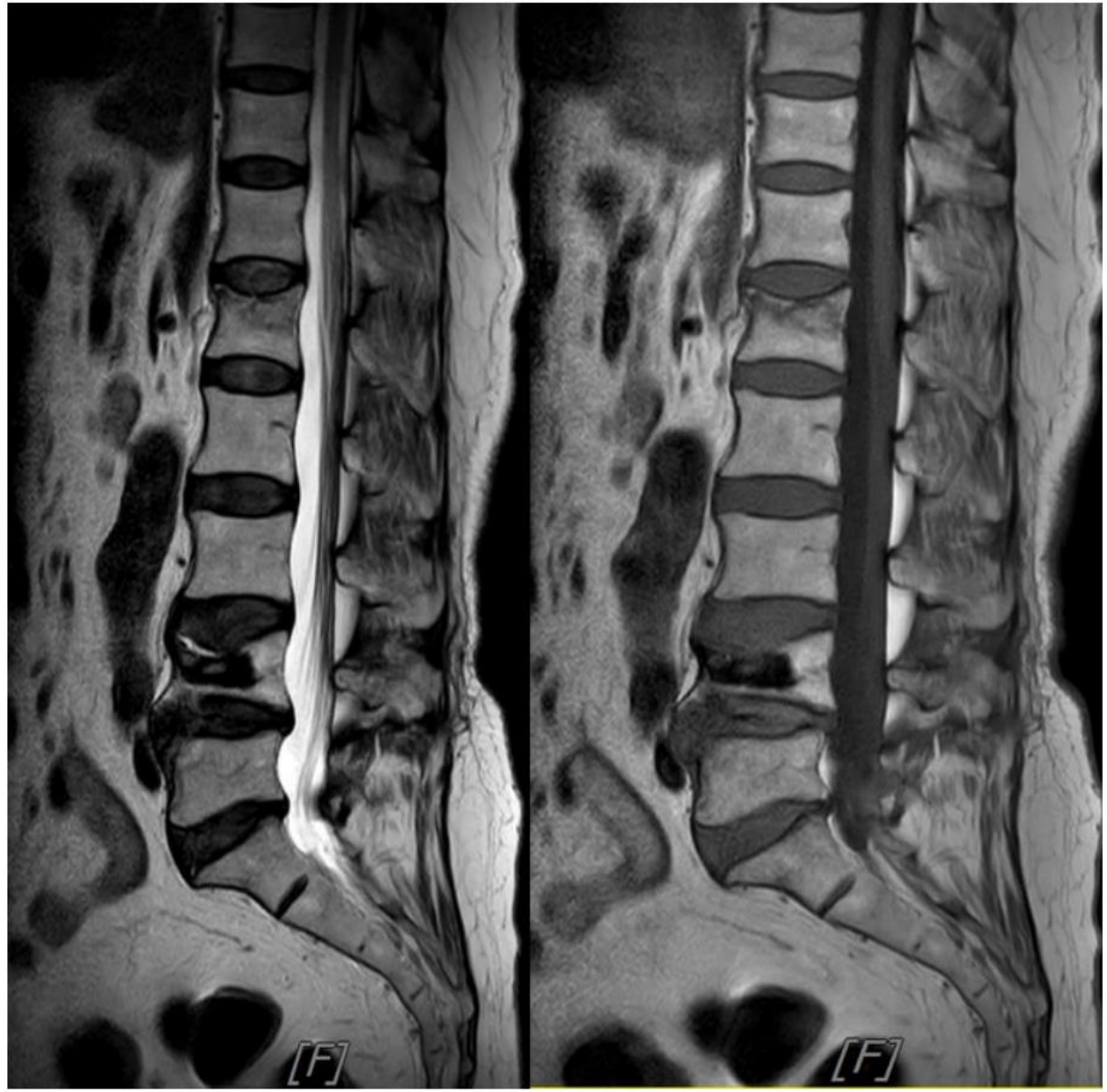


Image not for diagnostic use

IVA/FVA





. L-spine MRI images taken at another facility. Parasagittal T2 & T1-weighted images show acute L1 vertebral body compression fracture

Calculation Tool

Please answer the questions below to calculate the ten year probability of fracture with BMD.

Country: Iran Name/ID: About the risk factors

Questionnaire:

1. Age (between 40 and 90 years) or Date of Birth
   Age: 53 Date of Birth: Y: M: D:
2. Sex ○ Male ◉ Female
3. Weight (kg) 58
4. Height (cm) 163
5. Previous Fracture ◉ No ○ Yes
6. Parent Fractured Hip ◉ No ○ Yes
7. Current Smoking ◉ No ○ Yes
8. Glucocorticoids ◉ No ○ Yes
9. Rheumatoid arthritis ◉ No ○ Yes
10. Secondary osteoporosis ◉ No ○ Yes
11. Alcohol 3 or more units/day ◉ No ○ Yes
12. Femoral neck BMD (g/cm^2)

T-Score -2.5

Clear Calculate

BMI: 21.8

The ten year probability of fracture (%)

with BMD

Major osteoporotic	4.7
Hip Fracture	1.5

If you have a TBS value, click here: Adjust with TBS

Weight Conversion

Pounds → kg

Convert

Height Conversion

Inches → cm

Convert

00302269

Individuals with fracture risk assessed since 1st June 2011

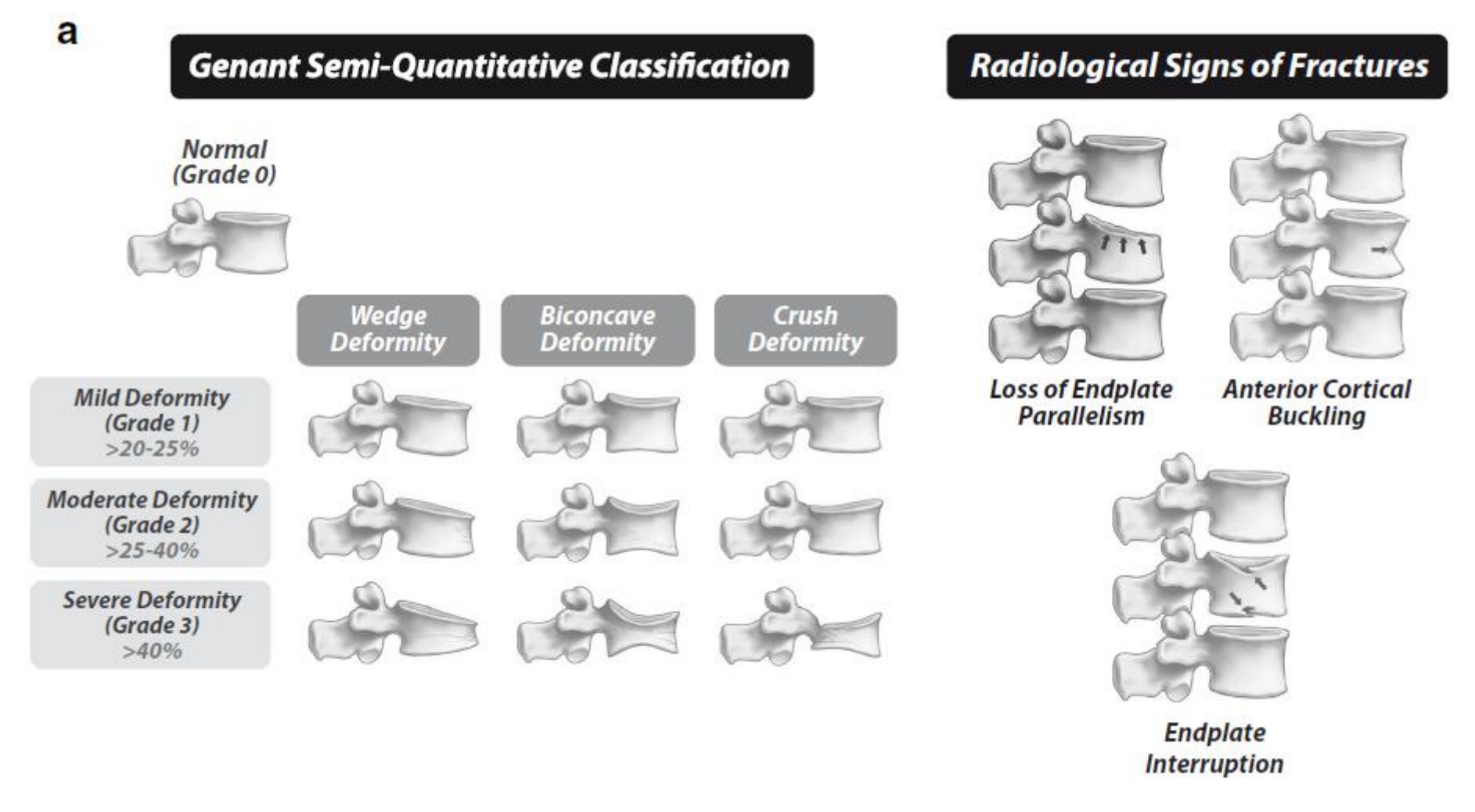
FRAX limitations:

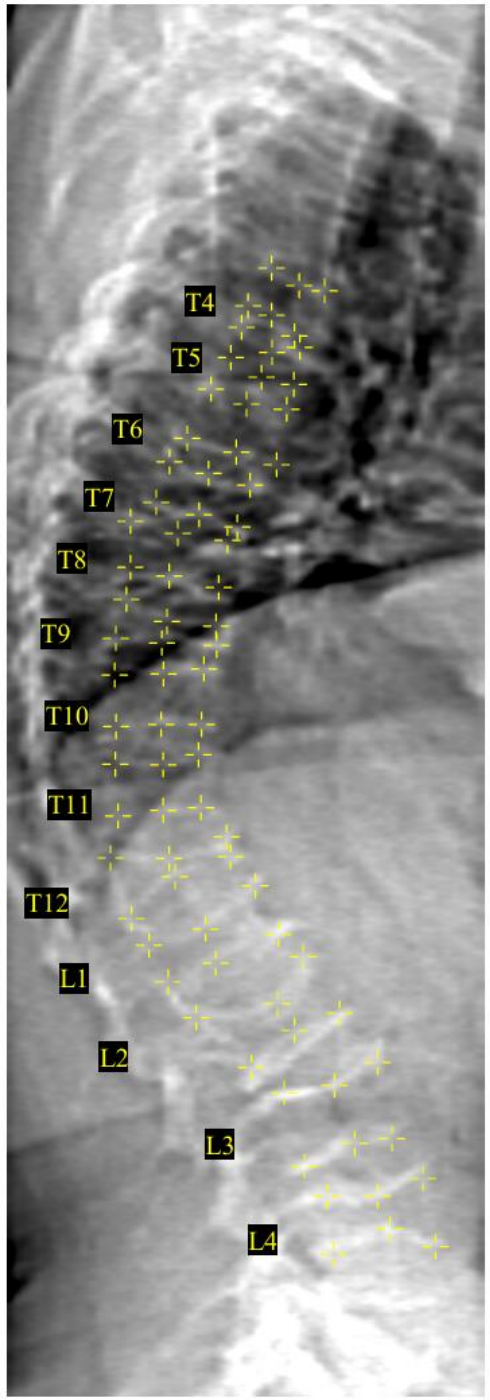
- FRAX does not take account of the dose or duration of glucocorticoid therapy and therefore underestimates risk in individuals receiving high doses, this adjustment may not correct for very high doses of GC (≥30 mg/day).
- FRAX does not incorporate falls, site, number or timing of fractures, or frailty that may put a person at higher risk of fracture.
- Use of total hip BMD in FRAX may lead to underestimation of fracture risk if spine BMD is differentially affected.

Adjustment in FRAX score by glucocorticoid dose and age

Dose		Age 40	50	60	70	80	90	All
	For hip fracture risk							
Low[a]	Multiply FRAX score by:	0.60	0.60	0.50	0.40	0.70	0.70	0.65
High[b]	Multiply FRAX score by:	1.25	1.25	1.25	1.20	1.10	1.10	1.20
	For major osteoporotic fracture risk							
Low[a]	Multiply FRAX score by:	0.80	0.80	0.85	0.80	0.80	0.80	0.80
High[b]	Multiply FRAX score by:	1.20	1.20	1.15	1.15	1.10	1.10	1.15

[a]Prednisolone < 2.5 mg/day or equivalent.
[b]Prednisolone ≥ 7.5 mg/day or equivalent.


a
Genant Semi-Quantitative Classification
Normal
(Grade 0)
Wedge Deformity
Biconcave Deformity
Crush Deformity
Mild Deformity
(Grade 1)
>20-25%
Moderate Deformity
(Grade 2)
>25-40%
Severe Deformity
(Grade 3)
>40%
Radiological Signs of Fractures
Loss of Endplate Parallelism
Anterior Cortical Buckling
Endplate Interruption



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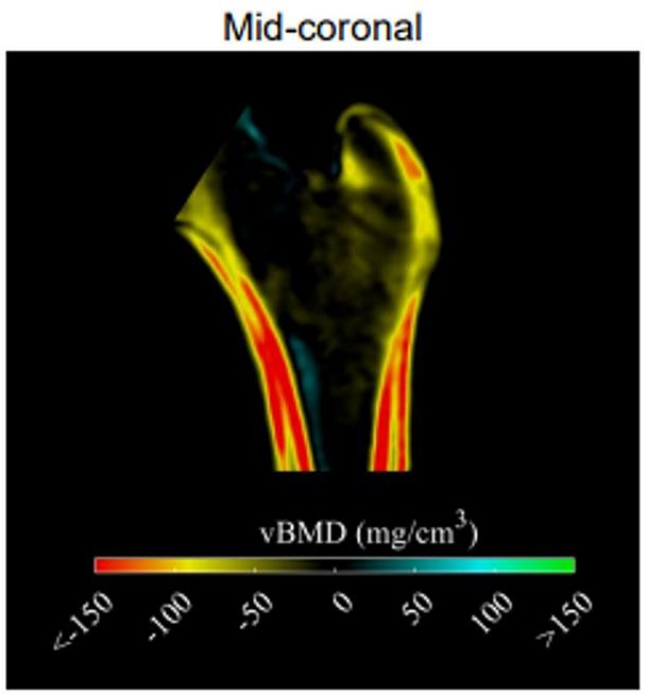
Scan Type: f SE R/L Lateral Image
Analysis: 25 December 2021 15:43
Operator: A
Model: Horizon Wi (304687M)
Comment:

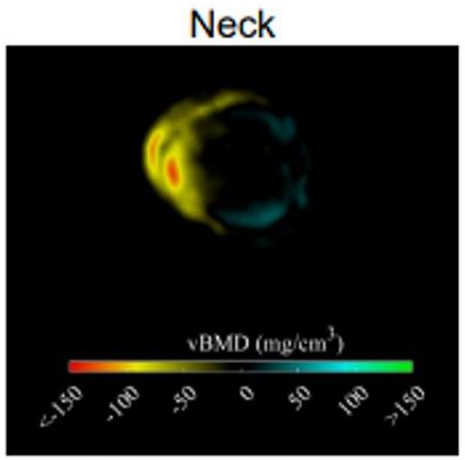
Vertebral Assessment:

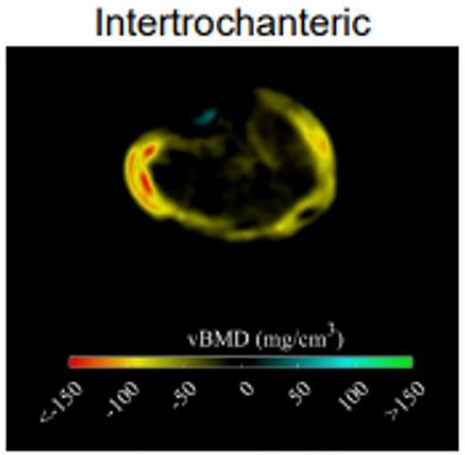
Label	Height (mm) Post	Mid	Ant	Percent Deformation Wedge	Biconcave	Crush
	Deformity (Grade)					
T4	12.7	11.6	15.7	0.0%	8.8%	18.6%
	Normal					
T5	9.2	7.7	10.8	0.0%	16.1%	14.7%
	Normal					
T6	15.7	14.1	16.2	0.0%	10.6%	2.9%
	Normal					
T7	12.3	12.2	12.5	0.0%	0.4%	1.7%
	Normal					
T8	13.2	12.5	13.8	0.0%	5.8%	4.2%
	Normal					
T9	11.6	6.3	5.5	52.3%	45.5%	0.0%
	Wedge (Severe)					
T10	14.7	14.5	15.9	0.0%	1.7%	7.5%
	Normal					
T11	14.9	13.0	15.2	0.0%	12.5%	2.1%
	Normal					
T12	18.4	5.4	5.8	68.6%	70.4%	0.0%
	Biconcave (Severe)					
L1	11.8	10.3	15.5	0.0%	12.8%	23.7%
	Crush (Mild)					
L2	21.4	9.1	19.2	10.0%	57.4%	0.0%
	Biconcave (Severe)					
L3	21.9	17.6	22.2	0.0%	19.4%	1.6%
	Normal					
L4	16.7	10.1	19.9	0.0%	39.8%	15.7%
	Biconcave (Moderate)					
Std Dev	1.0	1.0	1.0	5.0%	5.0%	5.0%

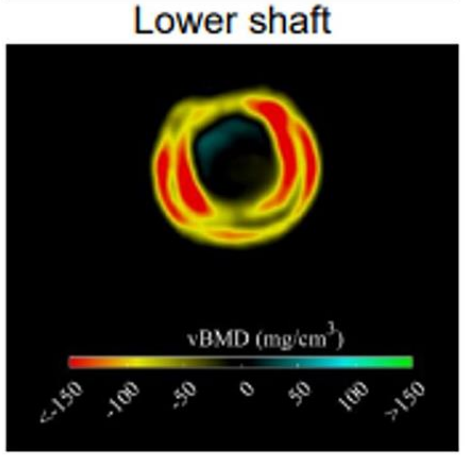
Physician's Comment:

HOLOGIC®









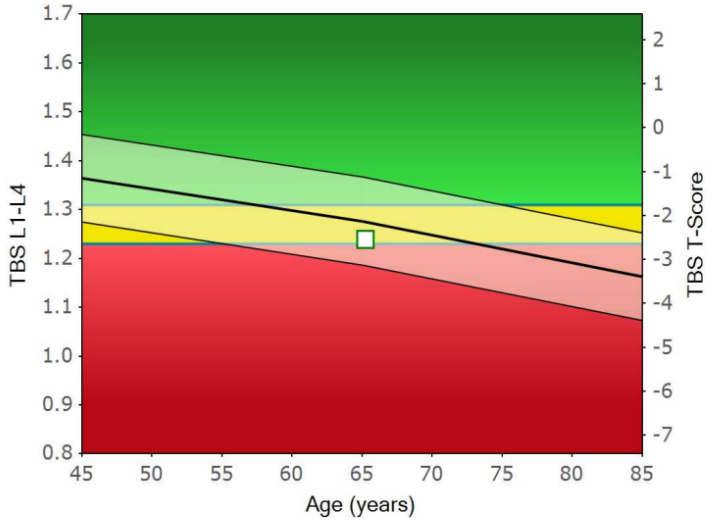
Anatomical distribution of the differences in the bone structure. Differences in the cortical and trabecular vBMD are displayed using cross-sectional images. The higher values in the case group compared to the control are presented in blue and green colors; the lower values in the case group compared to the control are presented in yellow and red colors.

SPINE TBS REPORT

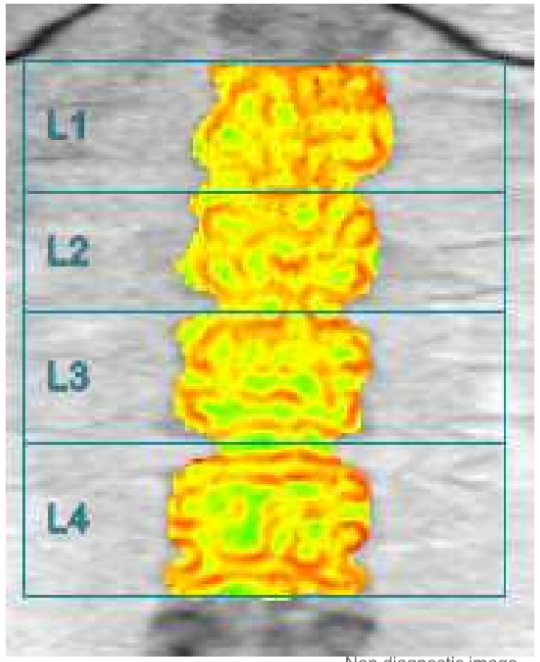
TBS reference graph

Reference population: European (Medimaps)

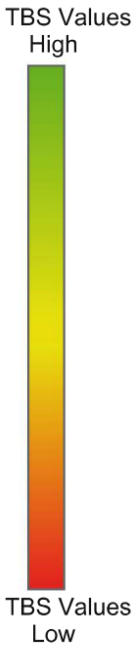
TBS T-Score L1-L4: -2.5



TBS Mapping



Non diagnostic image



Additional results

Region	TBS	TBS T-Score	TBS Z-Score	BMD
L1	1.062	---	---	0.689
L2	1.251	---	---	0.757
L3	1.385	---	---	0.733
L4	1.264	---	---	0.711
L1-L4	1.240	-2.5	-0.4	0.721
L1-L3	1.233	-2.9	-0.2	0.726
L1-L2	1.156	-3.7	-0.6	0.722
L2-L3	1.318	-2.2	0.2	0.744
L2-L4	1.300	-1.9	0.0	0.731
L3-L4	1.324	-1.4	0.0	0.721

FRAX

The 10 year probability of fracture, adjusted for TBS:
Major Osteoporotic Fracture: 9.8 %
Hip Fracture: 1.0 %

FRAX web site: https://www.shef.ac.uk/FRAX/?lang=en

To be used only if FRAX is displayed on the BMD report.

