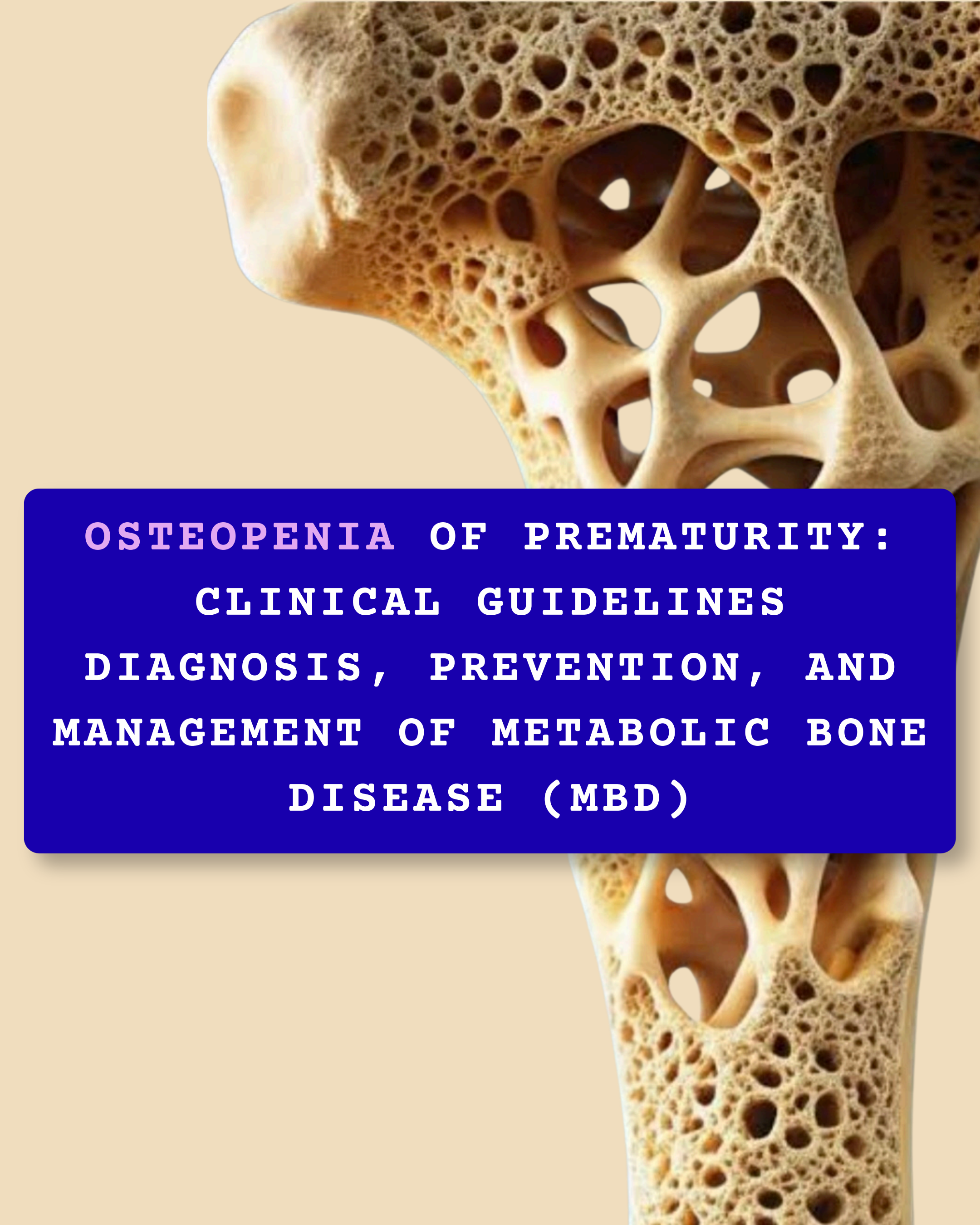
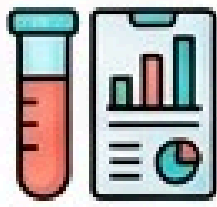


A detailed close-up photograph of a human bone, likely a vertebra or rib, showing the intricate internal trabecular structure. The bone is light beige with a complex network of small, interconnected pores and larger, irregularly shaped cavities. The texture is highly porous and delicate.

