MedNut Mail

The How, When, Where, Which and Why of pharmacotnutrition

Bone health and pharmaconutrition

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https://medicationsandnutrition.online

Commentary

Bone health is so important and so overlooked and is usually only considered once there is a problem.

Bone is constantly being remodelled and is fully replaced approximately every 10 years; remodelling enables growth in childhood and repair in adults. Loss of co-ordination between bone formation and bone degradation results in skeletal impairment.

Bone has several primary functions –

- to maintain body structure – which enables movement on dry land (rigid skeletons are technically not necessary in buoyant mediums such as water);
- to protect internal organs and central nervous system from injury;
- as a storage site for protein, minerals and energy (predominantly as lipids);
- as a site for haemotopoiesis production;
- endocrinal – regulates distant functions through secretion of hormones and other substances; osteoporosis is now considered a consequence of metabolic dysfunction.

There are 4 main types of bone cells –

- Lining cells – couple bone resorption to bone formation, initiate remodelling (site renewal) projects;
- Osteoblasts – build bone;
- Osteoclasts – break down bone;
- Osteocytes – monitor the amount of strain on their section of the skeleton and advise the lining cells; strain determines where remodelling occurs whilst parathyroid hormone determines the amount of remodelling.

Nutrients with U-curved impacts in bone health ie positive and negative, include –

Niacin (B3) – is important as an antioxidant, in decreasing inflammatory response, and speculatively in bone mineral density; a curiously conducted medical study found that intakes less than 21.8 mg/day and greater than 41 mg/day were associated with increased risk of hip fracture (Recommended intake is 14 mg/day for men and 11 mg/day for women).

Pantothenate (B5) – has a dual effect on bone status with low intakes increasing

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osteoclastogenesis and high intakes inhibiting osteoclastogenesis; dietary intake levels confer protection against oestrogen deficiency-induced bone loss.

Pyridoxine (B6) – high intake of both B6 and B12, and B6 alone, is associated with increased risk of hip fracture; low B6 may reduce collagen cross-linking strength.

Vitamin A – is important in bone mineral density; high intake can reduce vitamin D availability by about 30%, excessive intake suppresses osteoblast activity and stimulates osteoclast formation ie increases bone resorption and decreases bone formation.

Copper –is important in viability and growth of osteoblasts and inhibiting osteoclast resorption, and is also important in collagen cross-linking which influences bone strength. Low copper status is associated with low bone mass density and reduces mechanical bone strength, whilst high copper levels are associated with increased fracture rate especially in men, and excessive intake is cytotoxic.

Iron – is important in bone homeostasis and remodelling; both inadequate and excessive intakes associated with impaired bone structural integrity.

Nutrients with positive impacts in bone health include –

Cobalamin (B12) – is important in osteoblast activity, and bone strength.

Folate (B9) – is important in osteoclast activity, and in bone mineral density.

Vitamin C – is important in collagen formation, osteoblast synthesis, osteoclast suppression, reducing oxidative stress, regenerating vitamin E; increased intake is associated with increased bone density.

Vitamin D – is important in bone mineralization, regulating calcium absorption, regulating bone and renal resorption, parathyroid synthesis, bone strength.

Vitamin K – is important in skeletal strength, enhancing osteoblastogenesis and consequent collagen accumulation.

Calcium – is important in skeletal development and growth, and bone mineralization.

Magnesium – is important in cellular energy generation, bone formation and mineralization, calcium homeostasis, inflammatory response and endothelial function with resultant decreased osteoclastic and osteoblastic activity, osteopenia and skeletal fragility.

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Manganese - is a cofactor for many enzymes involved in bone metabolism.

Phosphorus – is important in skeletal strength.

Selenium – positive correlation between selenium status and bone health and bone density and an inverse correlation with bone turnover and hip fracture rate, however there is also evidence of no benefit.

Zinc – is important as a cofactor for many metalloproteins involved in bone development.

Carnitine – is important in intracellular calcium signalling, in stimulating human osteoblast functions, activity, differentiation and proliferation, in increasing expression of collagen type 1, bone sialoproteins, osteocalcin and osteopontin, as an antioxidant and protects against oxidative stress, modulates mitochondrial activity in osteoblasts, and by likely supporting fulfillment of the high metabolic demand of osteoblasts during bone formation.

Choline – is important in bone density, and as acetylcholine is important in bone development and homeostasis.

Nutrients with negative impacts in bone health include –

Sodium – excessive intake competes with calcium for reabsorption in the renal tubules ie excessive sodium intake increases calcium loss.