Comments

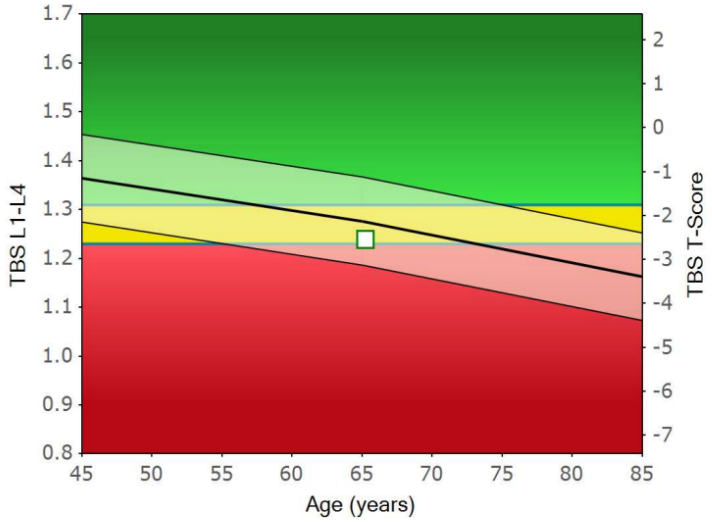
	Female	Male
Normal microarchitecture (NM)	> 1.302	> 1.201
Partial degradation microarchitecture (PDM)	1.157 – 1.302	1.003 – 1.201
Full degradation architecture (FDM/FM)	< 1.157	< 1.003

SPINE TBS REPORT

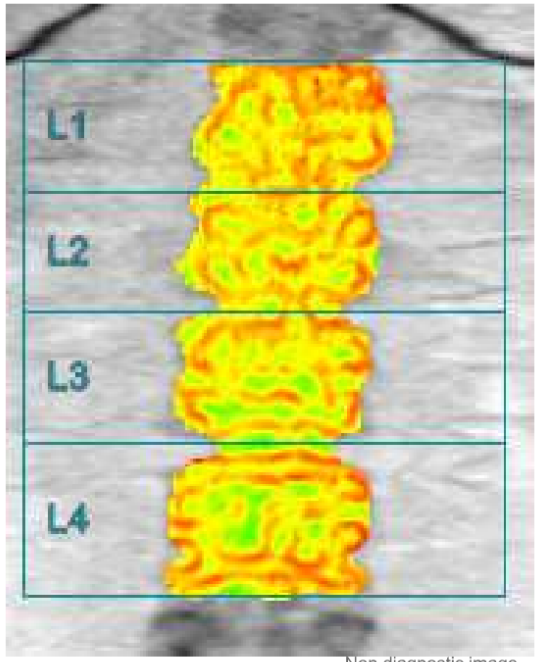
TBS reference graph

Reference population: European (Medimaps)

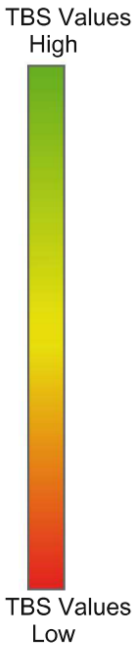
TBS T-Score L1-L4: -2.5



TBS Mapping



Non diagnostic image



Additional results

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FRAX

The 10 year probability of fracture, adjusted for TBS:
Major Osteoporotic Fracture: 9.8 %
Hip Fracture: 1.0 %

FRAX web site: https://www.shef.ac.uk/FRAX/?lang=en

To be used only if FRAX is displayed on the BMD report.

Comments

FDM/FM

Calculation tool

Country:	
Name/ID:	-
Age:	53
Sex:	Female
BMI (kg/m²):	21.8

Please enter the Trabecular Bone Score to compute the ten year probability of fracture adjusted for TBS

DXA device manufacturer: Hologic

Lumbar Spine TBS: 1.156 Calculate

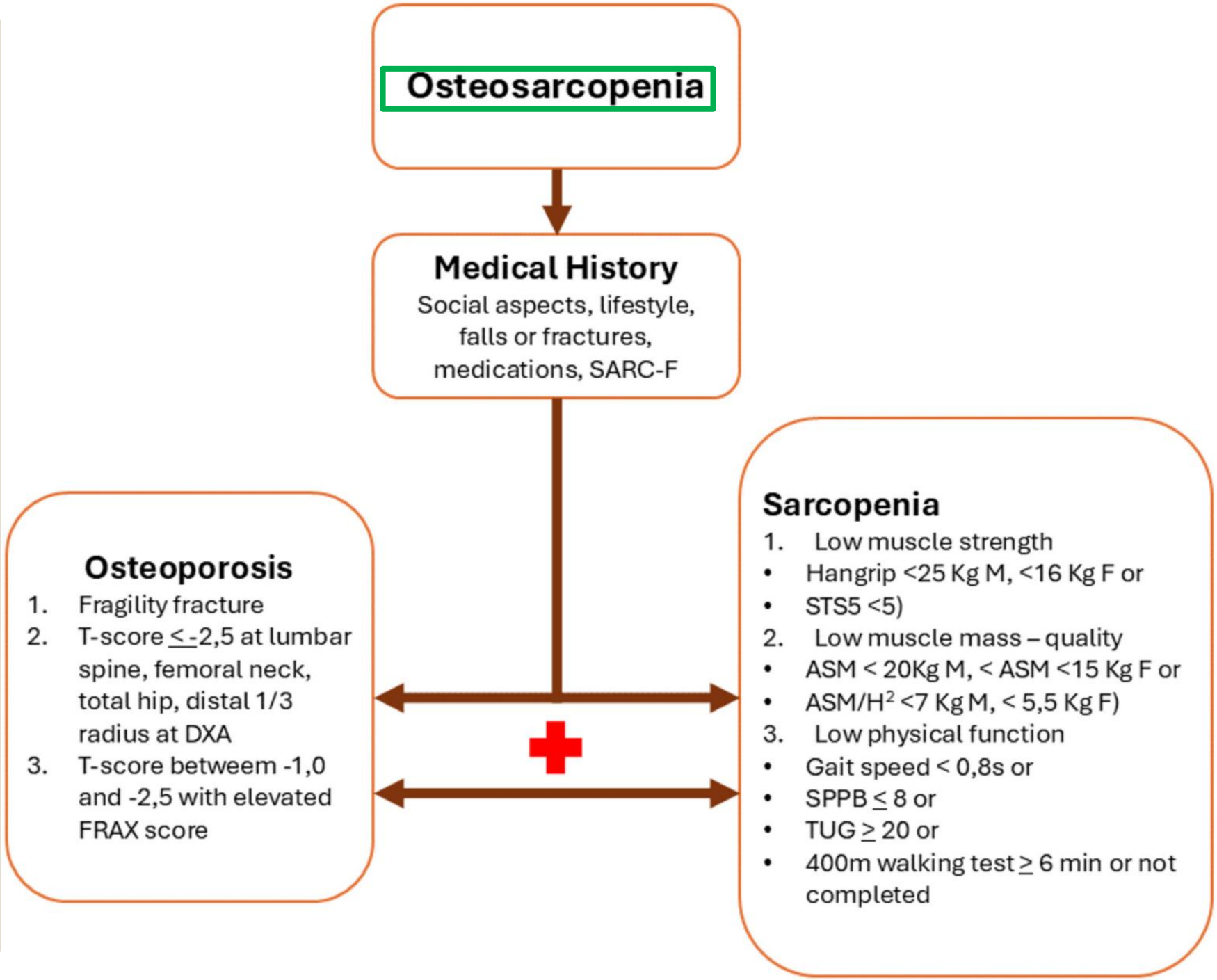
Attention: TBS values are accurate only for patients (women and men) with a BMI in the range [15 – 37 kg/m²]

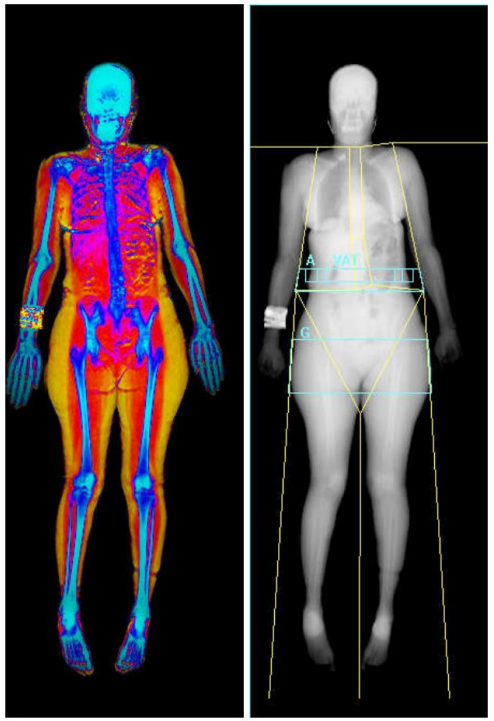
The 10 year probability of fracture (%) Adjusted for TBS

Major Osteoporotic Fracture:	7.0
Hip Fracture:	2.4

00063091

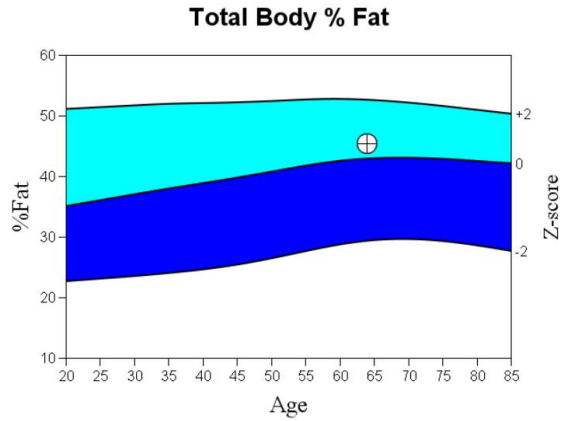
Individuals with fracture risk assessed since April 15, 2015


Osteosarcopenia
Medical History
Social aspects, lifestyle, falls or fractures, medications, SARC-F
Osteoporosis
1. Fragility fracture
2. T-score ≤ -2,5 at lumbar spine, femoral neck, total hip, distal 1/3 radius at DXA
3. T-score betweem -1,0 and -2,5 with elevated FRAX score
Sarcopenia
1. Low muscle strength
• Hangrip <25 Kg M, <16 Kg F or
• STS5 <5)
2. Low muscle mass – quality
• ASM < 20Kg M, < ASM <15 Kg F or
• ASM/H² <7 Kg M, < 5,5 Kg F)
3. Low physical function
• Gait speed < 0,8s or
• SPPB ≤ 8 or
• TUG ≥ 20 or
• 400m walking test ≥ 6 min or not completed



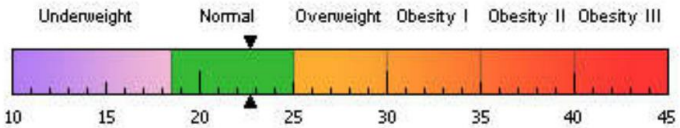
Images not for diagnostic use

Fat — Lean — Bone



Source: 2008 NHANES White Female

World Health Organization Body Mass Index Classification
BMI = 22.8 WHO Classification Normal



BMI has some limitations and an actual diagnosis of overweight or obesity should be made by a health professional. Obesity is associated with heart disease, certain types of cancer, type 2 diabetes, and other health risks. The higher a person's BMI is above 25, the greater their weight-related risks.

Body Composition Results

Region	Fat Mass (g)	Lean + BMC (g)	Total Mass (g)	% Fat	%Fat Percentile YN	%Fat Percentile AM
L Arm	1440	1374	2815	51.2	90	70
R Arm	1716	1801	3517	48.8	86	59
Trunk	10277	15036	25313	40.6	79	44
L Leg	5209	4259	9468	55.0	98	96
R Leg	5192	4278	9470	54.8	98	94
Subtotal	23835	26748	50583	47.1	90	71
Head	1127	3153	4280	26.3		
Total	**24962**	**29902**	**54863**	**45.5**	**89**	**68**
Android (A)	1450	2009	3458	41.9		
Gynoid (G)	4540	4413	8954	50.7		

Scan Date: 27 May 2025 ID: A0527251B
Scan Type: a Whole Body
Analysis: 27 May 2025 16:37 Version 13.6.0.5
Auto Whole Body
Operator: A
Model: Horizon Wi (S/N 304687M)
Comment:

Adipose Indices

Measure	Result	Percentile YN	Percentile AM
Total Body % Fat	**45.5**	**89**	**68**
Fat Mass/Height² (kg/m²)	10.5	65	34
Android/Gynoid Ratio	0.83		
% Fat Trunk/% Fat Legs	0.74	39	14
Trunk/Limb Fat Mass Ratio	0.76	43	14
Est. VAT Mass (g)	368		
Est. VAT Volume (cm³)	398		
Est. VAT Area (cm²)	76.4		

Lean Indices

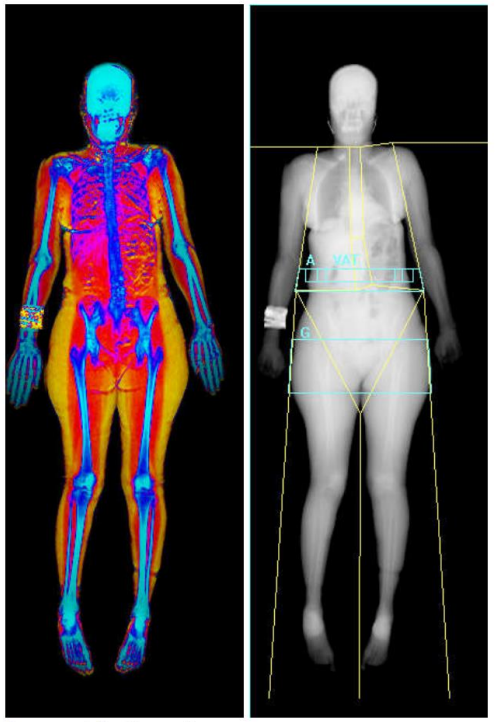
Measure	Result	Percentile YN	Percentile AM
Lean/Height² (kg/m²)	11.9	2	2
Appen. Lean/Height² (kg/m²)	4.60	1	2

Est. VAT = Estimated Visceral Adipose Tissue
YN = Young Normal
AM = Age Matched

Main ALMI (appendicular lean mass index) cut-offs values proposed for the diagnosis of sarcopenia with BC DXA

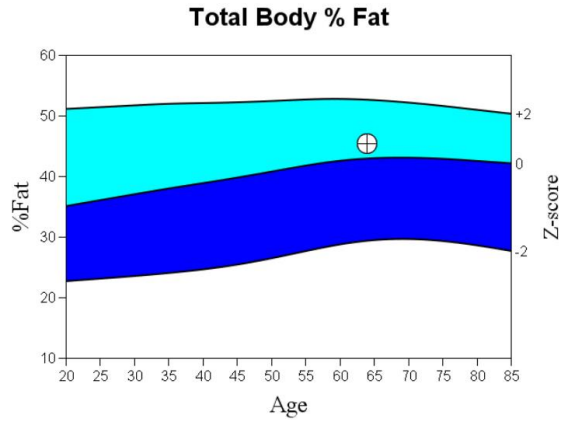
Reference	Year	ALMI cut-offs (kg/m^2)	
		Women	Men
Coin *et al.* (61)	2013	<5.47	<7.59
Morley *et al.* (62)	2011	<5.45	<7.26
Cruz-Jentoft *et al.* (4)	2010	<5.67	<7.25
Muscaritoli *et al.* (63)	2010	<5.67	<7.25
Delmonico *et al.* (64)	2007	<5.67	<7.25
Newman *et al.* (65)	2003	<5.67	<7.25
Baumgartner *et al.* (66)	1998	<5.45	<7.26

BC, body composition; DXA, dual-energy X-ray absorptiometry.



Images not for diagnostic use

Fat Lean Bone



Source: 2008 NHANES White Female

World Health Organization Body Mass Index Classification
BMI = 22.8 WHO Classification Normal

BMI has some limitations and an actual diagnosis of overweight or obesity should be made by a health professional. Obesity is associated with heart disease, certain types of cancer, type 2 diabetes, and other health risks. The higher a person's BMI is above 25, the greater their weight-related risks.

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Total	**24962**	**29902**	**54863**	**45.5**	**89**	**68**
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Est. VAT = Estimated Visceral Adipose Tissue
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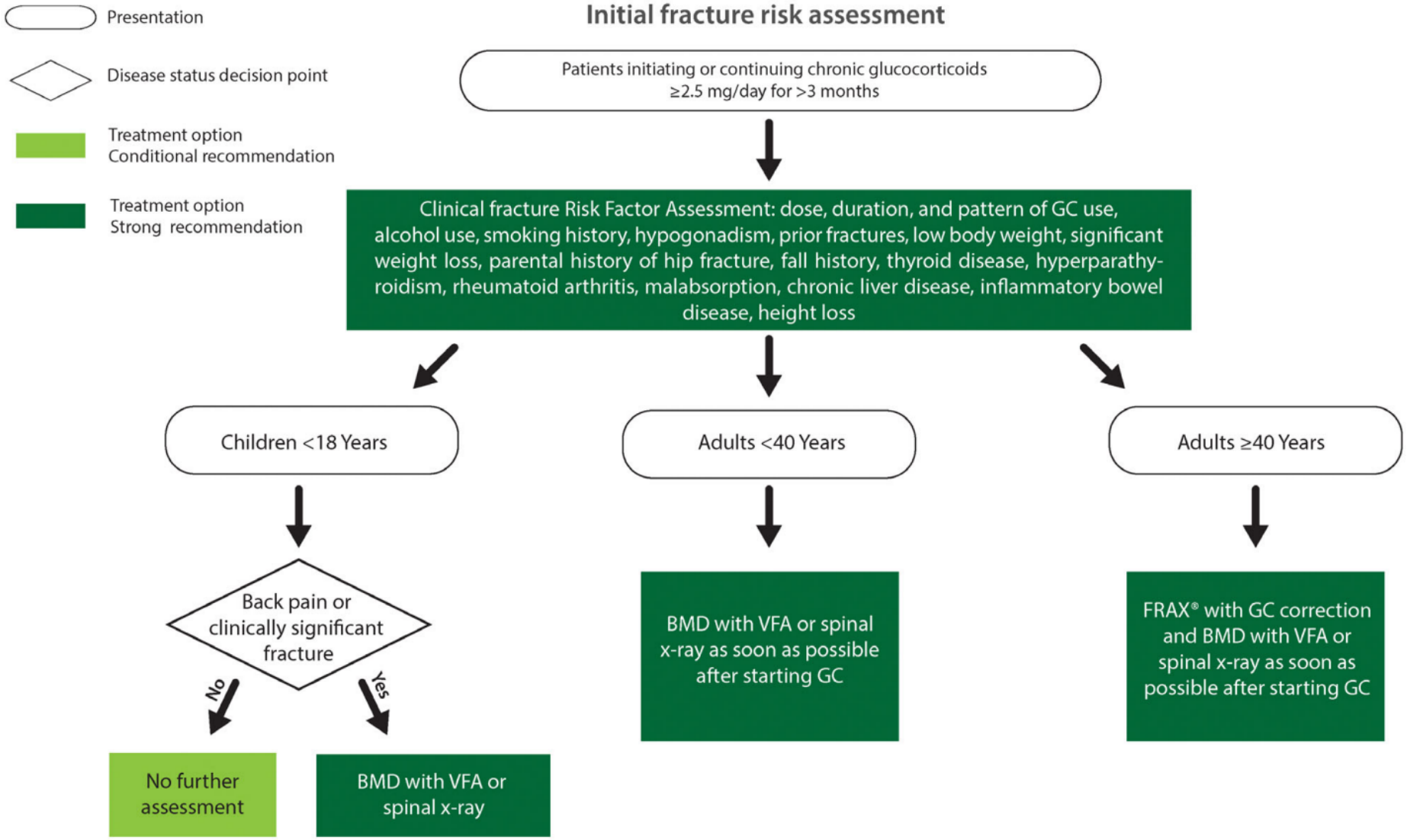
AM = Age Matched