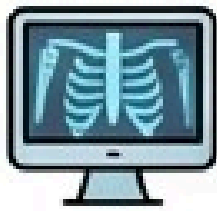
OSTEOPENIA OF PREMATURITY: CLINICAL GUIDELINES DIAGNOSIS, PREVENTION, AND MANAGEMENT OF METABOLIC BONE DISEASE (MBD)

DIAGNOSIS & MONITORING (MBD)



BIOCHEMICAL MARKERS

- Serum Alkaline Phosphatase (ALP) > 500 IU/L
- Serum Phosphate < 4.5 mg/dL (Postnatal Wk 2)
- Serum Calcium & Vitamin D levels



IMAGING

- Bone Mineral Density (BMD) via DXA
- Radiographic Signs (Fractures, Demineralization)
- Quantitative Ultrasound (QUS) (Experimental)



RISK FACTORS

- Very Low Birth Weight (<1500g)
- Extreme Prematurity (<28 weeks)
- Prolonged PN use, Diuretics, Steroids

MANAGEMENT PATHWAYS (THERAPIES)



SUPPLEMENTATION PROTOCOLS

- Oral Calcium & Phosphate Supplements
- Adjusted Vitamin D Dosage
- Consider Calcitriol (Severe cases)



FRACTURE MANAGEMENT

- Pain Control
- Immobilization as indicated
- Monitor Healing via X-rays



LONG-TERM MONITORING

- Follow-up in High-Risk Clinics
- Bone Health Assessment during Childhood
- Monitor Growth & Neurodevelopment

PREVENTION STRATEGIES (METRICS & NUTRITION)



NUTRITION OPTIMIZATION

- Enteral Feeding with Fortification
- Targeted Nutrient Intake (Ca:P Ratio 1.7:1)
- Vitamin D Supplementation (400-800 IU/day)



PHYSICAL ACTIVITY

- Gentle Passive Range of Motion Exercises
- Early Mobilization & Positioning



SCREENING METRICS

- Weekly ALP & Phosphate Screening
- BMD Assessment at Term Corrected Age (Selected cases)