Homocysteine – elevated levels associated with impaired collagen crosslinking and thus compromised bone strength, also negatively impacts osteoblast and osteoclast activities, and decreased bone mineral density.

What actions will you initiate when you see someone whose diagnoses include fracture and/or osteoporosis and/or other bone impairment, will you -

- review their prescribed medications for those that may impact nutritional factors associated with bone health impairment?
- include pharmaconutrition impacts on bone health in your clinical reports?

Conclusions

The evidence is increasing that compromised nutrition factors contribute to the risk of bone health impairment throughout life. By default, prescribed medications that impact nutritional factors associated with bone health impairment are likely to further exacerbate that impairment. Perhaps pharmaconutrition interventions and their impacts on bone health should become an integral component in our daily clinical assessments and reports.

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Case study

Medical History with Nutritional Aspect

Amputation	☐	Constipation	☐	Dysphagia	☐	MND	☐
Anaemia	☐	CVA	☐	Enteral Feed	☐	MS	☐
Arthritis	☑	CVD	☐	Falls	☑	Osteoporosis	☐
Cancer	☐	Dementia	☑	Fracture	☐	PD	☐
CCF	☐	Dentures	☐	Frailty	☐	Pressure Area	☐
Chest Infection	☐	Depression	☐	Gout	☐	Renal	☑
COAD	☐	DM Type 1	☑	Hypertension	☑	Ulcer	☐
Confusion	☐	DM Type 2	☐	Incontinent	☐	UTI	☐

Food Allergies:

Other: CKD, pain, hypercholesterolaemia

Biochemistry with Pharmaconutritional Consequences

Na:	140	mmol/l	Hb:	120	g/L	Albumin:		g/L	BSL:		mmol/l
K:	5.2	mmol/l	Lymph:	2.4		Total Protein:		g/L	HbA1C:	5.8	
Urea:	10.5	mmol/l	MCV:	89	mmol/l	B12:		pmol/L	INR:		
Creatinine:	0.101	mmol/l	Zn:		umol/l	Folate:		nmol/L	TSH:		mIU/L

Other: eGFR 45

Medications That May Adversely Affect Nutritional Status

Drug	Vits + Mins	bpp >90%	N/V	C/D	Wt	App	Tst	Thir	Sal	Drlg	d m	Dys	BSL
Aspirin	C, Fe	☑	NV				☐				☐	☐	☑
CALCIA D	(1/day)	☐					☐				☐	☐	☐
Mirtazapine		☐	N	D	↑	↑	☐				☑	☐	☐
Oxazepam		☑	N				☐		↕		☐	☐	☐
PANAMAX		☐	NV	CD			☐				☐	☐	☐
Risperidone		☑	NV	C	↑		☐		↑		☐	☐	☐
SOMAC	(40 mg/day) B1, B12, Ca, Fe,	☑	NV	CD		↓	☑				☑	☐	☐
		▩					▩				▩	▩	▩

Extra drug: norspan

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Comments – medication and nutrition impacts (direct and indirect) only

Advisable to check plasma proteins (albumin, total proteins) as they are the primary transporters for four of the prescribed drugs and hypoproteinaemia may alter their effects.

BSLs (Mar-Apr)

- before breakfast - 5.4-7.8; recommended range 4-6;
- reportable limits: < 4 and > 18;
- last HbA1c indicates very good glycaemic control.

Two prescribed medications, being aspirin and risperidone, may alter glycaemic status.

Nausea is a side effect of 6 of the prescribed medications – aspirin, mirtazapine, oxazepam, paracetamol, risperidone and pantoprazole.

Vomiting is a side effect of 4 of the prescribed medications – aspirin, paracetamol, risperidone and pantoprazole.

Anaemia is a side effect of 4 of the prescribed medications – aspirin, mirtazapine, paracetamol and pantoprazole.

Altered iron status is a side effect of 3 of the prescribed medications – aspirin, paracetamol and pantoprazole.

Vitamin C (960 mg/day) attenuates aspirin-induced gastric injury.

Regular monitoring sodium levels recommended whilst mirtazepine prescribed.

Concurrent ingestion of panamax and iron resulted increased rate of iron absorption and decreased extent of drug absorption; the authors advise drug and iron to be administered at different times from each other.

Dietary levels of caffeine intake in conjunction with paracetamol inhibit antinocieception.