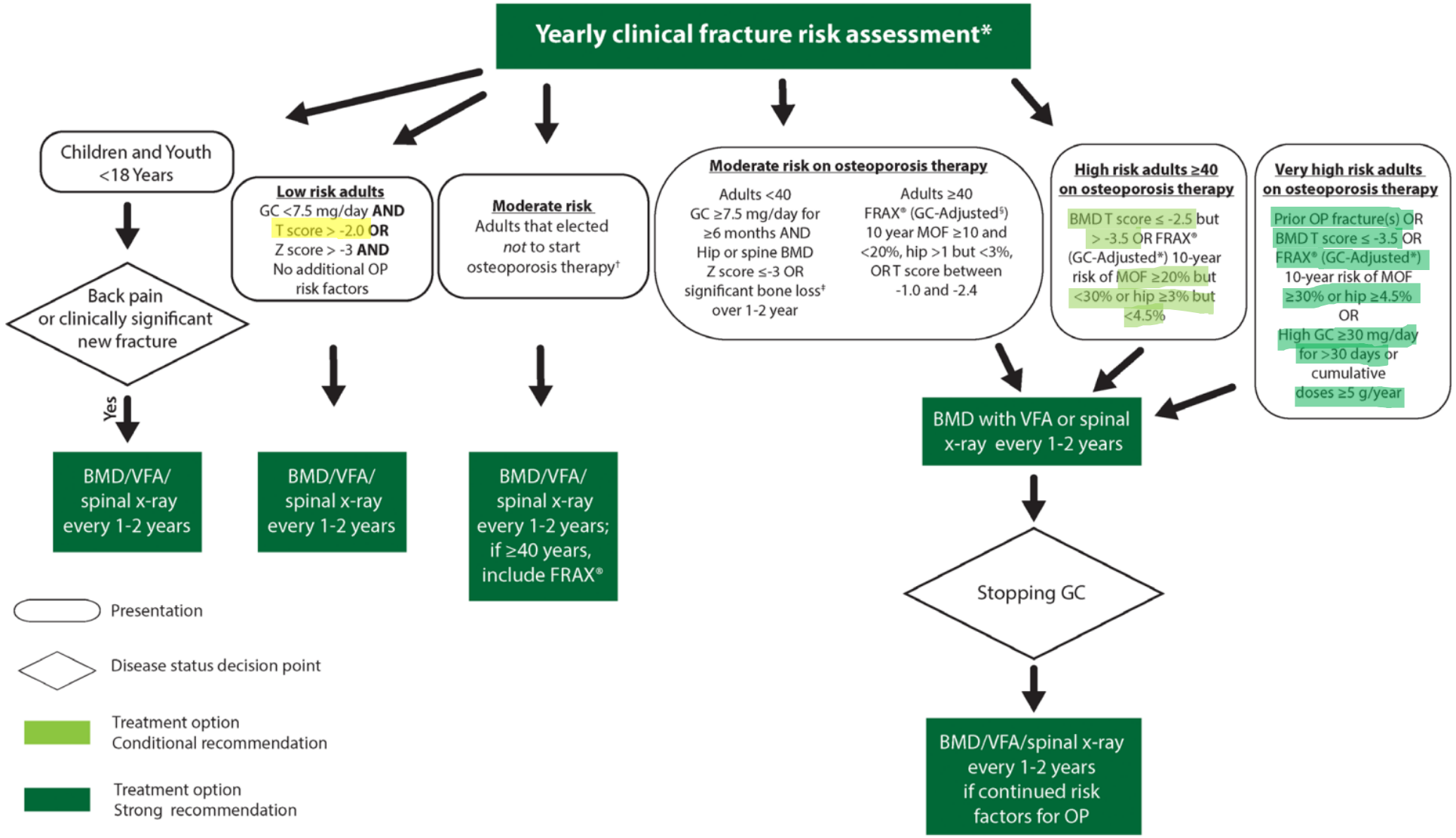
Sarcopenia



OP = osteoporosis; FRAX® = Fracture risk assessment tool, validated for adults ≥40 Years, https//www.shef.ac.uk/FRAX/Tool.jsp; FRAX® with GC correction = If GC dose is >7.5 mg/day, increase the MOF risk by multiplying 1.15 times and hip fracture risk by multiplying 1.2 times (e.g., if hip fracture risk is 2.0% multiply by 1.2 for adjusted risk =2.4%); BMD = bone mineral density testing

Initial fracture risk assessment. GC = glucocorticoid; MOF = major osteoporotic fracture; VFA = vertebral fracture assessment.

Fracture risk re-assessment for patients continuing chronic GC ≥ 2.5 mg/day for >3 months



OP = osteoporosis; GC = glucocorticoids; FRAX® = Fracture risk assessment tool can only be used in adults ≥40 years; BMD = bone mineral density testing; *Clinical fracture risk assessment: dose duration and pattern of GC use, alcohol use, smoking history, hypogonadism, prior fractures, low body weight, significant weight loss, parental history of hip fracture, fall history, thyroid disease, hyperparathyroidism, rheumatoid arthritis, malabsorption, chronic liver disease, inflammatory bowel disease, height; †Moderate risk adults should be offered therapy but may choose not to be treated; ‡ > least significant decline according to DXA machine (typically 3-5%); §FRAX® GC correction for GC ≥7.5 mg/day example: if hip fracture risk is 2.0% multiply by 1.2 for adjusted risk = 2.4%

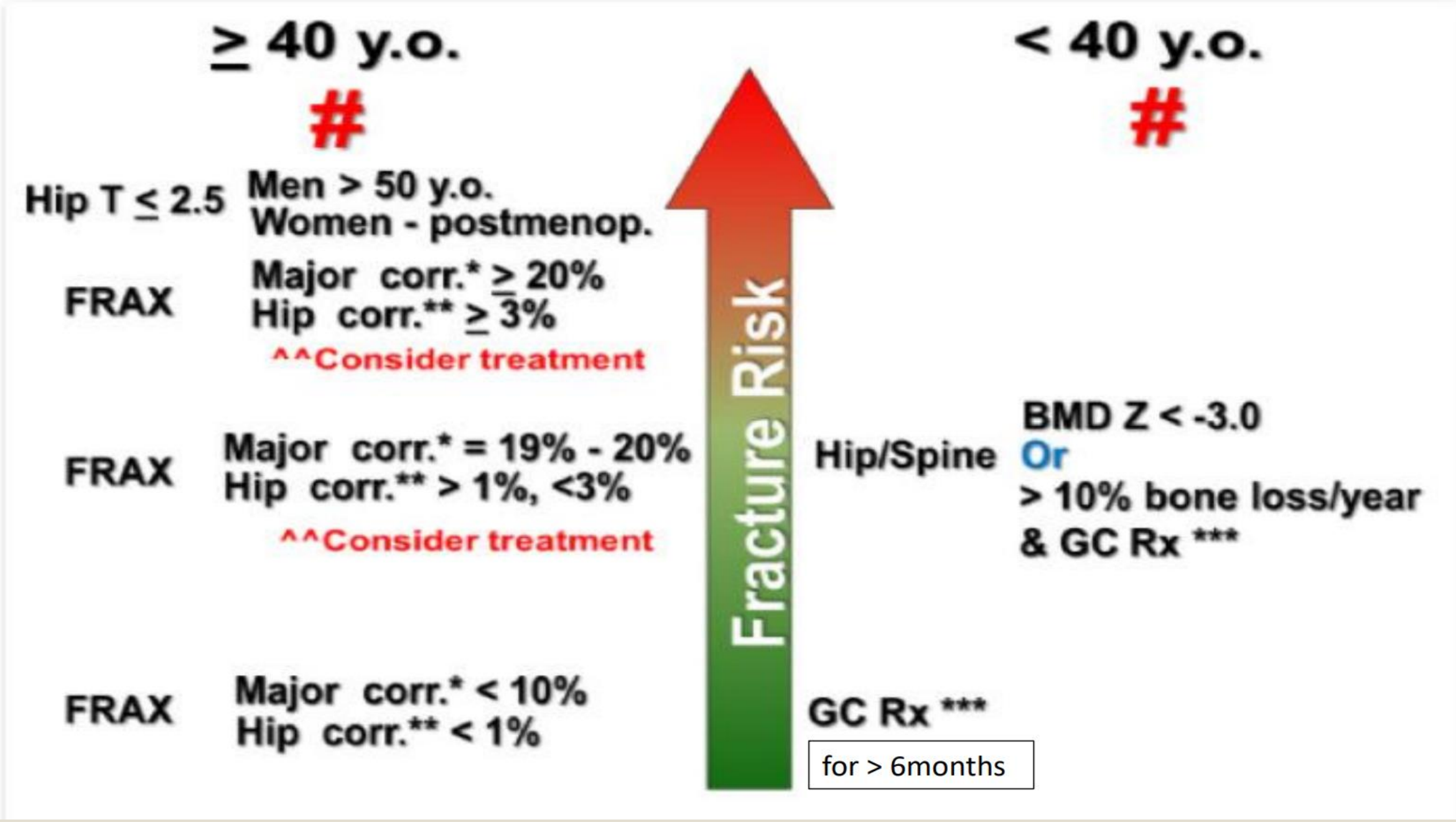
Non dialysis CKD stage 5 patients had increased hip fracture risks compared to CKD stages 1-4. Female gender, patients' age, history of fractures, diabetes, and Charlson–Deyo comorbidity index are independently associated with increased hip fracture risks.

Clinical risk factor scoring

Risk factors	Risk points
BMI < 20	1
Age > 60	1
Age > 70	2
Recent fracture	2
Fracture > 2 years ago	1
Parent with hip fracture	1
More than 1 fall event last year and/or immobility	1
Smoking and/or 3 or more alcoholic drinks per day	1
Comorbidities or drugs that interfere with bone metabolism	1

Final Formula of **S**teroid-**A**ssociated **F**racture **E**valuation (**SAFE**) tool

o**S**teoporosis (T-score≤ −2.5 at hip or lumbar spine)	Yes = 1 point No = 0 point
Accumulative prednisolone or equivalent dose of ≥750 mg within 6 months OR ≥4.5 mg/day for 6 months	Yes = 1 point No = 0 point
Previous **F**racture	Yes = 1 point No = 0 point
BMI ≥ 23.5	Yes = 1 point No = 0 point
Elderliness ≥70 years old	Yes = 2 point No = 0 point


≥ 40 y.o.
#
< 40 y.o.
#
Hip T ≤ 2.5
Men > 50 y.o.
Women - postmenop.
FRAX
Major corr.* ≥ 20%
Hip corr.** ≥ 3%
^^Consider treatment
FRAX
Major corr.* = 19% - 20%
Hip corr.** > 1%, <3%
^^Consider treatment
FRAX
Major corr.* < 10%
Hip corr.** < 1%
Fracture Risk
Hip/Spine
BMD Z < -3.0
Or
> 10% bone loss/year
& GC Rx ***
GC Rx ***
for > 6months

Name: [redacted] Sorayya
Patient ID: 99.12.29
DOB: 14 February 1957

Sex: Female
Ethnicity: Caucasian

Height: 149.0 cm
Weight: 55.0 kg
Age: 62

Referring Physician: Dr.Rajaei

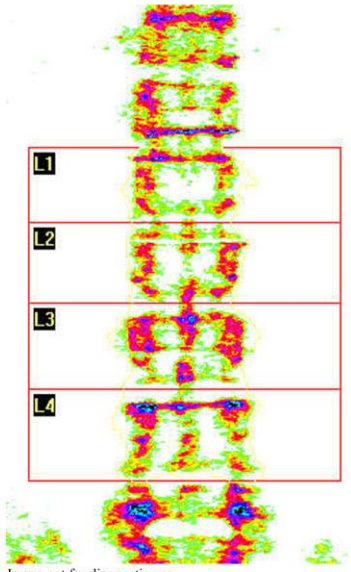


Image not for diagnostic use
116 x 121

Scan Information:
Scan Date: 24 February 2019 ID: A0224190N
Scan Type: [illegible]
Analysis: 24 February 2019 10:20 Version 13.3.0.1
Spine
Operator:
Model: Discovery W (S/N 83167)
Comment:

DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
L1	11.51	8.99	0.781	-1.9	79	-0.5	93
L2	12.44	9.69	0.779	-2.3	76	-0.7	91
L3	14.97	11.99	0.801	-2.6	74	-1.0	88
L4	16.89	12.96	0.767	-2.7	72	-1.0	87
Total	**55.81**	**43.63**	**0.782**	**-2.4**	**75**	**-0.9**	**89**

Total BMD CV 1.0%
WHO Classification: Osteopenia
Fracture Risk: Increased

Name: [redacted] Sorayya
Patient ID: 99.12.29
DOB: 14 February 1957

Sex: Female
Ethnicity: Caucasian

Height: 149.0 cm
Weight: 53.0 kg
Age: 64

Referring Physician: Dr.Rajaei

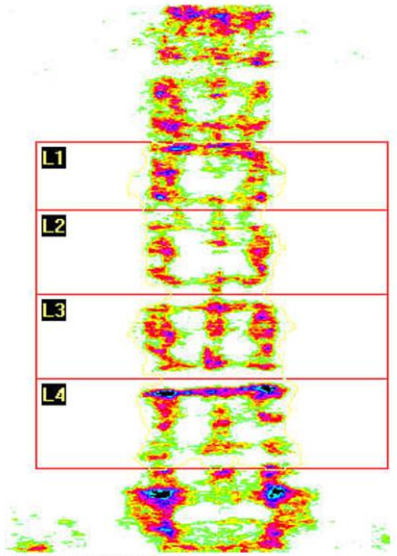


Image not for diagnostic use
116 x 121

Scan Information:
Scan Date: 22 February 2021 ID: A0222210U
Scan Type: [illegible]
Analysis: 22 February 2021 11:11 Version 13.6.0.2
Spine
Operator: NB
Model: Discovery W (S/N 83167)
Comment:

DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
L1	11.52	9.06	0.787	-1.8	79	-0.3	95
L2	13.10	9.28	0.709	-2.9	69	-1.2	84
L3	14.53	10.84	0.746	-3.1	69	-1.3	84
L4	16.58	12.52	0.755	-2.8	71	-1.0	88
Total	**55.72**	**41.70**	**0.748**	**-2.7**	**71**	**-1.0**	**87**

Total BMD CV 1.0%
WHO Classification: Osteoporosis
Fracture Risk: High

T-score vs. White Female. Source:2012 BMDCS/Hologic Z-score vs. White Female. Source:2012 BMDCS/Hologic

DXA Results Summary: L1-L4

Scan Date	Age	BMD (g/cm²)	T - score	BMD Change vs Baseline	BMD Change vs Previous
22.02.2021	64	0.748	-2.7	-4.3%*	-4.3%*
24.02.2019	62	0.782	-2.4		

* Denotes significance at 95% confidence level, LSC is 0.022 g/cm²

Name: [redacted] Sorayya
Patient ID: 99.12.29
DOB: 14 February 1957

Sex: Female
Ethnicity: Caucasian

Height: 149.0 cm
Weight: 55.0 kg
Age: 62

Referring Physician: Dr.Rajaei

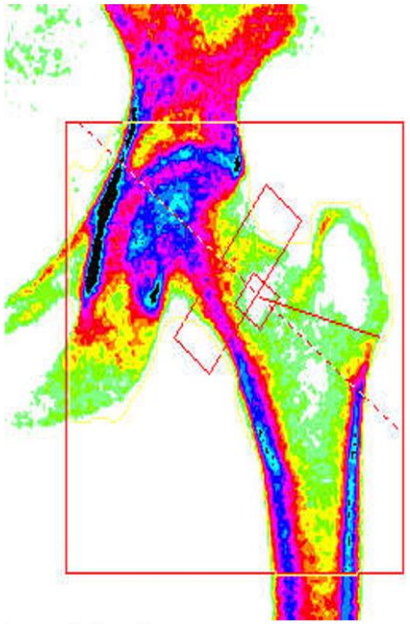


Image not for diagnostic use
107 x 113
NECK: 49 x 15

Scan Information:

Scan Date: 24 February 2019 ID: A0224190M
Scan Type: x Left Hip
Analysis: 24 February 2019 10:20 Version 13.3.0.1
Hip
Operator:
Model: Discovery W (S/N 83167)
Comment:

DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
Neck	4.94	3.98	0.807	-0.4	95	1.0	116
Troch	9.54	5.40	0.566	-1.4	81	-0.4	93
Inter	24.27	24.25	0.999	-0.7	91	0.2	102
Total	**38.74**	**33.63**	**0.868**	**-0.6**	**92**	**0.4**	**107**
Ward's	1.18	0.49	0.417	-2.7	57	-0.6	85

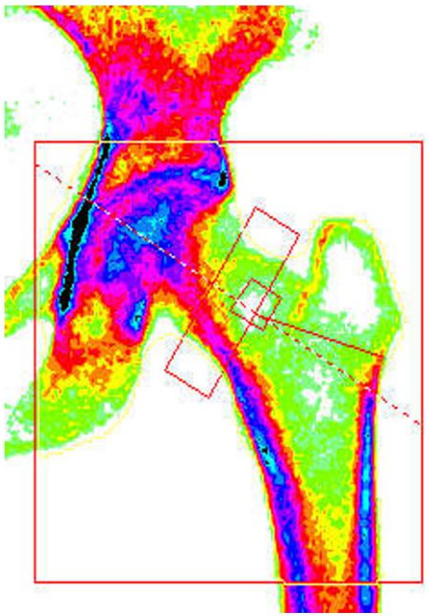
Total BMD CV 1.0%
WHO Classification: Normal

Name: [redacted] Sorayya
Patient ID: 99.12.29
DOB: 14 February 1957

Sex: Female
Ethnicity: Caucasian

Height: 149.0 cm
Weight: 53.0 kg
Age: 64

Referring Physician: Dr.Rajaei



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108 x 112
NECK: 49 x 15
HAL: 101 mm

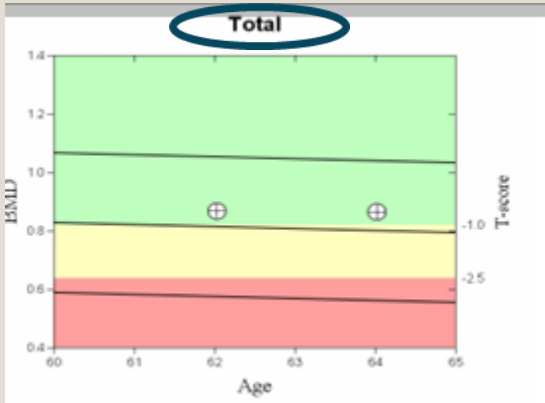
Scan Information:

Scan Date: 22 February 2021 ID: A0222210T
Scan Type: x Left Hip
Analysis: 22 February 2021 11:10 Version 13.6.0.2
Hip
Operator: NB
Model: Discovery W (S/N 83167)
Comment:

DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
Neck	**4.73**	**3.56**	**0.753**	**-0.9**	**89**	**0.6**	**110**
Troch	10.00	5.72	0.572	-1.3	81	-0.3	96
Inter	22.41	22.87	1.020	-0.5	93	0.4	106
Total	37.14	32.15	0.866	-0.6	92	0.5	108
Ward's	1.12	0.49	0.441	-2.5	60	-0.3	93

Total BMD CV 1.0%
WHO Classification: Normal



DXA Results Summary:

Scan Date	Age	BMD (g/cm²)	T - score	BMD Change vs Baseline	BMD Change vs Previous
22.02.2021	64	0.866	-0.6	-0.3%	-0.3%
24.02.2019	62	0.868	-0.6		

* Denotes significance at 95% confidence level, LSC is 0.027 g/cm²

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Review Article Open Access

Serial or compare bone mineral densitometry: how to do it step by step

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Bone mineral densitometry (BMD) is the most valuable method for assessing bone and calculating fracture risk. Serial or comparative bone densitometry is important in rheumatologists' work on osteoporosis management. The response or lack of response to osteoporosis treatment based on densitometry scans is crucial. This paper examines the timing of scan requests concerning the history of glucocorticoid use, renal or other solid organ transplantation, malignancy, and other situations discussed. We encountered four types of compared scans based on the centers where BMD was performed and the precision of the devices used for this survey: Same Center, Same Device (SSSD), Same Center Different Devices (SCDD), Different Centers Same Devices (DCSD), and Different Centers Different Devices (DCDD). We discussed the principles of comparison and the key indicators.