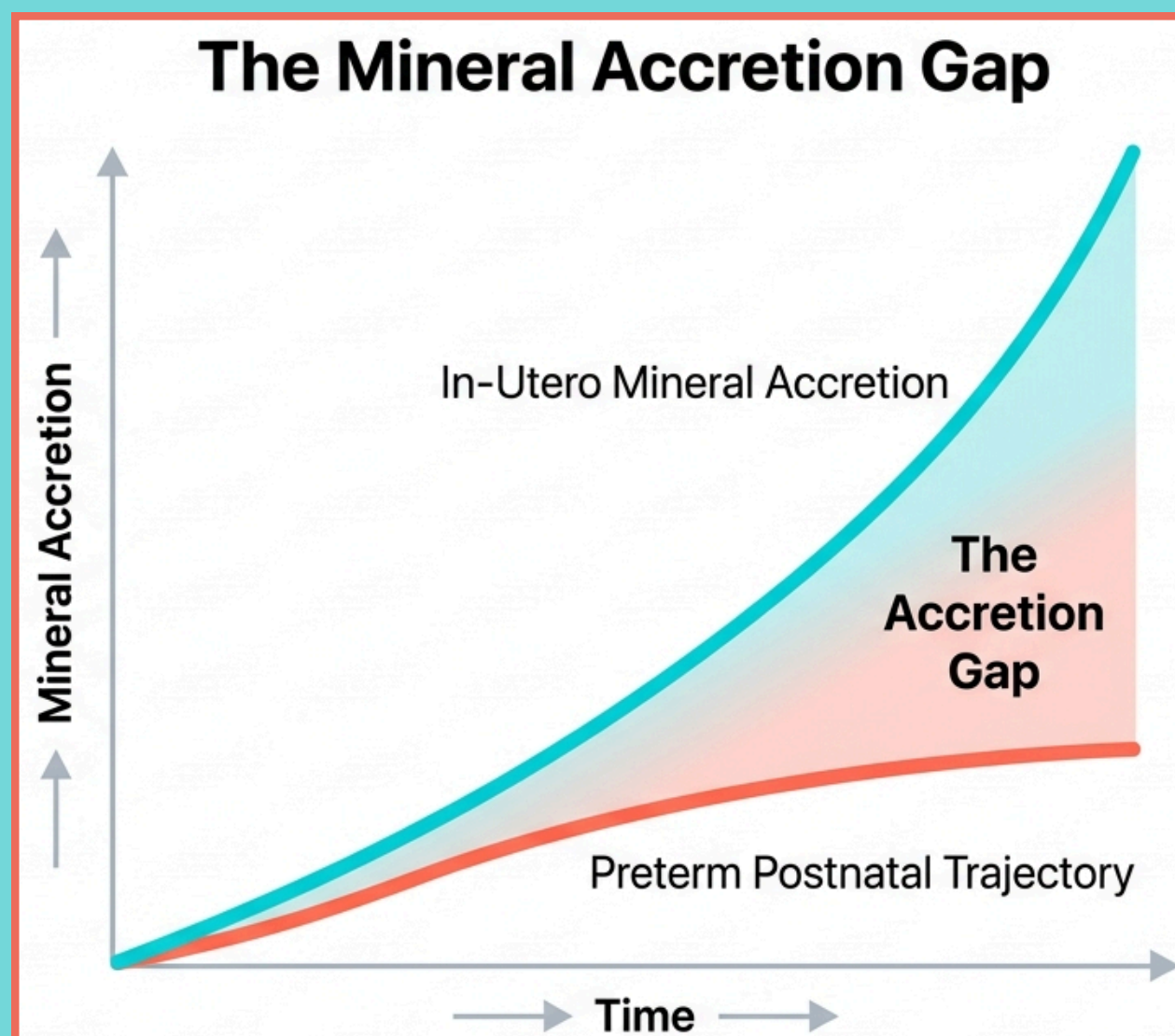
Defining the Mineral Accretion Gap

Decreased Bone Mineralization

In preterm infants due to deficient phosphate (P04), calcium (Ca), or Vitamin D.

Core Etiology

Inadequate postnatal intake or absorption to match the rapid intrauterine mineral accretion rate.



The High-Risk Patient Profile

Demographic Baseline

< 32 weeks gestation OR
< 1500 g birth weight.

Male gender.

Medical Complexities

Chronic Lung Disease (CLD).
Cholestatic jaundice. Short gut
syndrome (malabsorption).

Nutritional Deficits

Prolonged Parenteral Nutrition (PN)
(> 2 weeks). Delayed enteral feeds.
Use of unfortified expressed breast
milk (EBM) or term formula.
PO₄ / Ca / Vit D deficiency.