Somac decreases B12, vitamin C, magnesium, zinc and iron levels, may decrease calcium status, and decreases thiamine availability.

A vitamin D intervention providing 1,000 IU (25 mcg)/day, has been prescribed for at least 2 years and likely longer. Advisable to clarify vitamin D levels and if still low then review current vitamin D management strategy.

Bowels

- no regular intervention prescribed,
- oral PRN aperient prescribed; administered 1 x Apr, 2 x Mar, 5 x Feb, 1 x Jan;
- Nurse Initiated oral aperient administered 1 x Jan.

Staff advise Mrs ABW mostly eats her breakfast, has a variable, mostly minimal intake at midday and evening meals, and that she has a variable intake of dessert.

Mrs ABW is a small, rubinesque Italian lady with a lovely smile and who seems to walk a lot.

Mrs ABW's diagnoses include chronic pain - nutritional factors that may be useful to consider in pain management include -

- vitamin D - current intervention may not be adequate to attain acceptable range. Evidence indicates brittle pain

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control whilst vitamin D levels are low. Advisable to check vitamin D levels and if still low then review current vitamin D management strategy.

- vitamin C - pain increases the reactive substances (formerly Reactive Oxygen Species) within cells. Vitamin C is important in quenching reactive substances and if there is insufficient vitamin C then cell status becomes compromised and the cells typically die which also causes pain. The optimal intervention is 500 mg vitamin C/dose (if more than 500 mg vitamin C administered at a time then the excess above 500 mg is not absorbed as the vitamin C transporters are overloaded). Vitamin C is not considered part of the pain management armament however it won't cause harm and evidence suggests it may confer benefit. Currently prescribed Somac which decreases conversion of vitamin C to its active form.

- low B12 exacerbates elevated TNF- α which is an inflammatory response marker; elevation of the inflammatory response can include a pain response. Currently prescribed Somac therefore advisable to check B12 status.

- magnesium – proposed mechanism magnesium blocks the NMDA receptor channels in the spinal cord and thus limits the influx of calcium ie reduces the risk of excitotoxicity and consequent exacerbation of pain. Currently prescribed Somac which decreases magnesium absorption therefore advisable to clarify status.

Nutritional factors that may be contributing to falls include -

- low calcium - more likely to be low if potassium or magnesium low; currently prescribed Somac therefore may be advisable to clarify status;

- low vitamin D - current intervention may not be adequate to attain acceptable range therefore advisable to clarify status;

- low B12 - is important in the righting reflex when a person stumbles; currently prescribed Somac therefore advisable to check status;

- low iron – currently prescribed Somac therefore advisable to check status;

- low zinc - more likely to be low if loss of weight or prescribed a proton pump inhibitor; advisable to check status as Somac prescribed;

- low magnesium - magnesium is important in muscle function, especially cardiac muscle, amongst other functions. Currently prescribed Somac which significantly decreases magnesium absorption therefore advisable to clarify magnesium status.

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Summary of organs and some transporters, relevant prescribed medications, and impacted nutrients

Organ (transporter)	Thiamine	Choline	Carnitine
Liver (OCT1 inhibitor)	pantoprazole risperidone	pantoprazole risperidone	pantoprazole
Kidneys (OCT2 inhibitor)	mirtazepine oxazepam pantoprazole risperidone	mirtazepine oxazepam pantoprazole risperidone	
Skeletal muscle (OCT3 inhibitor)	pantoprazole	pantoprazole	Pantoprazole

Organ uptake of 3 key nutrients is inhibited by 4 of the prescribed medications therefore it remains in the blood.

It is likely blood test results will reveal high-normal or elevated nutrient levels; duration of inhibition is currently unknown therefore fasting results are likely to be more reliable. Except for pyridoxine (B6) we don't know how elevated blood nutrients are expressed in the body so we don't know what factors to monitor.

What else would you include?

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Medications have profoundly and positively changed health outcomes however they do generally come with some nutritional harms. By identifying and addressing the nutritional harms, optimal health outcomes are closer to being achieved.

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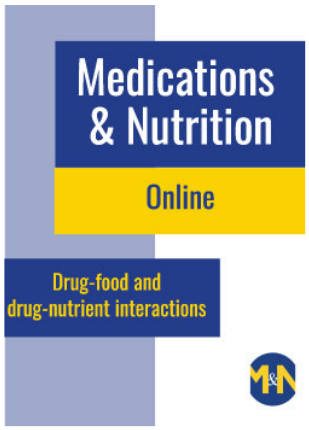

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