Keywords: Bone densitometry; Bone density; Serial BMD; Compared BMD; Center; Device

Definitions

Very high fracture risk:

- ❑ Adults ≥40 years of age

  - Prior OP fracture(s) OR
  - BMD t-score ≤−3.5 OR
  - FRAX (GC-Adjusted) 10-year risk of MOF ≥30% or hip ≥4.5% OR
  - High GC ≥30 mg/day for >30 days OR
  - Cumulative doses ≥5 g/y

- ❑ Adults <40 years of age

  - Prior fracture(s) OR
  - GC ≥30 mg/day OR
  - Cumulative doses ≥5 g/y

Definitions

High fracture risk:

❑Adults ≥40 years of age

- BMD t-score ≤−2.5 but >−3.5 OR
- FRAX (GC Adjusted) 10-year risk of MOF ≥20% but <30% or hip ≥3% but <4.5%

Moderate fracture risk:

❑Adults ≥40 years of age

- FRAX (GC-Adjusted) 10-year risk of MOF ≥10 and <20%, hip >1 and <3% OR
- BMD t-score between −1 and −2.4

❑Adults <40 years of age

- Continuing GC treatment ≥7.5 mg/day for ≥6 months and BMD z-score < −3 OR
- Significant BMD loss (more than the least significant change of DXA)

Definitions

Low fracture risk:

- ❑ Adults ≥40 years of age

  - FRAX (GC-Adjusted) 10-year risk of MOF <10%, hip <1 %
  - BMD t-score >−1.0

- ❑ Adults <40 years of age

  None of the above risk factors other than GC treatment

Evaluation of the patient's fracture risk profile

Very high risk	High risk	Low risk
• Fracture within the last 12 months • Multiple fractures • Fractures during osteoporosis treatment • Fractures during treatment that negatively affects the bone • Very low T-score − 3.0 SD • FRAX ≥ 30% for a large osteoporotic fracture, ≥ 4.5% for hip fracture	• Age ≥ 65 years • Overcome fracture in ≥ 12 months • T-score ≤ − 2.5 SD • T-score − 1.0 to − 2.5 SD and FRAX ≥ 20% for large osteoporotic fracture or ≥ 3% for hip fracture	• Age after menopause • Without a previous fracture • T-score ≥ − 1.0 SD and FRAX < 20% for a large osteoporotic fracture or < 3% for a hip fracture

Risk stratification of fractures in adults receiving GC therapy from ACR guidelines

Fracture risk	very High	Moderate	Low
Adults <40 years	History of osteoporotic fracture(s)	Hip or spine Z score <-3 or Rapid bone loss of ≥10% (at the hip or spine) over 1 year and Continuing GC treatment of ≥7.5 mg/day for ≥6 months	None of the above risk factors other than GC treatment
Adults ≥40 years	History of osteoporotic fracture(s) Hip or spine T-score ≤ -2.5 in men age ≥50 years and postmenopausal women FRAX® (GC adjusted) 10-year risk of major osteoporotic fracture ≥20% FRAX® (GC adjusted) 10-year risk of hip fracture ≥3%	FRAX® (GC adjusted) 10-year risk of major osteoporotic fracture 10 - 19% FRAX® (GC adjusted) 10-year risk of hip fracture >1% and < 3%	FRAX® (GC adjusted) 10-year risk of major osteoporotic fracture <10% FRAX® (GC adjusted) 10-year risk of hip fracture ≤1%

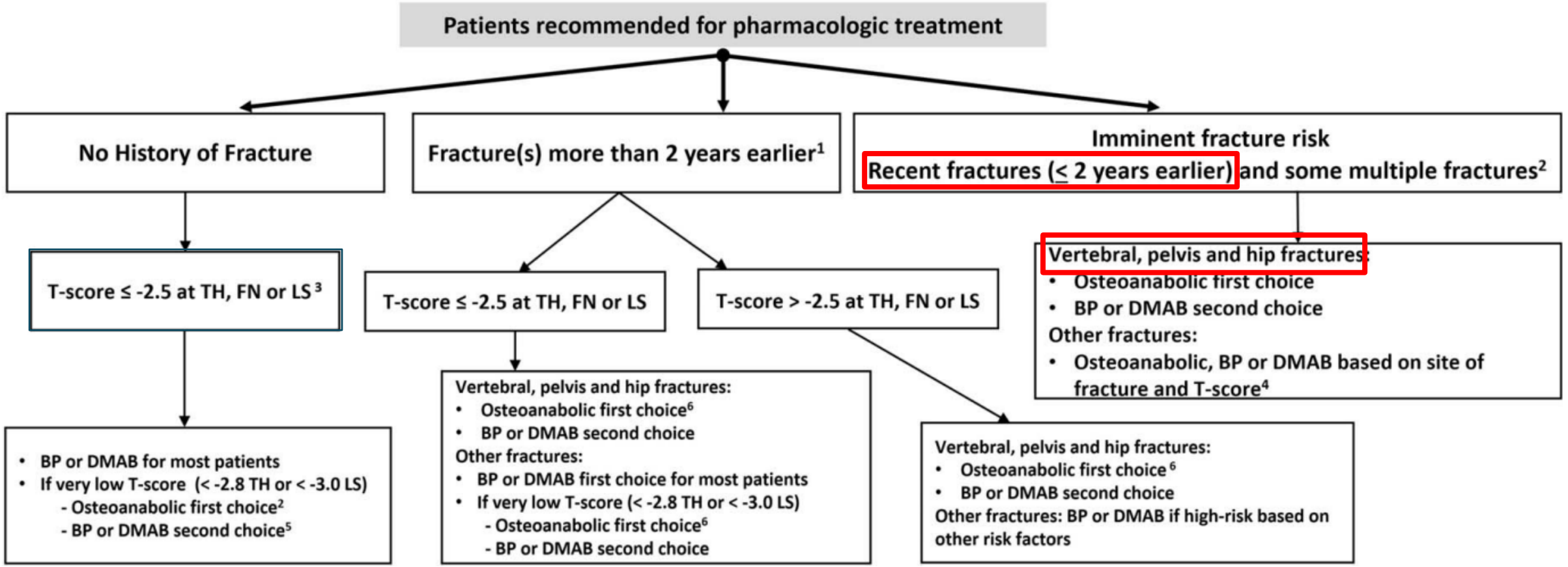
Before beginning of treatment , secondary causes by lab. Tests should be ruled out

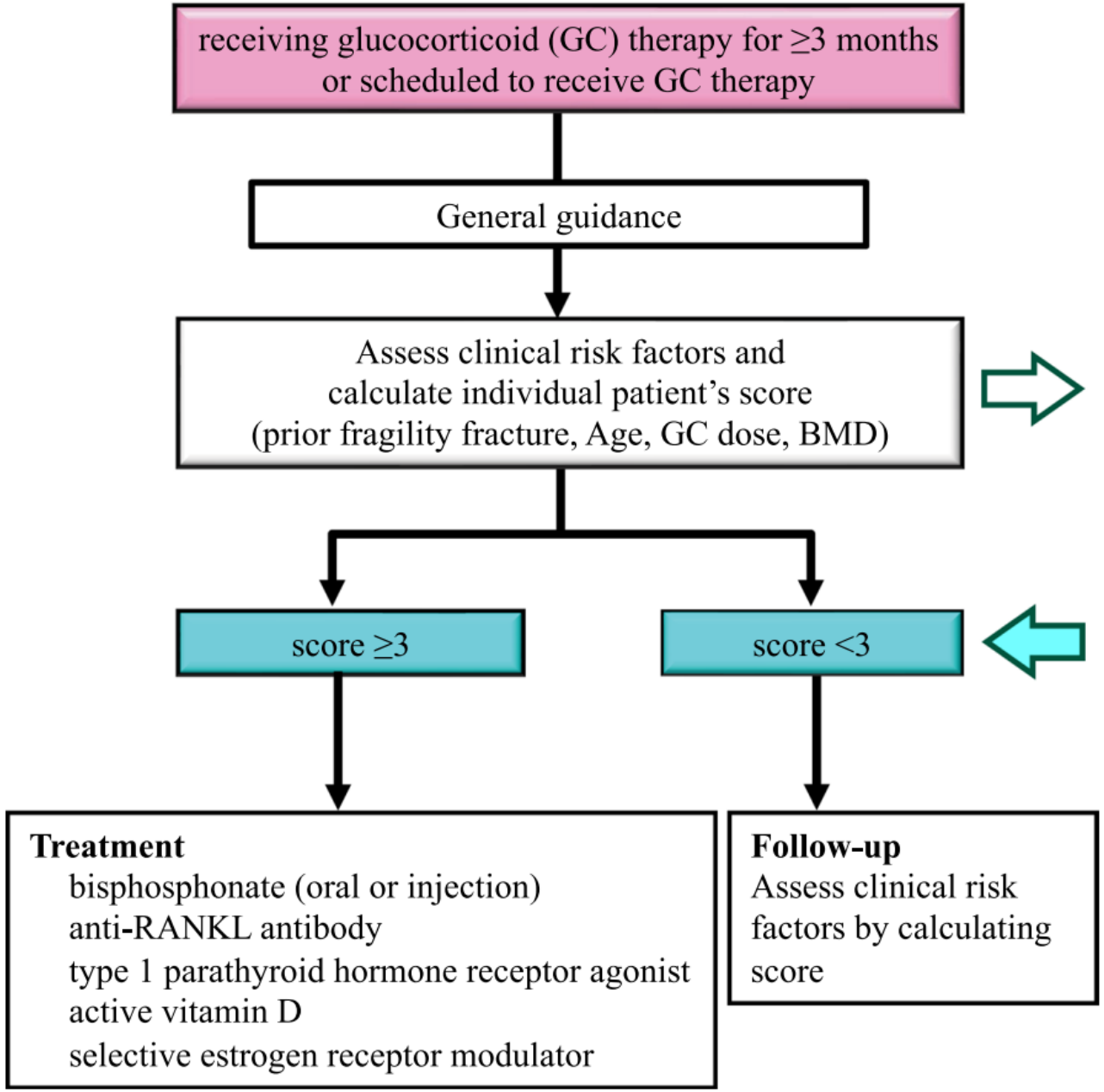
Biochemical tests to assess phosphocalcic metabolism

Complete blood count, erythrocyte sedimentation rate, CRP
Uremia, blood creatinine level, creatinine clearance
Liver function tests
Anti-transglutaminase antibodies, anti-endomysial antibodies, anti-gliadin antibodies
Serum IgA level
TSH Free T4
Total and ionized calcium levels, blood albumin level, blood phosphate level, blood magnesium level AP PTH
Vitamin 25(OH)D level
24-hour urine: urine calcium level, urine creatinine level, urine phosphate level, TRP

Treatment Targets:

- For imminent risk patients, maximal rapid reduction in fracture risk
- For patients with T-score ≤ -2.5, minimal target is to increase T-score to > -2.5, higher for patients with fracture history, or other major risk factors
- For patients with T-score > -2.5, increase TH T-score by 0.2 (3%) and LS by 0.5 (6%)





Risk factors		Score
Prior fragility fractures	No	0
	Yes	7
Age (years)	<50	0
	50≤ <65	2
	≥65	4
GC dose (PSL equivalent mg/day)	<5	0
	5≤ <7.5	1
	≥7.5	4
BMD (%YAM)	≥80	0
	70≤ <80	2
	<70	4

The 2023 Guidelines for the Management and Treatment of Glucocorticoid-induced Osteoporosis published by the Japanese Society for Bone and Mineral Research. BMD bone mineral density, GC glucocorticoid, PSL prednisolone, YAM young adult means

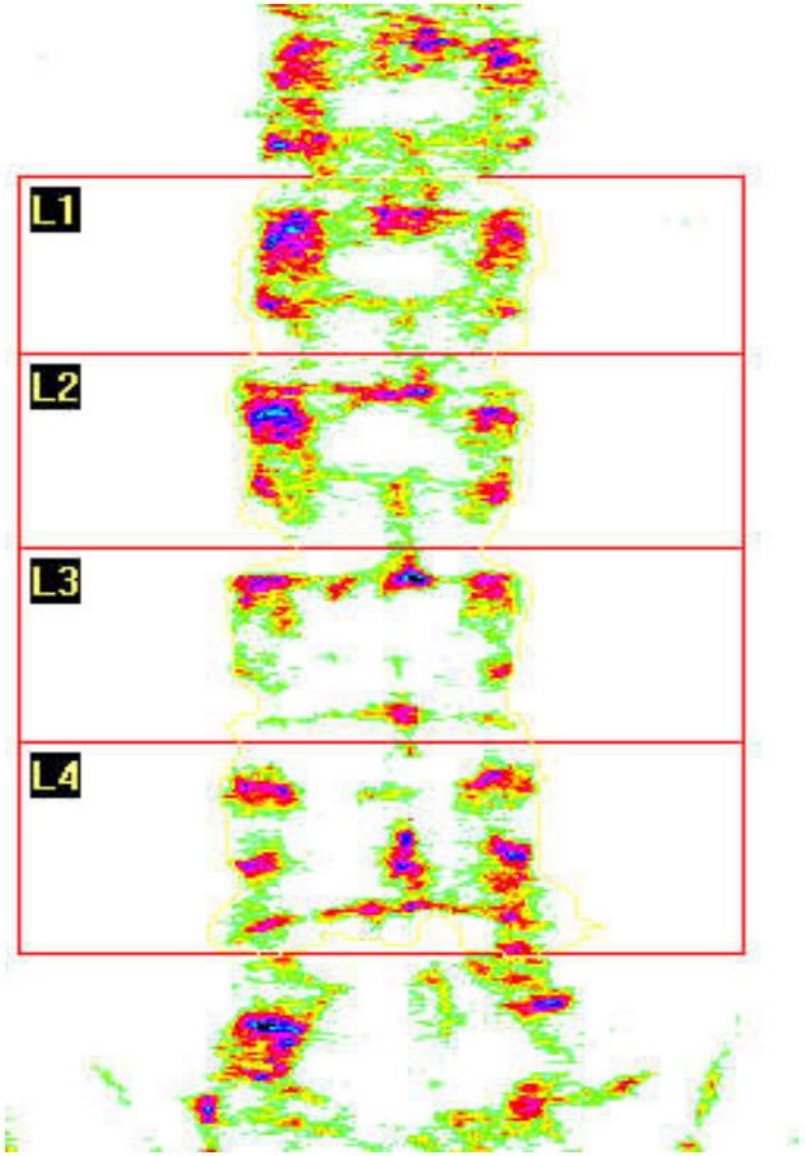


Image not for diagnostic use
116 x 137

Scan Information:

Scan Date: 25 June 2018 ID: A0625181C
Scan Type: f Lumbar Spine
Analysis: 25 June 2018 15:24 Version 13.3
Spine
Operator:
Model: Discovery W (S/N 83167)
Comment:

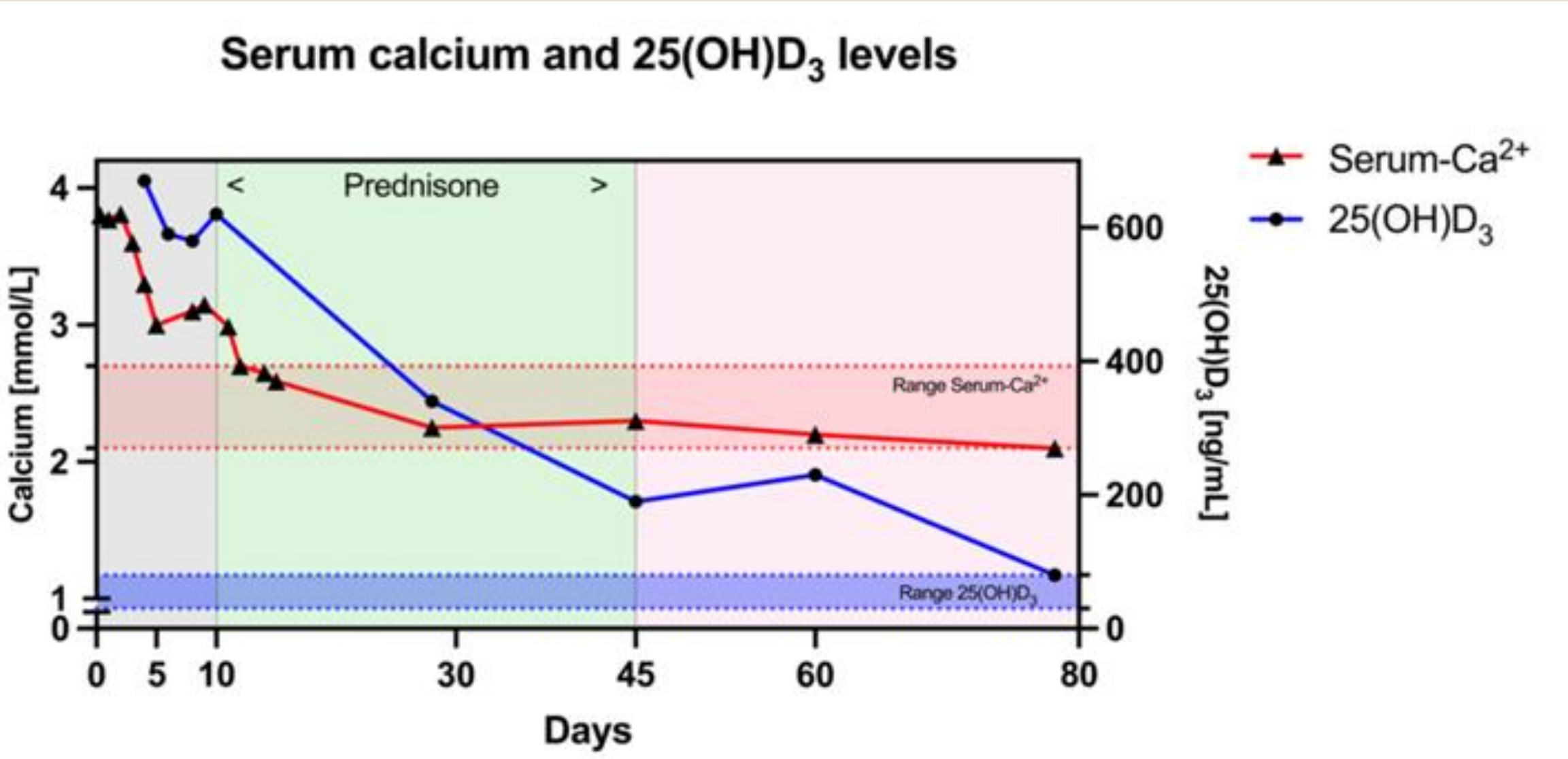
DXA Results Summary:

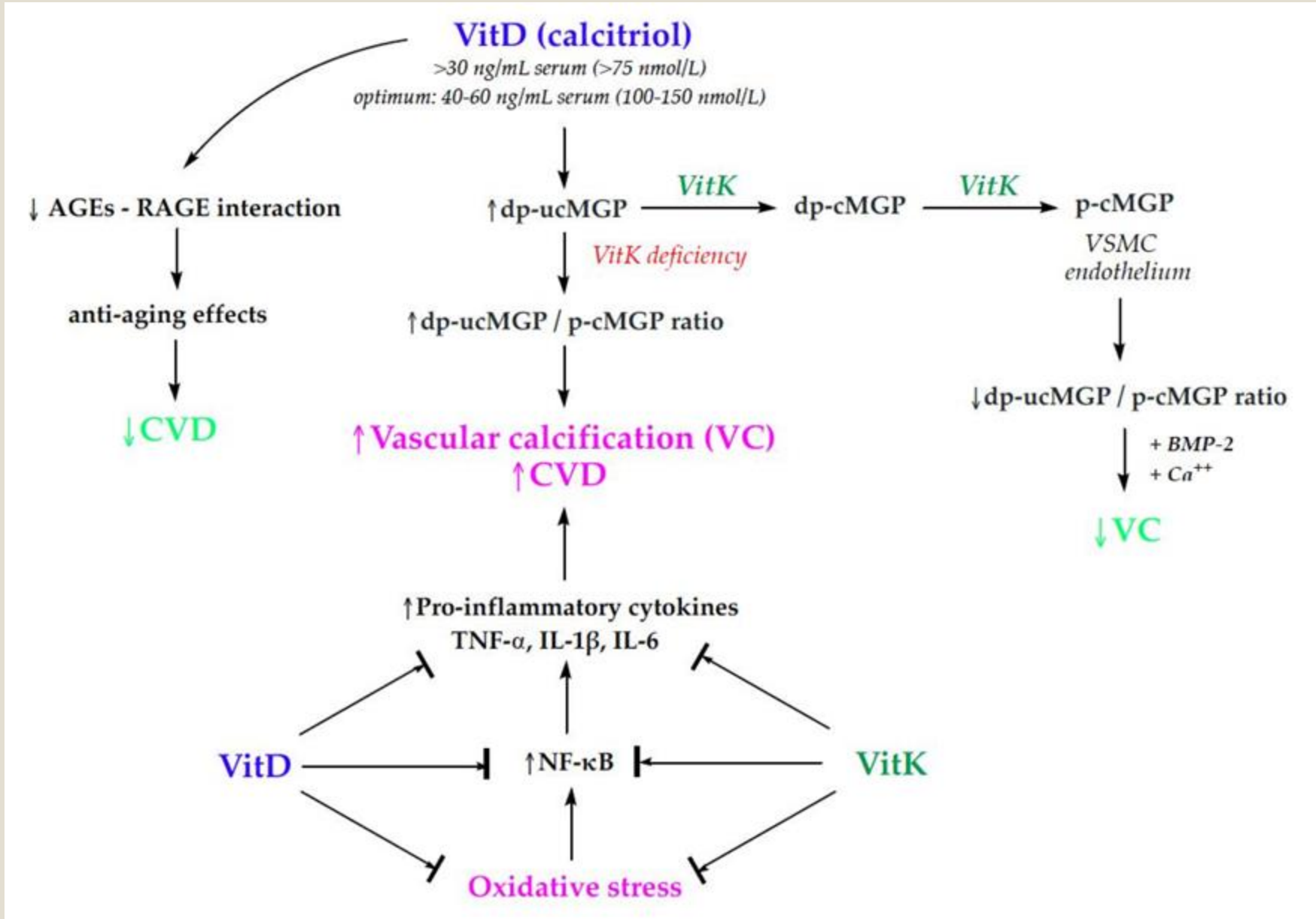
Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	PR (%)	Z - score	AM (%)
L1	14.31	10.63	0.743	-3.0	69	-2.1	76
L2	15.20	10.66	0.701	-3.6	64	-2.6	71
L3	15.57	9.25	0.594	-4.6	54	-3.6	60
L4	19.43	12.83	0.660	-3.9	61	-2.9	68
Total	**64.52**	**43.37**	**0.672**	**-3.8**	**62**	**-2.8**	**68**