Physical & Iatrogenic

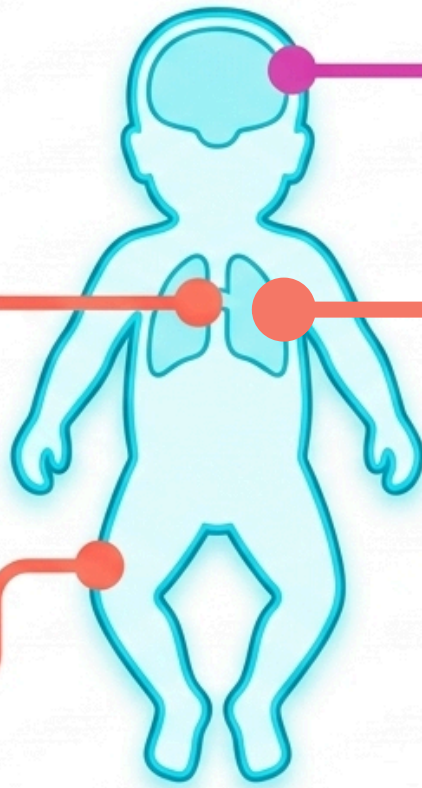
Lack of mechanical stimulation
(sedation/paralysis). Chronic use
of mineral-excreting drugs
(diuretics, steroids).

The Silent Progression: Clinical Timeline

≤ 6 Weeks

Usually asymptomatic.
Normal on clinical
examination.

6 - 12 Weeks



Systemic: Poor weight gain /
faltering growth.

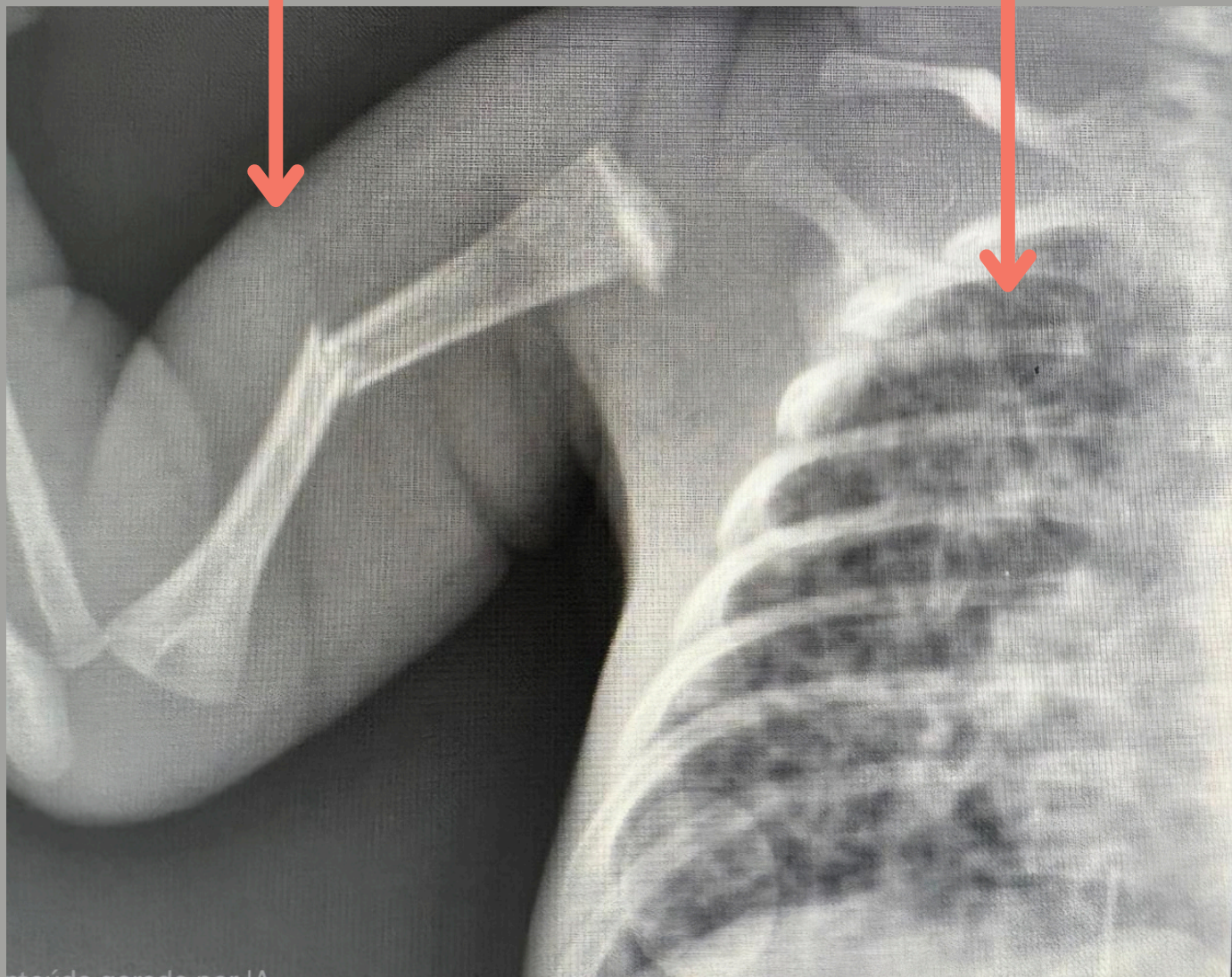
Respiratory: Difficulties or failure
to extubate due to increased
chest wall compliance.

Skeletal: Fractures with minor or
no trauma; manifests as pain on
handling.

Later Consequences

Marked dolicocephaly
(long, narrow skull).

Reduced overall linear
growth.



Diagnostic Biomarkers & Radiology

The Primary Screen

< 1.8

Serum PO₄
mmol/L

> 900

ALP
IU/L

100% sensitive, 70% specific
for low bone mineral density.

Note: Low PO₄ alone is 96%
specific but only 50% sensitive.

The Calcium Trap



Serum Calcium levels
may remain strictly
normal until late in the
disease process
despite severe bone
losses.

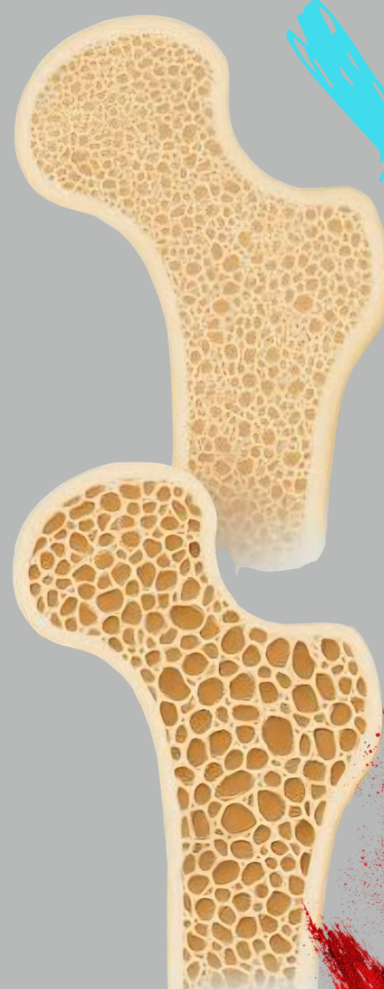
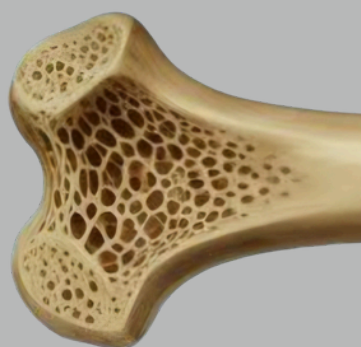
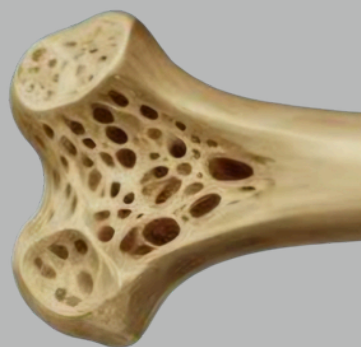
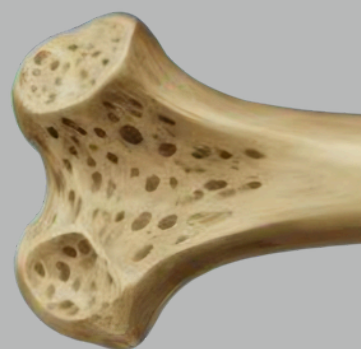
Advanced Diagnostics



Urine: %TRP (Tubular
Reabsorption of
Phosphate) > 95%
indicates inadequate
intake.