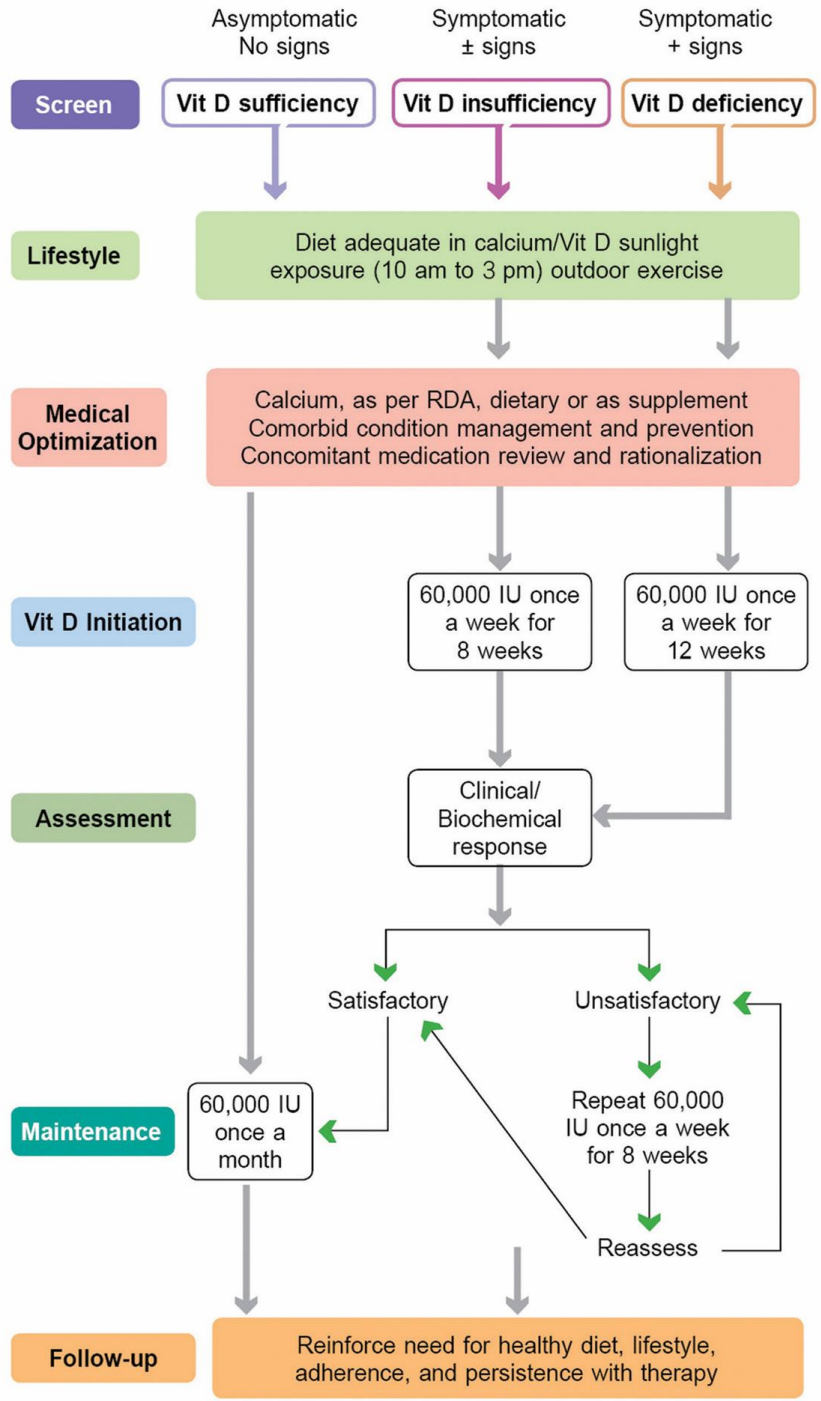
Total BMD CV 1.0%
WHO Classification: Osteoporosis
Fracture Risk: High

High-risk Conditions Needing Routine Vitamin D Supplementation

1. Conditions such as cerebral palsy, neuromuscular disorders
2. Chronic kidney disease
3. Chronic liver disease
4. Malabsorption syndromes
5. Chronic use of glucocorticoids, antiepileptic drugs, ketoconazole
6. Endocrine diseases such as hyperparathyroidism
7. Diseases with extensive cutaneous involvement


Serum calcium and 25(OH)D3 levels
Prednisone
<
>
Serum-Ca2+
25(OH)D3
Range Serum-Ca2+
Range 25(OH)D3
Calcium [mmol/L]
25(OH)D3 [ng/mL]
Days
0
1
2
3
4
0
200
400
600
0
5
10
30
45
60
80


VitD (calcitriol)
>30 ng/mL serum (>75 nmol/L)
optimum: 40-60 ng/mL serum (100-150 nmol/L)
↓ AGEs - RAGE interaction
anti-aging effects
↓CVD
↑dp-ucMGP
VitK
dp-cMGP
VitK
p-cMGP
VSMC
endothelium
VitK deficiency
↑dp-ucMGP / p-cMGP ratio
↑Vascular calcification (VC)
↑CVD
↓dp-ucMGP / p-cMGP ratio
+ BMP-2
+ Ca++
↓VC
↑Pro-inflammatory cytokines
TNF-α, IL-1β, IL-6
VitD
↑NF-κB
VitK
Oxidative stress


Asymptomatic
No signs
Symptomatic
± signs
Symptomatic
+ signs
Screen
Vit D sufficiency
Vit D insufficiency
Vit D deficiency
Lifestyle
Diet adequate in calcium/Vit D sunlight exposure (10 am to 3 pm) outdoor exercise
Medical Optimization
Calcium, as per RDA, dietary or as supplement
Comorbid condition management and prevention
Concomitant medication review and rationalization
Vit D Initiation
60,000 IU once a week for 8 weeks
60,000 IU once a week for 12 weeks
Assessment
Clinical/ Biochemical response
Satisfactory
Unsatisfactory
Maintenance
60,000 IU once a month
Repeat 60,000 IU once a week for 8 weeks
Reassess
Follow-up
Reinforce need for healthy diet, lifestyle, adherence, and persistence with therapy

Recommended calcium intake in adults and children with chronic kidney disease – a European consensus statement

Focus of study was to establish optimal calcium intake in chronic kidney disease (in adults and children) which is not addressed in current clinical practice guidelines

Methods

Literature review by expert panel

Delphi survey

Revision based on survey response

Results

Key recommendations:

Adults

Total calcium intake (diet and medications): 800–1000 mg/day

Children

Total calcium intake: age-appropriate normal range

Evenepoel, P. *et al.* NDT (2023) @NDTSocial

This consensus statement provides key evidence and clinical practice points on calcium management that may assist in clinical decision-making in children and adults with CKD.

- **NCPB(non-calcium-based phosphate binders)** improves survival outcomes not only in the patients with **CKD stages G3–4** but also in the patients with **CKD stage G5D** compared to CPB(calcium-based phosphate binders).
- Therefore, NCPB should be selected over CPB, particularly in cases with **high serum calcium levels or severe vascular calcification.**

QUESTION 2: WHAT ARE THE DETERMINANTS OF CALCIUM BALANCE IN CKD?

Calcium intake and bioavailability in CKD

Key evidence points

- The average dietary calcium intake is 500–900 mg/day in adults with CKD G3–4 and 400–800 mg/day in CKD G5–5D. The average dietary calcium intake in children with CKD varies with age.
- The dietary intake of calcium decreases with the progression of CKD.
- The dietary intake of calcium shows regional variability, with notably lower intake in Asian countries.

Calcium losses in CKD

Key evidence point

- Urinary calcium excretion decreases early in the course of CKD prior to homeostatic hormonal changes and parallels kidney function decline, to average 40 mg/day at CKD G3.
- Endogenous fecal calcium losses are estimated at 100–200 mg/day.

Dialytic calcium mass transfer in CKD G5D

Key evidence points

- In addition to the calcium load from diet and medications, dialytic calcium mass transfer must be considered when assessing calcium balance in maintenance dialysis patients.
- Dialytic calcium mass transfer is determined by plasma-to-dialysis fluid ionized calcium gradient, dialysis session duration, ultrafiltration rate and skeletal remodeling rate.

QUESTION 3: WHAT IS THE RECOMMENDED DAILY INTAKE OF CALCIUM IN PATIENTS WITH CKD ACROSS STAGES AND AGE/SEX CATEGORIES?

Recommended daily intake of calcium in CKD

Key evidence points

- Whole-body calcium balance studies, although difficult to perform, are essential to make conclusive recommendations for calcium intake from diet or medications.
- Whole-body calcium balance is unrelated to (soft or bone) tissue calcium balance. Skeletal demineralization may maintain serum calcium levels within a normal range, but this internal shift of calcium would not be reflected in whole-body calcium balance studies.

Clinical practice points

- In children with CKD, we suggest a total elemental calcium intake within the age-appropriate normal range.
- In adults with CKD, we suggest a minimum total elemental calcium intake of 800–1000 mg/day to maintain a neutral calcium balance.
- In adults with CKD, we suggest not to exceed a total elemental calcium intake of 1500 mg/day to avoid hypercalcemia and risk of vascular calcification.
- In children or adults with CKD, a higher calcium intake may be appropriate in special circumstances such as for patients with re-mineralization of the skeleton ("hungry bone syndrome"), those on intensified dialysis regimens or in physiological conditions requiring additional calcium supply (rapid growth in infancy or adolescence and during pregnancy and lactation).

Recommended dialysis fluid calcium concentrations

Clinical practice points

- We suggest using a dialysis fluid calcium concentration of 1.25–1.50 mmol/L (2.5–3.0 mEq/L) in peritoneal dialysis and hemodialysis to maintain a neutral calcium mass transfer during dialysis.
- We suggest that a dialysis fluid calcium concentration of 1.75 mmol/L (3.5 mEq/L) be restricted to situations where a positive calcium balance is intended.

Clinical practice points

- We recommend that patients with CKD receive individualized dietary counseling, preferably by a qualified dietitian.
- In children with CKD, we suggest that the diet is regularly assessed for total calcium content. The frequency of assessment is based on the child's age, CKD grade and trends in serum calcium, phosphorus and PTH.
- In adults with CKD, we suggest assessing calcium status routinely at first presentation, every 12 months, and when clinically indicated (unexplained hypo- and hypercalcemia, prior to initiating or adjusting therapy for secondary hyperparathyroidism or osteoporosis).
- The following groups of patients are at greater risk of calcium deficiency or reduced calcium absorption and require close monitoring of their calcium intake: children during periods of rapid growth, elderly patients, patients with specific dietary preferences (vegans, vegetarians), patients in CKD G5-5D, patients on phosphate-restricted diets, patients with malabsorption or on PPIs and patients with severe vitamin D deficiency.
- Treatment decisions should be based on trends in serum calcium, phosphate, PTH, alkaline phosphatase and 25 dihydroxy vitamin D, considered together.
- The whole-body calcium status of an individual may be estimated by evaluating the calcium intake (from diet and calcium-containing medications) and calcium mass transfer from dialysis, together with biomarkers of mineral metabolism and bone turnover, and bone imaging.

Preferred calcium source and intake conditions

Clinical practice points

- In patients with CKD we recommend optimizing calcium intake through the diet, rather than with supplements.
- Advice on dietary calcium intake should consider calcium content and bioavailability, as well as adhering to dietary phosphate restrictions, if required, and ensuring an adequate protein intake. Adapt the dietary intake to respect planetary health whenever possible.
- Calcium supplementation should be individualized, with consideration of calcium content and bioavailability, phosphate binding capacity and personal preferences.
- In individuals who require a phosphate binder, consider using a calcium-based phosphate binder, as opposed to a calcium supplement, if dietary calcium intake is low.
- For efficient phosphate binding, calcium salts (and other phosphate binding medications) must be given with meals.
- Avoid combination of calcium citrate with aluminum containing medications.

For people taking osteoporosis treatments: • Calcium supplements should be recommended if their dietary calcium intake is less than 1300 mg per day. • Vitamin D supplements should be recommended to correct low serum vitamin D levels (25-hydroxyvitamin D <50 nmol/L).	C

A recent Australian study assessing the effectiveness of a nutritional intervention in institutionalised older adults by improving calcium and protein intake (<1 g/kg body weight protein per day) using dairy foods showed an 11% reduction in the risk of falls, a 48% reduction in hip fractures, and a 30% reduction in all fractures.

Clinical toxicity is uncommon with vitamin D, even at high doses. Single doses of up to 500,000 IU are tolerated without causing hypercalcemia or hypercalciuria. However, the use of higher-dose formulations of vitamin D in older people has been associated with an increased risk of falls. Overall, daily, or at most, weekly vitamin D supplements are preferred.

The role of nutritional vitamin D in CKD-MBD in children and adults with CKD, on dialysis, and after kidney transplantation – a European consensus statement

The focus of the study was to address whether to screen for, and correct, vitamin D deficiency in patients with chronic kidney disease.

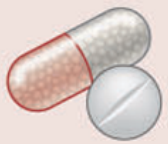
Methods

Literature review by expert panel

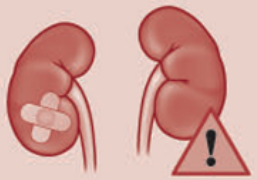
Delphi survey

Revision based on survey replies

Results

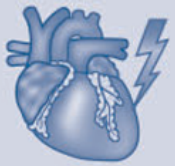


Nutritional vitamin D



Chronic kidney disease

CKD-associated osteoporosis



Cardiovascular complications

Key recommendations

✓ Target 25(OH)D >75 nmol/L (>30 ng/mL) in CKD, dialysis and post-transplant

✗ Avoid Vitamin D mega-doses (>100,000 IU) and 25(OH)D >150–200 nmol/L (60–80 ng/mL)

Jørgensen, H. S. *et al.*
NDT (2024)
@NDTSocial

This consensus provides key evidence and clinical practice points, as well as future research recommendations, on vitamin D supplementation in children and adults with CKD, on dialysis, and after kidney transplantation.

Definitions of vitamin D deficiency and adequacy according to different organizations (divide by 2.5 to convert from nmol/l to ng/ml).

Agency	Deficiency threshold (nmol/l)	Adequacy threshold (nmol/l)
European Food Safety Authority[a]	<30	>50
Nordic co-operation[b]	<30	>50
Institute of Medicine[c]	<30	>50
Endocrine Society	<50	>75
European Calcified Tissue Society	<50	

[a]Dietary reference values for vitamin D 4547 (European Food Safety Authority, 2016).
[b]Nordic nutrition recommendations 2012: integrating nutrition and physical activity (Nordic Council of Ministers, Copenhagen, 2012).
[c]Dietary reference intakes for calcium and vitamin D (Institute of Medicine, Washington, DC, 2010).

Clinical practice points

- In adults and children with CKD or after kidney transplantation, we suggest withholding nutritional vitamin D supplements when serum 25(OH)D levels are above 150–200 nmol/l (60–80 ng/ml) in the absence of hypercalcemia.
- In patients with CKD and hypercalcemia, check for and manage other causes of high calcium including iatrogenic (the use of active vitamin D compounds, high dialysate calcium, oral calcium-containing medications), CKD-related (presence of tertiary hyperparathyroidism), and non-CKD-related conditions (malignancy, haematological conditions, sarcoidosis, hypovitaminosis A, etc.) before stopping vitamin D supplementation.

- **Calcitriol** must be used in chronic kidney disease (CKD) primarily to **manage secondary hyperparathyroidism (SHPT),** which occurs due to declining kidney function leading to reduced calcitriol production. It is typically indicated in patients **with CKD stages 4 and 5** who have severe and progressive hyperparathyroidism, especially when parathyroid hormone (PTH) levels are markedly elevated. Calcitriol helps control hypocalcemia by increasing intestinal calcium absorption and suppresses PTH secretion to prevent high bone turnover disease.

- Clinical guidelines suggest starting calcitriol in CKD patients when PTH levels rise above a certain threshold (e.g., **between 150-250 pg/mL**) along with hypocalcemia. Initial doses often begin low (e.g., **0.25 to 0.5** mcg orally) and are adjusted based on PTH and calcium levels. Calcitriol use is also recommended in **CKD patients on dialysis to control SHPT**, and in certain **post-kidney transplant patients with low bone mineral density and reduced kidney function**.

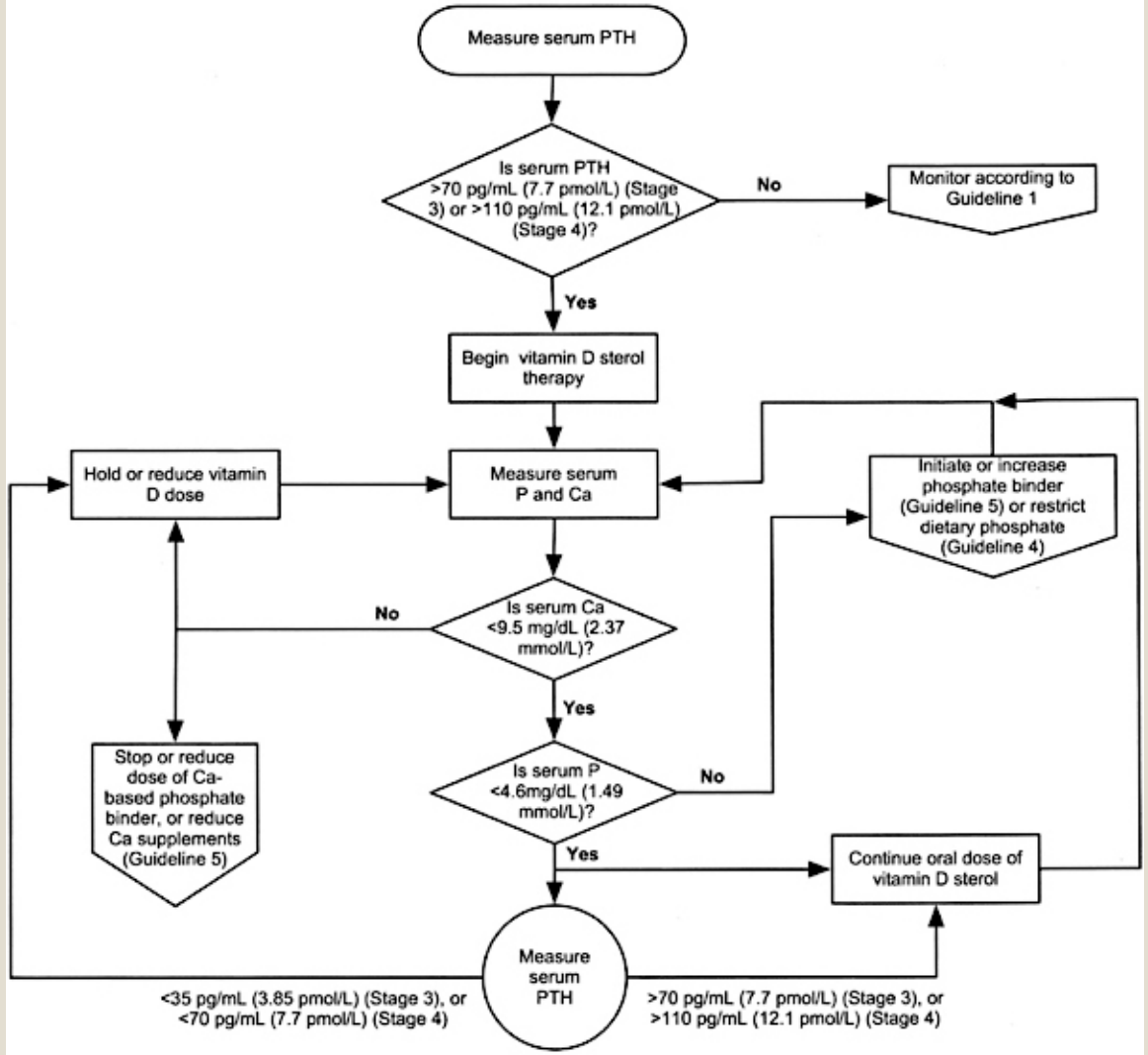
In summary, **calcitriol is reserved for:**

- **CKD stage 4 or 5 with severe and progressive secondary hyperparathyroidism,**
- **Hypocalcemia with elevated PTH,**
- **Patients on dialysis needing PTH suppression,**
- **Sometimes in early post-transplant with low eGFR and bone disease risk.**

Careful monitoring of calcium and PTH levels is essential to avoid hypercalcemia.

Algorithm Management of CKD Patients (Stages 3 and 4) with Vitamin D sterols.

In CKD patients, Stages 3 and 4, with stable renal function, compliant with visits and medications with serum phosphorus levels <4.6 mg/dL (1.49 mmol/L), calcium <9.5 mg/dL (2.37 mmol/L), and 25(OH)D ≥30 ng/mL (75 nmol/L)



Oral active vitamin D sterols available include calcitriol, alfacalcidol, and doxercalciferol; calcitriol (USA, Canada) and alfacalcidol (Canada and Europe) are approved for use in CKD, Stages 3 and 4. Initial doses should be low (calcitriol 0.25 µg/day or alfacalcidol, 0.25 µg/day). The dose of calcitriol should rarely exceed 0.5 µg/day and then only if the corrected levels of calcium increase by less than 0.2-0.3 mg/dL.

Recommendations for patients on treatment with supraphysiological doses of GC (> 8 mg m^2/day of hydrocortisone or equivalent) for more than 3 months

Recommendations	Level of evidence
1. Calcium and vitamin D are strongly recommended over placebo in children and adolescents on oral GC treatment, both for prevention and in those under treatment for osteoporosis.	Very low
2. The administration of vitamin D (on a daily/weekly/monthly basis, as applicable) is strongly recommended in children and adolescents on oral GC treatment, both for prevention and in those under treatment for osteoporosis.	Very low
3. Physical activity (adequate to the underlying condition) is recommended in children and adolescents on oral GC treatment. *Expert opinion*.	Very low*
4. Alendronate is conditionally recommended over placebo in children and adolescents on chronic oral GC treatment, diagnosed with osteoporosis.	Moderate to very low
5. Risedronate is conditionally recommended over placebo in children and adolescents on chronic oral GC treatment, diagnosed with osteoporosis.	Moderate to low
6. Pamidronate is conditionally recommended over placebo in children and adolescents on chronic oral GC treatment, diagnosed with osteoporosis.	Very low
7. Zoledronic acid is suggested over placebo in children and adolescents on chronic oral GC treatment, diagnosed with osteoporosis. *Expert opinion*.	Very low*

** This recommendation is based on the consensus of expert opinion due to the absence of evidence; for this reason, it is classified as very low quality.*

Drugs Approved by the U.S. Food and Drug Administration for Prevention and Treatment of Postmenopausal Osteoporosis[a]

	Postmenopausal Osteoporosis	
Drug	**Prevention**	**Treatment**
Abaloparatide (Tymlos)	—	80 µg SQ daily
Alendronate (Fosamax)	5 mg PO daily 35 mg PO weekly	10 mg PO daily 70 mg PO weekly[b] 70 mg + D[c]
Calcitonin (Miacalcin, Fortical)	—	200 IU intranasally once daily, or 100 IU SQ qod
Denosumab (Prolia)	—	60 mg SQ every 6 months
Estrogen (multiple formulations; estrogen-bazodoxifene)	Multiple regimens	—
Ibandronate (Boniva, generic form)	2.5 mg PO daily 150 mg PO monthly	2.5 mg PO daily 150 mg PO monthly 3 mg IV every 3 months
Raloxifene (Evista)	60 mg PO daily	60 mg PO daily
Risedronate (Actonel, Atelvia, generic form)[d]	5 mg PO daily 35 mg PO weekly 150 mg PO monthly	5 mg PO daily 35 mg PO weekly 150 mg PO monthly
Romosozumab (Evenity) Teriparatide (Forteo)	— —	210 mg SQ monthly 20 µg SQ daily
Zoledronate (Reclast, generic infusion form)	5 mg IV every 2nd year	5 mg IV once yearly

Abbreviations: IV = intravenously; PO = orally; qod = every other day; SQ = subcutaneously.
[a]Please review the package inserts for specific prescribing information.
[b]Fosamax 70 mg is available as both a tablet and a unit dose liquid. Alendronate (generic Fosamax) is available.
[c]Fosamax Plus D is a tablet containing 70 mg of alendronate and 2,800 IU or 5,600 IU of vitamin D for weekly administration.
[d]Risedronate 150 mg once monthly tablet is available.

Efficacy of antiporotic medications

Antiporotic treatment	Effect on vertebral fractures		Effect on non-vertebral fractures		Osteoporosis in men	GIOP
	Osteoporosis	Prevention of further fractures	Osteoporosis	Prevention of further fractures		
Alendronate	+	+	*	+a)	+	+
Risedronate	+	+	*	+a)	+	+
Ibandronate	NA	+	NA	+ b)	NA	NA
Zoledronic acid	+	+	NA	+c)	+	+
Denosumab	+	+ c)	+a)	+c)	+d)	+
HRT	+	+	+	+a)	NA	NA
Raloxifene	+	+	NA	NA	NA	NA
Romosozumab	+	+	+	+	NA	NA
Teriparatide	NA	+	NA	+	+	+

contrasts the effectiveness and adverse effects of traditional treatment approaches (year < 2019) with recent treatment options (year ≥ 2019) for osteoporosis in postmenopausal women.[88–92]

	Teriparatide	Denosumab	Bazedoxifene	Romosozumab	Osteoboost
Year FDA approved	2003	2010	2013	2019	2024
Mechanism of action	It stimulates osteoblasts, and when given intermittently, it increases calcium absorption and retention, thereby improving bone density and reducing the likelihood of fractures in individuals with osteoporosis.[93]	It inhibits RANKL, which prevents osteoclast development and decreases bone resorption, leading to higher bone density and a reduced risk of fractures in osteoporosis.[94]	It inhibits bone resorption via estrogen receptor activation in bone tissue, which increases bone density and lowers the risk of fractures in postmenopausal osteoporosis.[95]	It suppresses sclerostin, promoting osteoblast activity and new bone formation while decreasing bone resorption. This combined action boosts bone mineral density and lowers the risk of fractures in osteoporosis.[92]	It provides high-frequency, low-magnitude vibrations that stimulate bone formation, reduce bone resorption, and improve blood circulation. It enhances osteoblast activity, limits osteoclast development via osteocyte signaling, and strengthens muscles, leading to improved bone density and fracture prevention.[85]
Efficacy	56%	72%	20–40%	73%	5–10%
FDA box warning	Though FDA has removed the warning regarding Osteosarcoma, it still recommends to avoid in patients with an increased risk of osteosarcoma[96]	Increased risk of severe hypocalcemia in patients with advanced chronic kidney disease (CKD)[22]	Endometrial cancer, cardiovascular disorders and dementia[97]	Potential risk of myocardial infarction (MI), stroke, cardiovascular death[98]	NA


OSTEOBOOST
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Bone Health
TECHNOLOGIES

The key points before and during denosumab treatment

1. Ensure patient (and family) compliance and manage injection dates at the doctor's office
2. A broad biological work-up to exclude a secondary cause of osteoporosis
3. Injections should be given strictly every 6 months (+/- 2 weeks). Do not exceed 6 months for treatments lasting more than 3 years.
4. Dose CTX once a year on the day of denosumab injection. CTX must be very low. If they rise to 50% of the upper limit of the norm for premenopausal women, think of an early rebound.
5. Perform DXA every 2 years
6. Anticipate denosumab discontinuation with bisphosphonate therapy

Denosumab: clinical consequences related to the number of doses

One dose

No rebound effect.

As emergency (acute vertebral fracture) and decide 6 or 7 months later which treatment to use.

One or two doses followed by a bisphosphonate give good BMD results.

Two to six doses

The rebound effect is less severe.

More than six doses

The rebound effect is more severe.

The risk of missing a dose or of a delay of more than six months between two doses is increased.

Risk of early rebound effect (after 5 months).

Risk of multiple vertebral fractures during the rebound effect increases with duration of treatment.

Management of denosumab discontinuation with alendronate

1. Start Alendronate 4 months after the last denosumab injection.
2. Measure CTX 7 months after last denosumab injection.

3a If CTX are low*, continue alendronate and measure CTX every two months.

3b If CTX are in the target**, switch to zoledronate iv and measure CTX every three months

3c If CTX are above the normal values for premenopausal women, repeat a new denosumab injection, and start again at point 1, advancing the various proposals by 1 month.

4. Each time CTX is above the optimal target***, repeat zoledronate iv.
5. If DXA 18 months after the last denosumab show a significant bone loss, repeat zoledronate

* low: < 20% of the upper limit of the normal value for premenopausal women

** between 20% and 100% of the normal value for premenopausal women (if CTX are slightly increased, Alendronate 2x/week may be an option)

*** below the 60% of the normal values for premenopausal women

Management of denosumab discontinuation with zoledronate

A. Without CTX measurement

1. Start Alendronate 4 months after the last denosumab injection.

2. Give iv Zoledronate 7 and 12 months after the last denosumab injection.

3. If DXA 18 months after the last denosumab show a significant bone loss, repeat zoledronate

B. With CTX measurement

1. Measure CTX 6 months after the last denosumab injection.

2a If CTX are low*, measure it again every month until it reaches the target value**.

2b If CTX are above the normal values for premenopausal women, repeat the denosumab injection and repeat the above regimen at 5 months instead of 6 months.

2c If CTX are within target**, give zoledronate

3. measure CTX every three months. Each time CTX is above the optimal target***, repeat zoledronate iv.

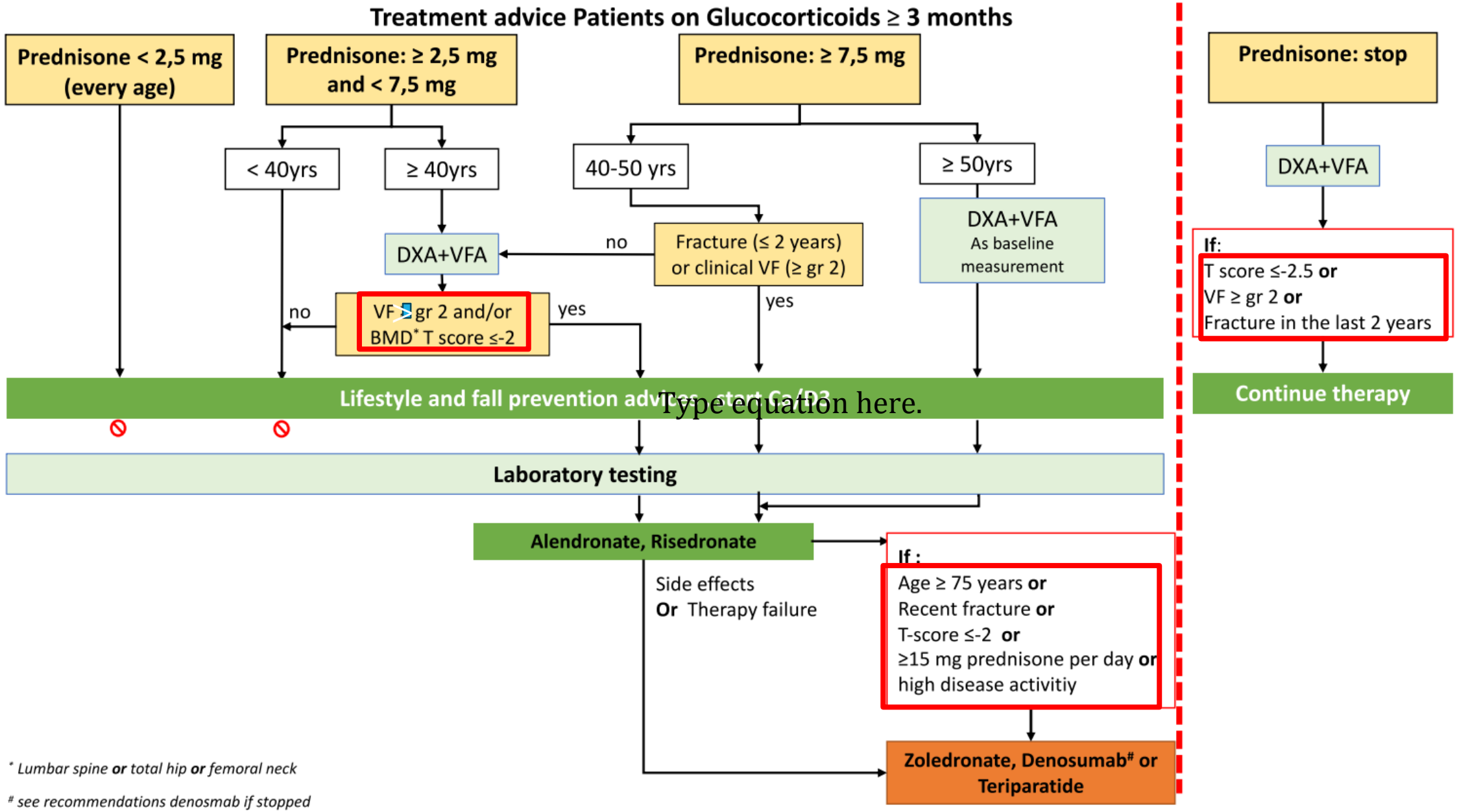
4. If DXA 18 months after the last denosumab show a significant bone loss, repeat

zoledronate

* low: < 20% of the upper limit of the normal values for premenopausal women

** between 20% and 100% of the normal values for premenopausal women

*** below the 60% of the normal values for premenopausal women



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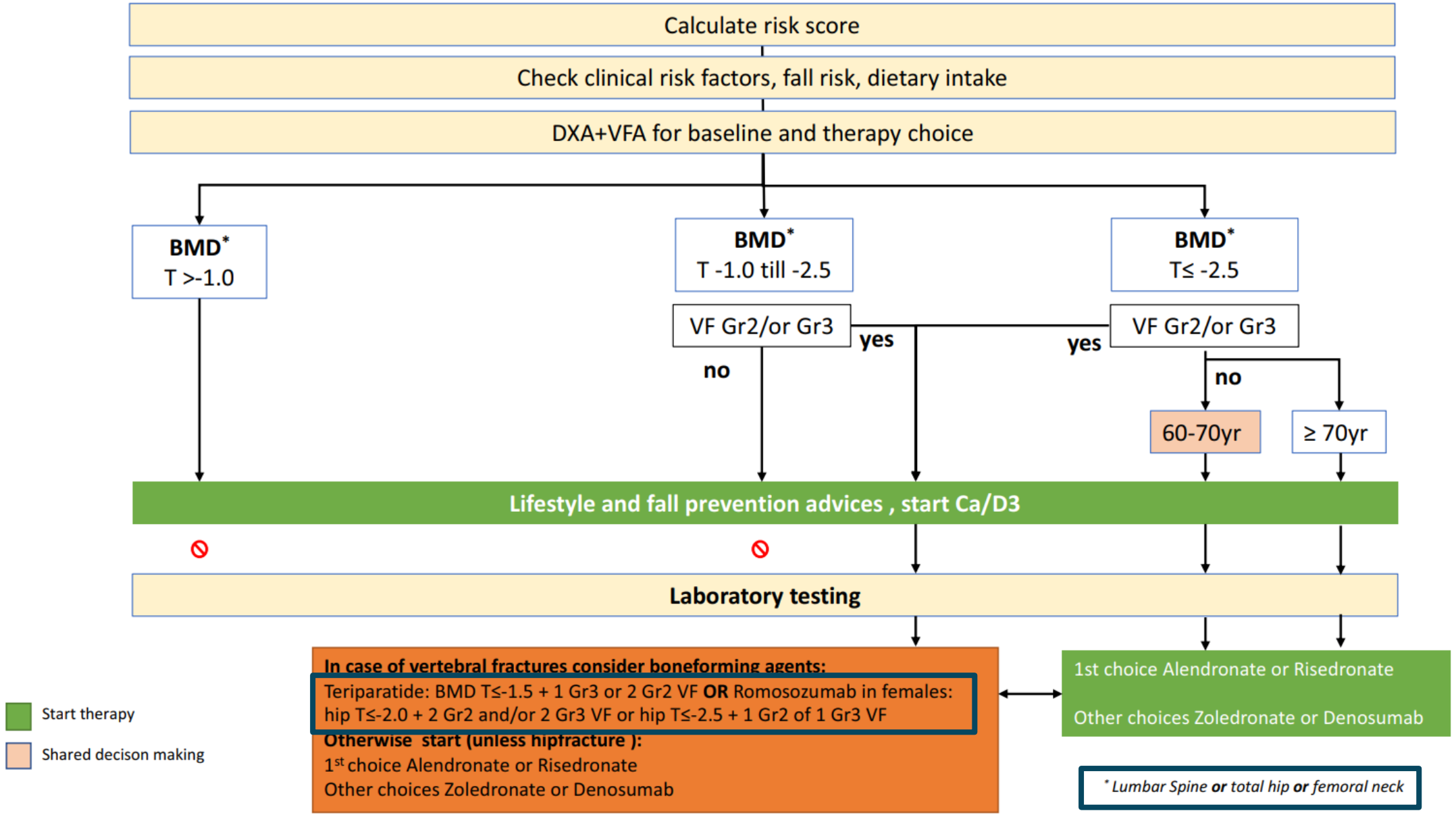
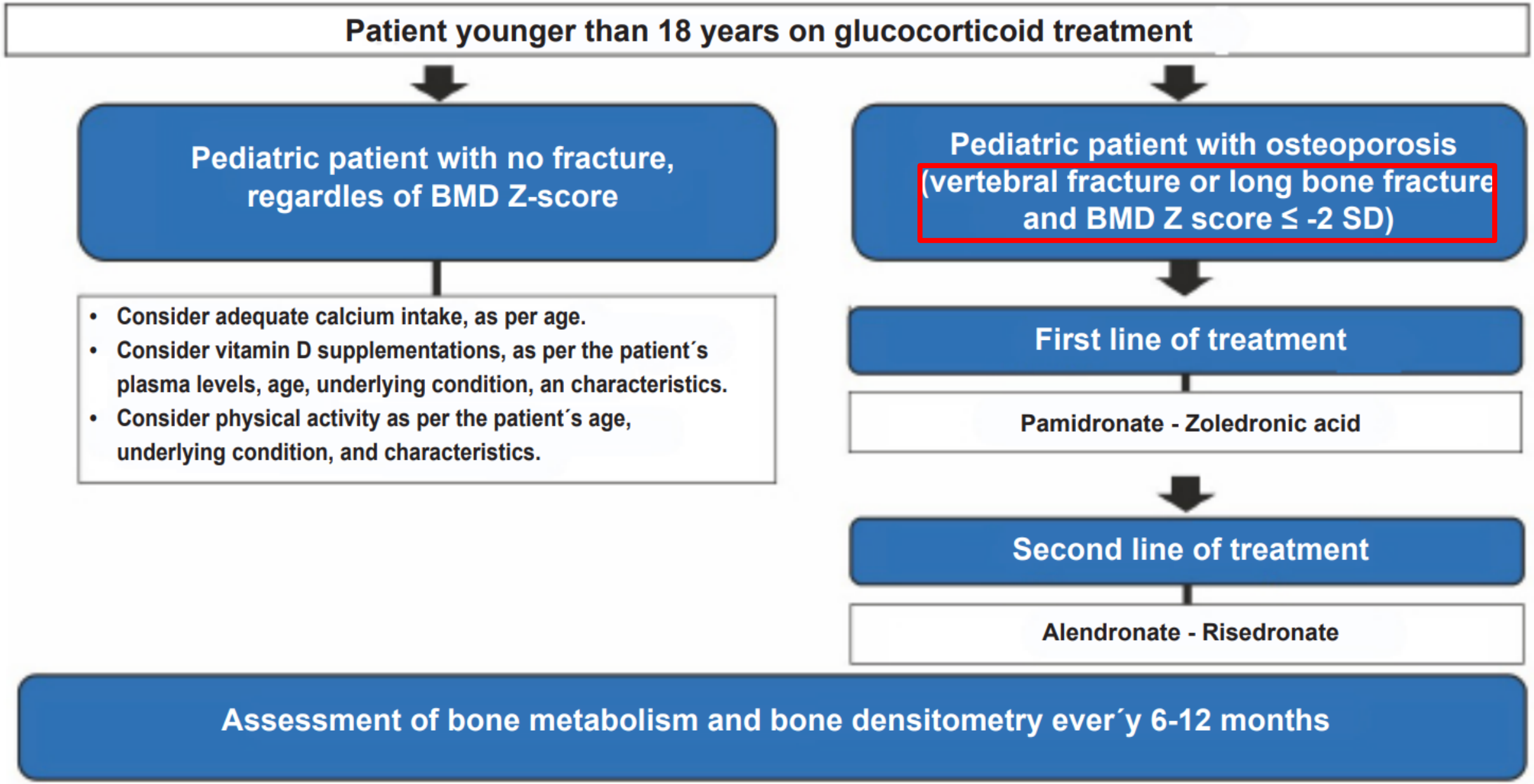
Treatment advice for patients treated with glucocorticoids

Evaluation of therapy naive patient without a fracture but with increased risk profile



Evaluation of therapy-naive patient without a recent fracture, but with an increased risk profile


Patient younger than 18 years on glucocorticoid treatment
Pediatric patient with no fracture, regardles of BMD Z-score
Consider adequate calcium intake, as per age.
Consider vitamin D supplementations, as per the patient´s plasma levels, age, underlying condition, an characteristics.
Consider physical activity as per the patient´s age, underlying condition, and characteristics.
Pediatric patient with osteoporosis (vertebral fracture or long bone fracture and BMD Z score ≤ -2 SD)
First line of treatment
Pamidronate - Zoledronic acid
Second line of treatment
Alendronate - Risedronate
Assessment of bone metabolism and bone densitometry ever´y 6-12 months