Radiology: X-rays show
low bone density
(cortical thinning) or
fractures. DEXA
ultrasound can assess
density.



The Three Pillars of Prevention

Early Nutrition



Initiate early Parenteral Nutrition (PN) with optimized Ca and PO₄ content. Transition rapidly to early enteral feeds.

Enteral Fortification



Utilize fortified Expressed Breast Milk (EBM) or preterm formula to ensure high mineral mineral bioavailability. Guarantee daily intake of $\geq 400 - 700$ units/kg/day of Vitamin D.

Active Bone Loading



Ensure appropriate handling and positioning by using deep boundaries. This promotes active mechanical bone loading to stimulate mineralization.

The Enteral Nutritional Target Dashboard

Calcium Target

3.0 - 5.0
mmol/kg/day

Strict Target Ratio

1.3:1 to 1.4:1

(Ca:PO₄ mmol-to-mmol basis) to avoid secondary hyperparathyroidism.



Phosphate Target

2.2 - 3.7
mmol/kg/day

Achieving these targets requires ≥ 140 mL/kg/day of fortified EBM or preterm formula.

The Week 3 Screening Trigger

Who to Screen

ALL high-risk babies who have tolerated ≥ 1 week of full enteral feeds (≥ 140 mL/kg/day of fortified EBM or preterm formula).

When to Screen

Measure serum Ca, PO₄, and ALP starting in the third week of life.

The Treatment Trigger (Condition to Act)

ALP > 800 IU/L (or > 600 IU/L and increasing)

AND

Serum PO₄ < 1.8 mmol/L

Immediate Action

Check if adequate Ca/PO₄ requirements are met with feeds/PN.
Check PTH and Vitamin D with the next blood draw.

The PTH Diagnostic Matrix

Raised PTH

Etiology: Likely Calcium / Vitamin D deficiency.



STOP PO₄ supplements.



START Ca supplements at 1 mmol/kg/day (divided doses).



If Vit D < 50 nmol/L, **ADD** 600 units/day of colecalciferol for a minimum of 4 weeks.

Normal or Low PTH

Etiology: Likely Phosphate deficiency.



START PO₄ supplements at 1 mmol/kg/day (divided doses).



START Ca supplements at 1.2 mmol/kg/day (divided doses).

Crucial Administration Warnings (The Do Nots)



Precipitation Risk

Do NOT give Calcium and Phosphate at the same time. They will physically precipitate.



Absorption Interference

Do NOT give Calcium or Phosphate supplements with milk feeds or iron supplements.



Intestinal Hazards

Calcium supplementation carries a risk of causing intestinal obstruction and hypercalcinosis.



Renal Monitoring

Regular monitoring of the urinary Ca / urinary creatinine ratio is mandatory. A ratio > 0.6 detects hypercalciuria.

Ongoing Monitoring and Resolution

ADJUST

- **Vitamin D:** Stop additional supplementation when Vit D and PTH levels normalize.
- **Calcium:** Adjust dose based on serum Ca; STOP only when PTH normalizes.
- **Phosphate:** Adjust based on serum PO₄ and ALP (adjusting Ca to maintain ratios).

MONITOR

- 🕒 If ALP > 1000 IU/L: Repeat in 1 week.
- If ALP 600 - 1000 IU/L: Repeat in 2 weeks.
- If ALP < 600 IU/L: Repeat every 2 weeks until term.

CONCLUDE

- ✓ Continue treatment until biochemical indices are normal AND radiographic evidence of healing is visible.



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Neonatal Prescription



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