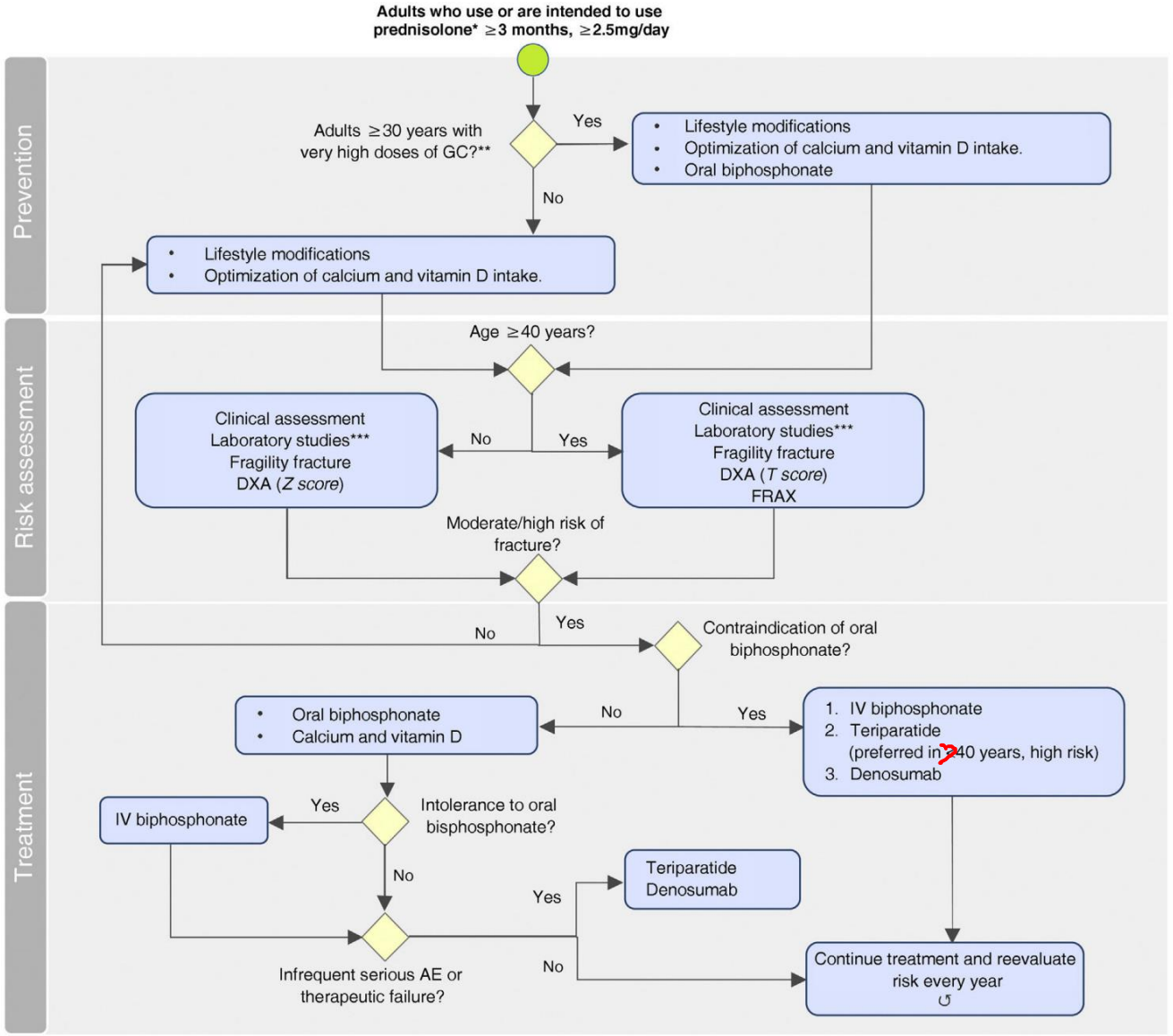


Fig. 1 – Algorithm for the preve valuation and management of glucocorticoid-induced osteoporosis in adults.
***Or equivalent doses.**
****Initial dose ≥ 30 mg of prednisolone for more than 3 months or cumulative dose > 5 g in one year, or its equivalent.**
*****Paraclinical tests before starting therapy: glucose, kidney and thyroid function and others, depending on comorbidities and general condition.**
IV bisphosphonate: zoledronic acid; oral biphosphonate: alendronate, risedronate; DXA: Dual-energy X-ray absorptiometry; AE: Adverse events; FRAX: fragility fracture risk calculation instrument; GC: glucocorticoids; IV: intravenous.

Adults

Very High Risk

Prior OP fracture(s) OR BMD T score ≤ -3.5 OR FRAX® (GC-Adjusted*) 10-year risk of MOF ≥30% or hip ≥4.5%
OR
High GC ≥30 mg/day for >30 days or cumulative doses ≥5 g/year

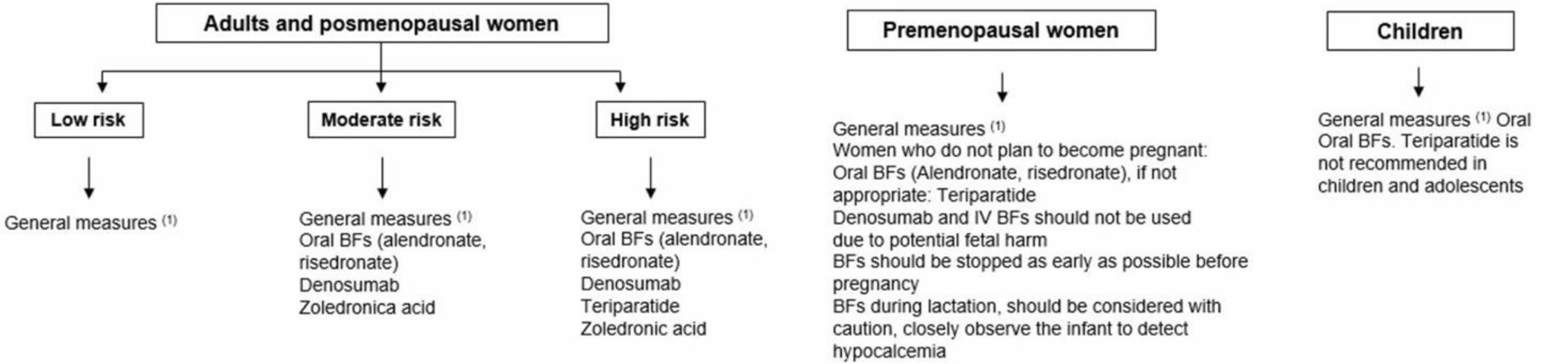
Adults ≥40 Years

High Risk

BMD T score ≤ -2.5 but > -3.5
OR
FRAX® (GC-Adjusted*) 10-year risk of MOF ≥20% but <30% or hip ≥3% but <4.5%

Adults <40 Years	Adults ≥40 Years
Moderate Risk	
BMD Z score ≤ -3 OR significant bone loss over 1-2 years AND GC ≥7.5mg/day for ≥6 months	FRAX® (GC-Adjusted*) 10-year risk MOF ≥10 and <20%, or hip ≥1 but <3%, OR BMD T score between -1 and -2.4

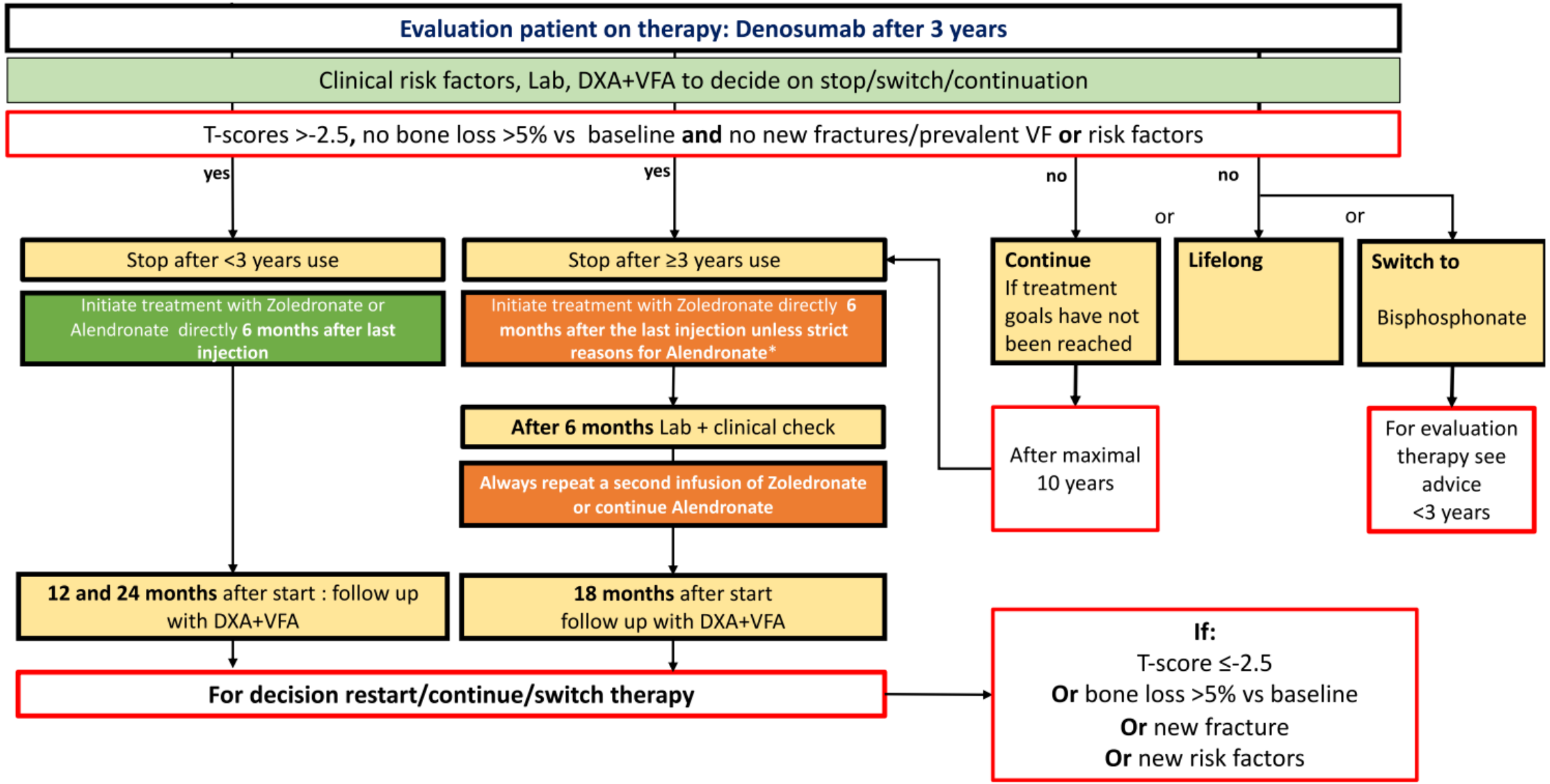
Panel proposal for pharmacologic therapies according to fracture risk stratification



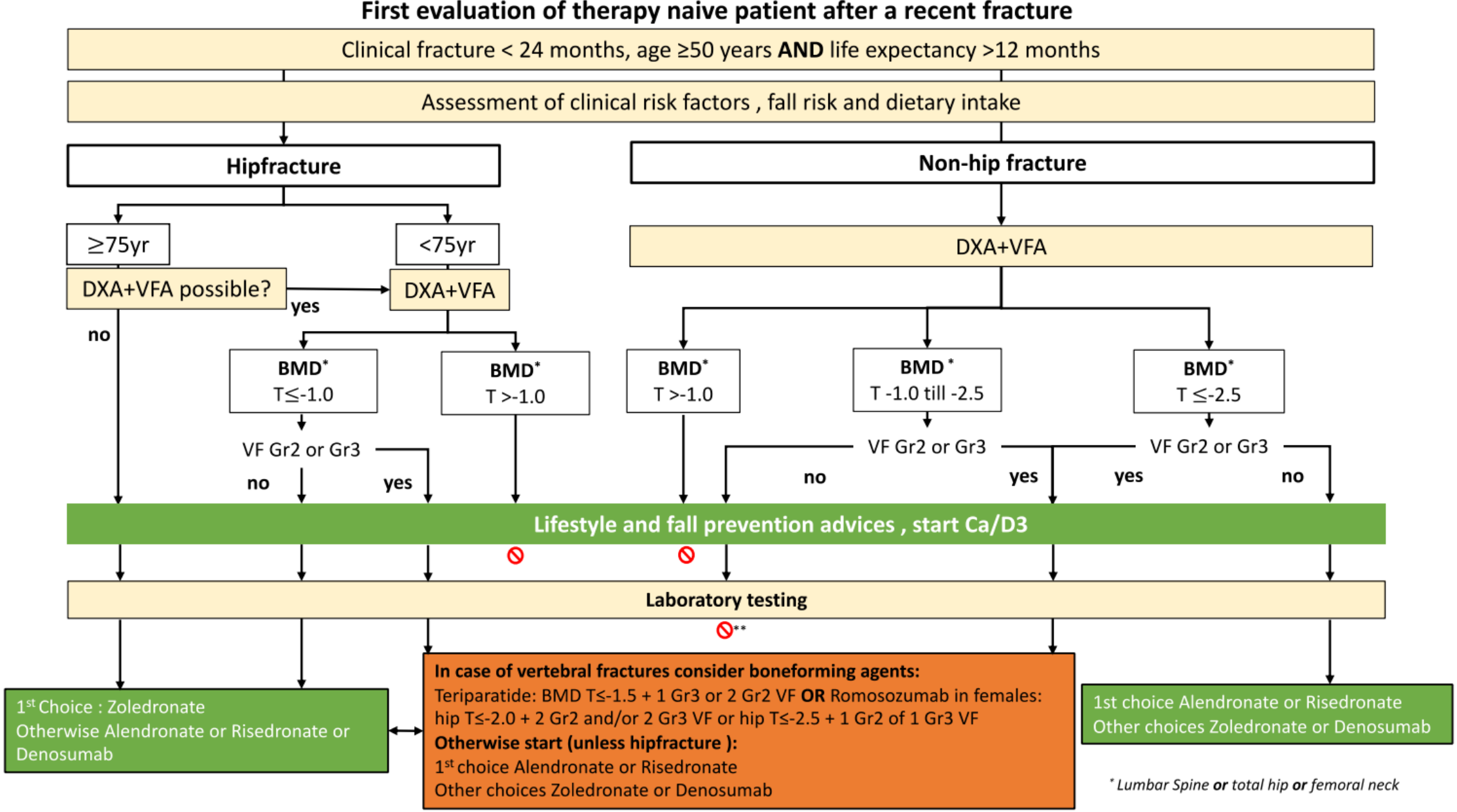
Special populations: GC pulse therapy: Zoledronic acid or teriparatide
Inhaled GC: BF (alendronate)

(1) General measures
Lifestyle recommendations (see text)
Prescribe and mantain the lowest effective dose for the shortest amount of time.
When possible, switch from systemic to topical corticosteroids.
Optimal total daily calcium intake from 1,200 to 1,500 mg/day (Calcium carbonate or citrate should be supplemented in those patients who do not fulfill this dietary intake)
Vitamin D supplementation to achieve 25(OH)D levels ≥ 30 ng/dl

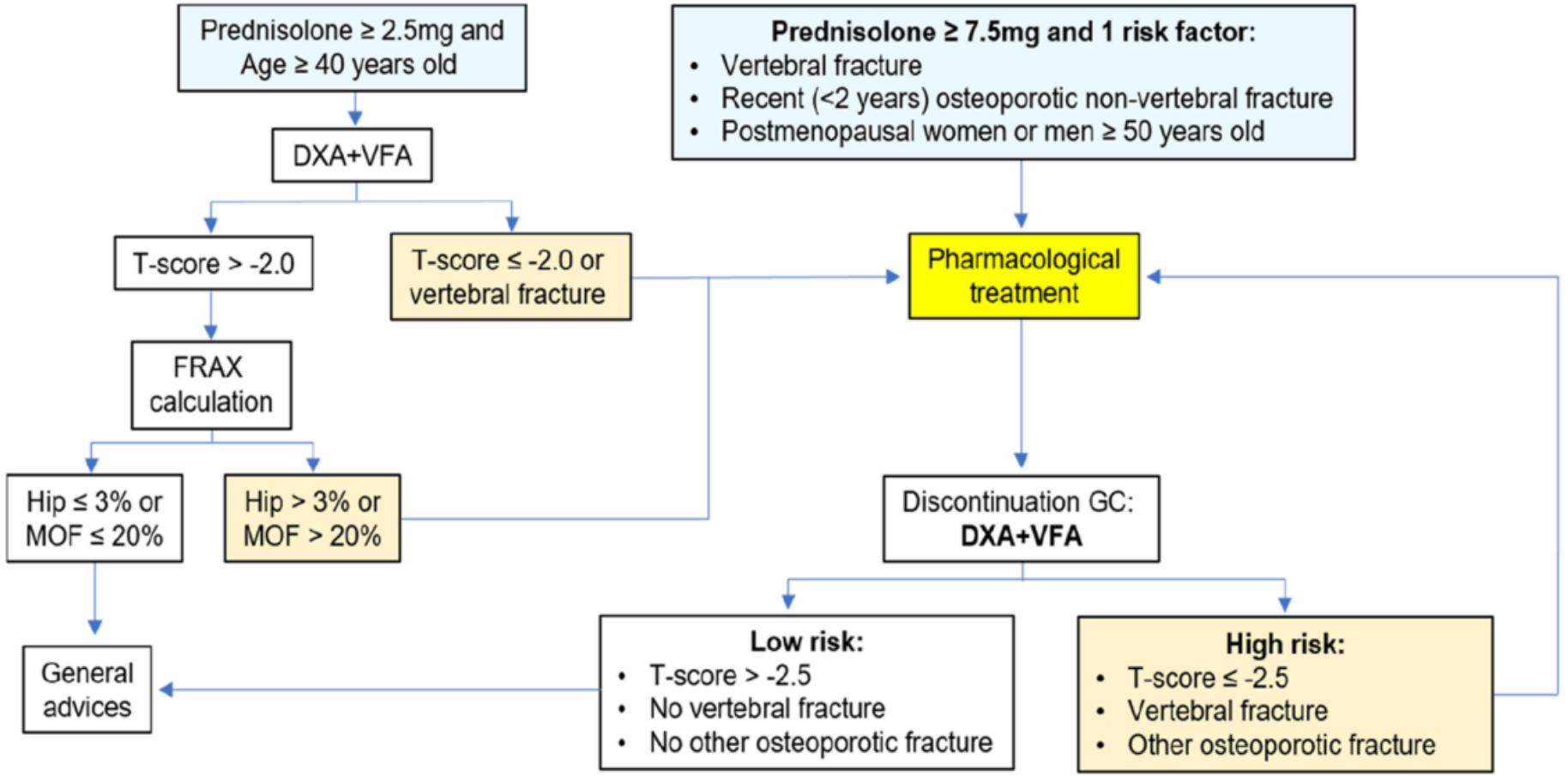
BF: Bisphosphonates
GC: Glucocorticoids



Evaluation on therapy: denosumab

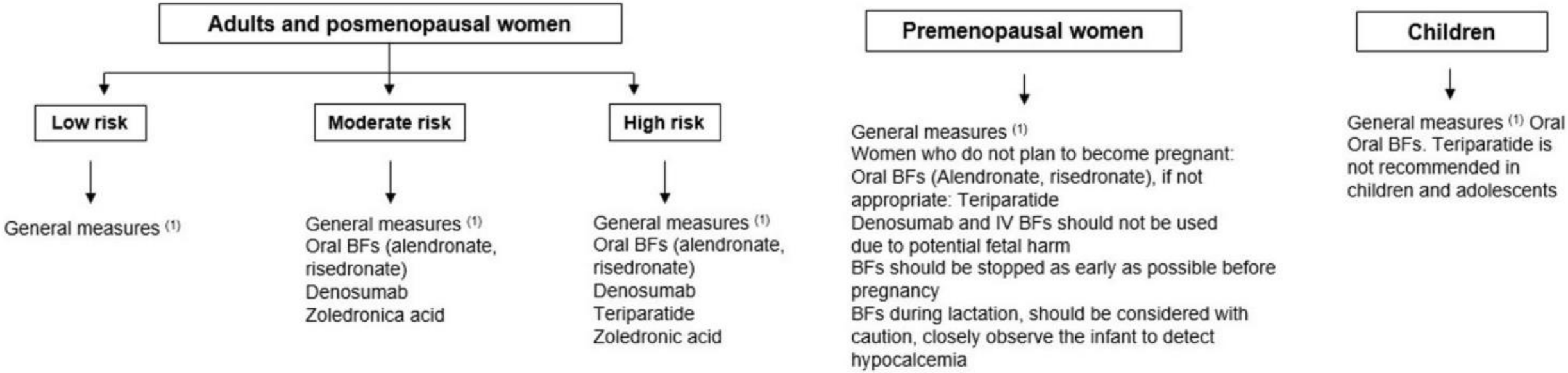


Evaluation of therapy-naive patient ≥ 50 years with a recent fracture



Algorithm of diagnosis and management of glucocorticoid-induced osteoporosis. For women age 70 years and above, the intervention threshold set by NOGG is a MOF 10-year probability of 20% (or hip fracture probability of 4.8%) Assessment thresholds between which a BMD test would be undertaken to refine the probability assessment lie between 11 and 24%. Figure adapted from original article of Messina et al.

Panel proposal for pharmacologic therapies according to fracture risk stratification



Special populations: GC pulse therapy: Zoledronic acid or teriparatide
Inhaled GC: BF (alendronate)

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Lifestyle recommendations (see text)
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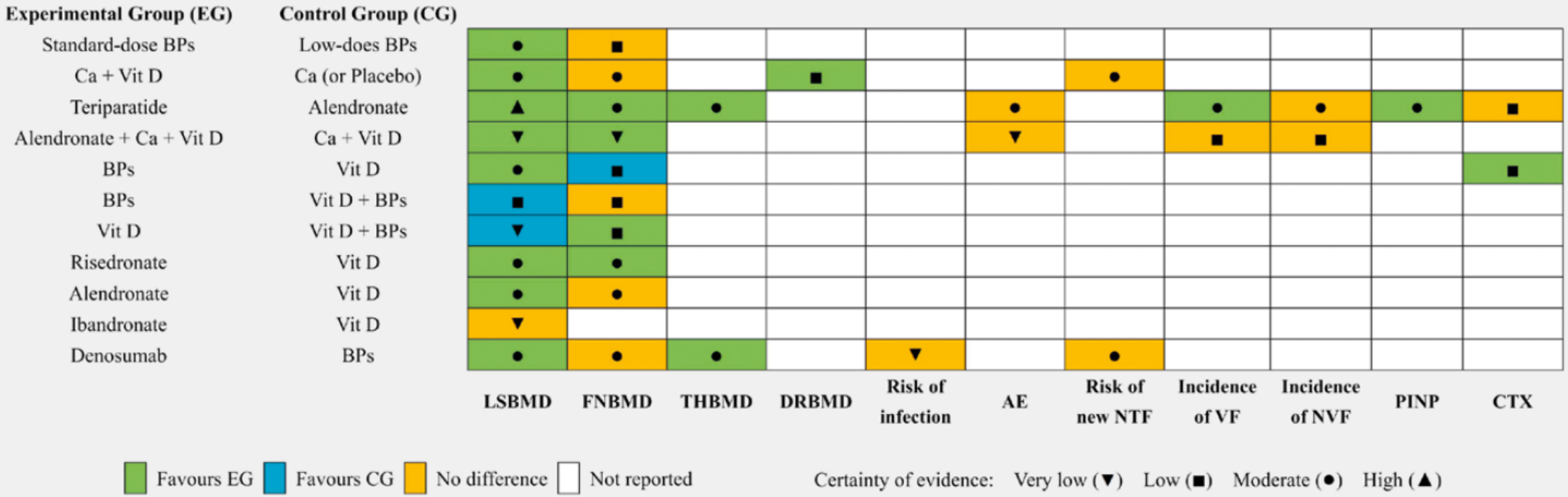
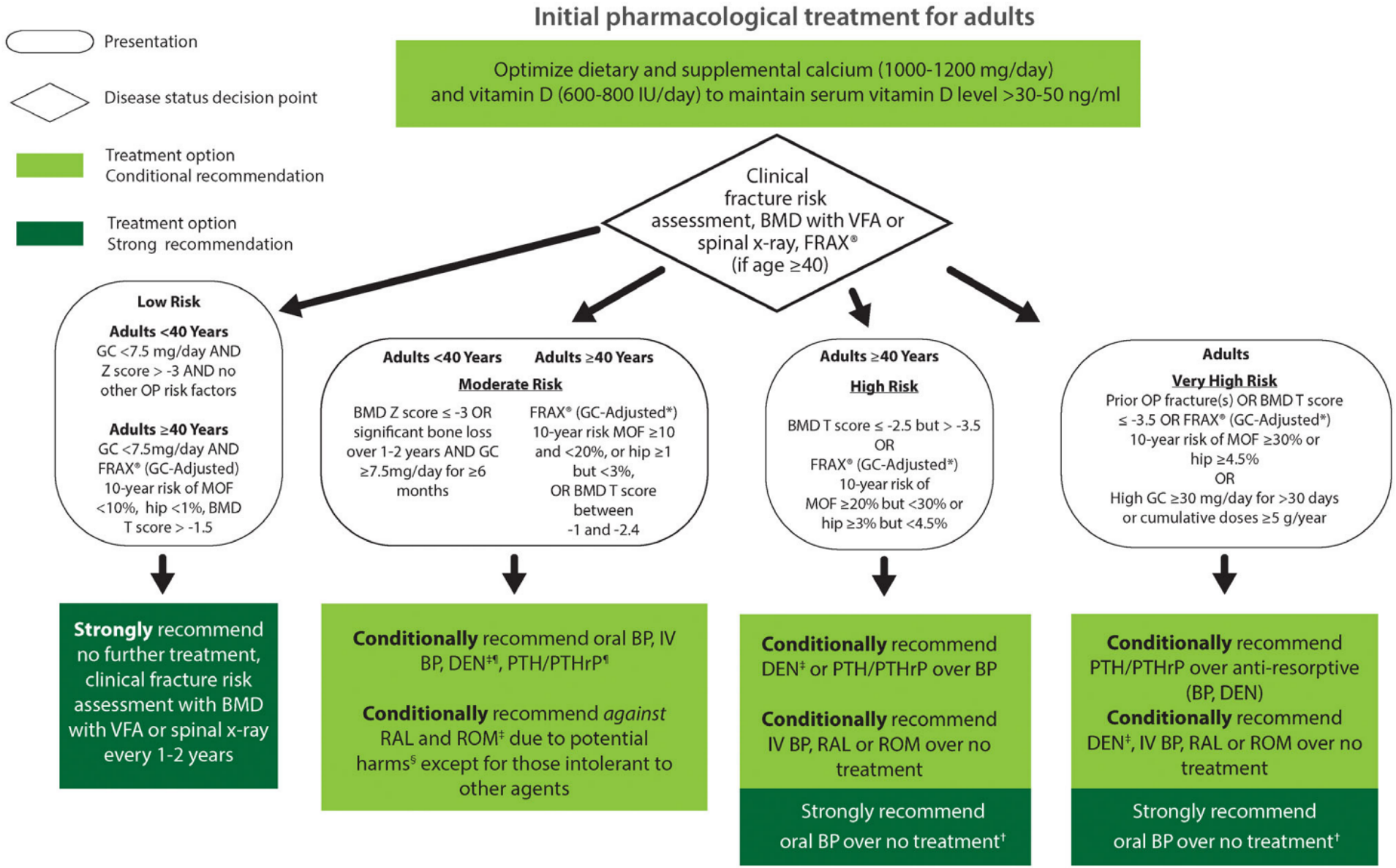
When possible, switch from systemic to topical corticosteroids.
Optimal total daily calcium intake from 1,200 to 1,500 mg/day (Calcium carbonate or citrate should be supplemented in those patients who do not fulfill this dietary intake)
Vitamin D supplementation to achieve 25(OH)D levels ≥ 30 ng/dl

BF: Bisphosphonates
GC: Glucocorticoids



Heat map of pharmacological Interventions on GIOP. BPs: Bisphosphonates; Ca: Calcium; Vit D: Vitamin D; BMD: Bone Mineral Density; AE: Adverse Events; LSBMD: BMD of Lumbar Spine; FNBMD: BMD of femoral neck; THBMD: BMD of total hip; DRBMD: BMD of distal radius; NTF: Nontraumatic fracture; VF: Vertebral fractures; NVF: Nonvertebral fractures; PINP: N-terminal propeptide of type I collagen; CTX: C-telopeptide of type I collagen.



FRAX® = https//www.shef.ac.uk/FRAX/Tool.jsp; MOF= major osteoporotic fracture; *FRAX® GC correction for GC ≥7.5 mg/day example: if hip fracture risk is 2.0% multiply by 1.2 for adjusted risk = 2.4%, BP = bisphosphonate, IV = intravenous, PO = oral, PTH/PTHrP = parathyroid hormone/ parathyroid hormone related protein, DEN = denosumab, RAL = raloxifene, ROM = romosozumab, †Based on fracture data in GIOP, ‡Women who may become pregnant need birth control and avoid pregnancy until >5 months after last dose; §RAL(PE, DVT, fatal stroke); ROM (myocardial infarction, stroke and death; conditionally recommend RAL/ROM use in the highest risk patients unable to tolerate other agents; ¶Use with caution in persons with open growth plates

Special populations of patients beginning long-term GC therapy at very high risk for fracture

- For adults with solid organ transplants and an estimated glomerular filtration rate (eGFR) ≥35 mL/min who are continuing chronic GC treatment, we conditionally recommend treatment with BP, DEN, PTH/PTHrP, or RAL, based on individual patient factors over no treatment.
  - ✓ This group of patients is typically considered at increased risk of fracture regardless of BMD, due to the known risk of OP associated with solid organ transplantation and anti-rejection medications.

- In this solid organ transplant population, we conditionally recommend against using ~~ROM~~ due to potential harms in this population.

Special populations of patients beginning long-term GC therapy at very high risk for fracture

- For adult renal transplant recipients on chronic GC treatment, we conditionally recommend metabolic bone disease expert evaluation for chronic kidney disease–mineral and bone disorder (CKD-MBD).
  - ✓ In patients with stage IV and V CKD, renal osteodystrophy, including adynamic bone disease, osteomalacia, osteitis fibrosa cystica, and mixed uremic osteodystrophy, is nearly universal.
  - ✓ Bone-specific alkaline phosphatase, intact PTH, and bone biopsy may exclude renal osteodystrophy.
  - ✓ ~~BP~~ should generally not be used if eGFR <35 mL/min.

<30 mL/min for risedronate and ibandronate
<35 mL/min for alendronate and zoledronate

Special populations of patients beginning long-term GC therapy at very high risk for fracture

- ✓ Once renal osteodystrophy and hyperparathyroidism is excluded, no dose adjustment is needed when prescribing DEN, PTH/PTHrP, or ROM.
- ✓ However, if eGFR is <30 mL/min, DEN is not contraindicated but induces prolonged and more severe hypocalcemia.
- ✓ The panel recommended that patients without hyperparathyroidism and eGFR ≥30 mL/min could use vitamin D3 (cholecalciferol) or vitamin D2 (ergocalciferol) instead of biologically active forms of vitamin D (calcitriol, paricalticol, or doxercalciferol).
- ✓ Patients with GFR <30 mL/min might require biologically active VitD to maintain neutral calcium balance.

Sequential Therapy of Osteoporosis Drugs

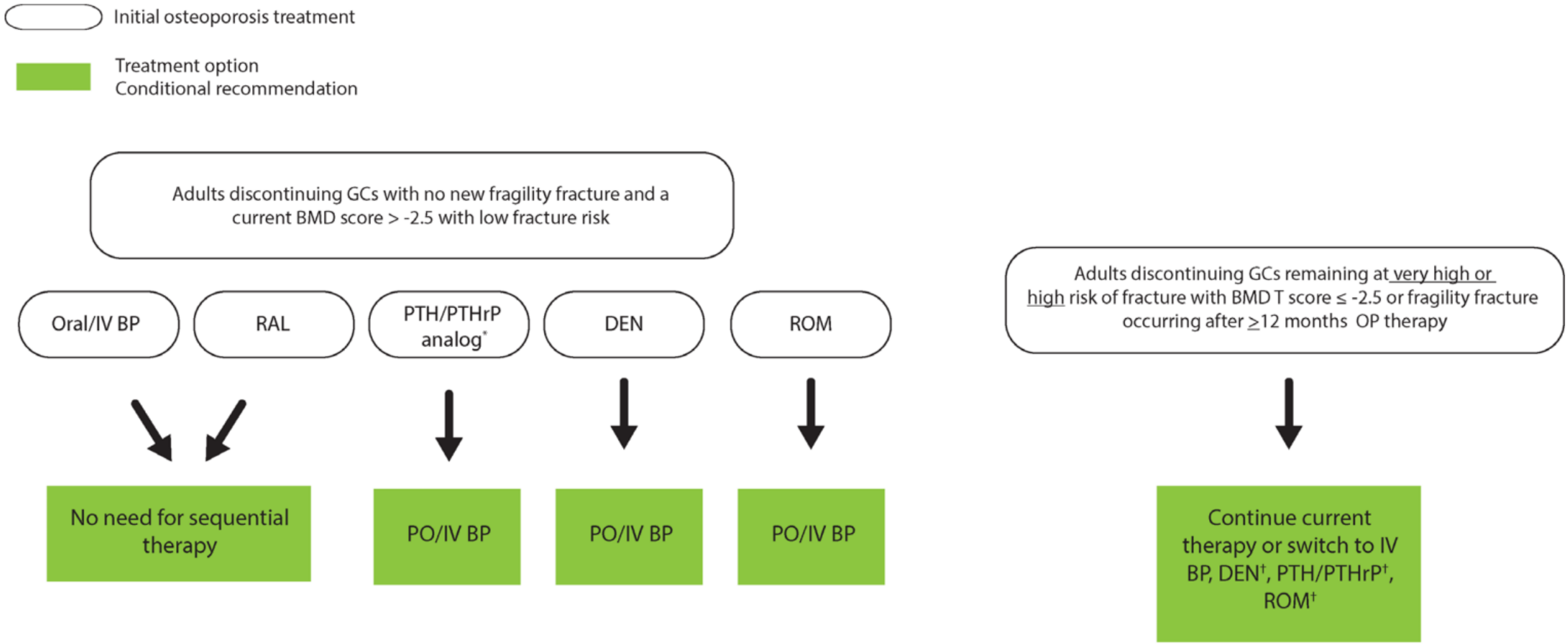
- Consideration for sequential drug therapy should be made in the following scenarios:

- **(i)Ineffectiveness or adverse side effects of bone resorption inhibitors or prolonged therapy period;**
- **(ii)When the recommended treatment course of bone formation promotors such as parathyroid hormone analogues is completed, the fracture risk still remains high, thus requiring continued treatment;**
- **(iii)After discontinuation of short-acting drugs like teriparatide or denosumab, treatment needs to be maintained to sustain effects.**

Sequential Therapy of Osteoporosis Drugs

- **Sequential Treatment from Bone Formation Promoters to Bone Resorption Inhibitors**
- **Sequential Treatment from Bone Resorption Inhibitors to Bone Formation Promoters**
- **Sequential Treatment of Different Types of Bone Resorption Inhibitors**
- **Sequential Treatment of Other Drugs**

Sequential osteoporosis treatment recommendation when initial therapy and GC are discontinued



BP = bisphosphonate, IV = intravenous, PO = oral, DEN = denosumab, ROM = romosozumab, PTH = parathyroid hormone, PTHrP = PTH related peptide, RAL = raloxifene, OP = osteoporosis; *Bone loss may be gradual and anti-fracture efficacy maintained 18 months but antiresorptive is recommended; †Will require sequential therapy with BP

Treatments when GC are discontinued

- For adults taking OP therapy and discontinuing GC therapy, with no new fragility fracture and a current BMD t-score ≥−2.5, we strongly recommended stopping current OP therapy and continuing calcium and vitamin D. However, sequential therapy is strongly recommended after stopping DEN, PTH/PTHrP, and ROM.

  - ✓BP and RAL can be discontinued without need for sequential therapy.
  - ✓DEN, PTH/PTHrP, and ROM should be transitioned to anti-resorptive therapy, but the best formulation and duration of treatment is unclear at this time.

Treatments when GC are discontinued

- For adults ≥40 years discontinuing GC therapy and continuing to be at high risk of fracture (BMD t-score ≤−2.5, or history of a fragility fracture occurring after ≥12 months of therapy), we conditionally recommend continuing current OP therapy or switching to another class of OP medication.

GONADAL HORMONE THERAPY

Sex hormone treatment should be considered whenever a patient with GC excess develops hypogonadism.

A retrospective study in postmenopausal women taking GCs found an increased BMD in those who were taking estrogens, compared to increasing bone loss in those who were not.

Moreover, in a randomized controlled clinical trial of postmenopausal women taking GCs for rheumatoid arthritis, a significant increase in lumbar spine BMD was observed in those receiving hormone replacement therapy (HT) compared to those receiving placebo.

GONADAL HORMONE THERAPY

However, a large randomized clinical trial in postmenopausal women treated with a combination of estrogen and progestin planned to last 8.5 years was interrupted after 5 years, because the overall risks exceeded the benefits of the treatment.

GONADAL HORMONE THERAPY

Similarly, adult men with GC excess who develop hypogonadism benefit from testosterone replacement.

In GC-treated asthmatic men with testosterone deficiency, i.m. testosterone injections increased lumbar spine but not hip BMD.

However, since most studies have shown an increase in prostate size and prostate-specific antigen levels in older men on testosterone supplementation/therapy, testosterone administration should be monitored with yearly digital examinations and prostate-specific antigen measurements.

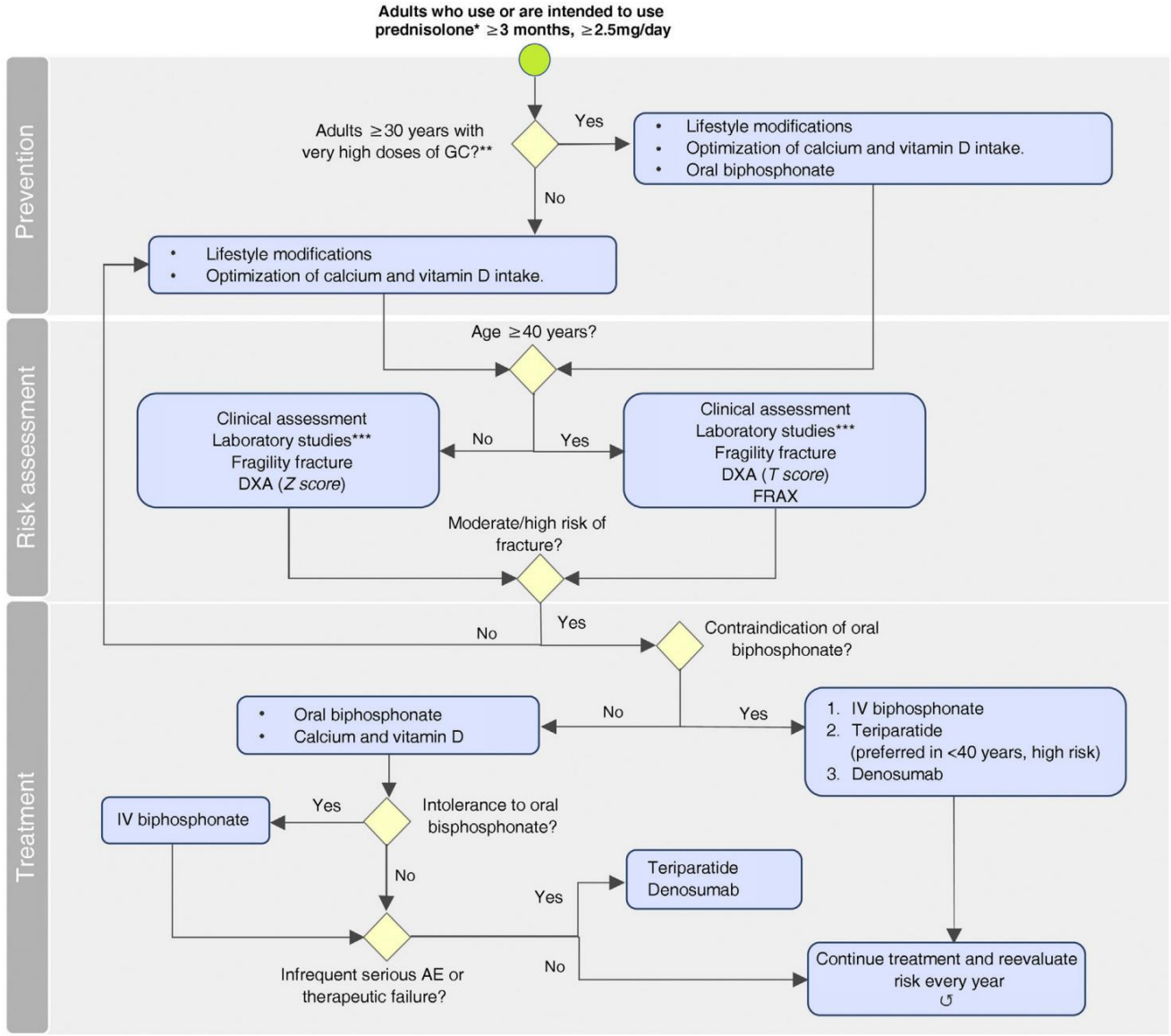


Fig. 1 – Algorithm for the preventic uation and management of glucocorticoid-induced osteoporosis in adults.
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Adults

Very High Risk

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OR

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Adults ≥40 Years

High Risk

BMD T score ≤ -2.5 but > -3.5

OR

FRAX® (GC-Adjusted*) 10-year risk of MOF ≥20% but <30% or hip ≥3% but <4.5%

Adults <40 Years	Adults ≥40 Years
Moderate Risk	
BMD Z score ≤ -3 OR significant bone loss over 1-2 years AND GC ≥7.5mg/day for ≥6 months	FRAX® (GC-Adjusted*) 10-year risk MOF ≥10 and <20%, or hip ≥1 but <3%, OR BMD T score between -1 and -2.4