PAEDIATRIC RENAL NUTRITION TASKFORCE

The dietary management of Calcium and Phosphate in children with CKD stages 2-5 and on dialysis

A practical guide

Contents

Foreword

The Pediatric Renal Nutrition Taskforce (PRNT) is an international team of pediatric renal dietitians and pediatric nephrologists, who develop clinical practice recommendations (CPRs) for the nutritional management of various aspects of kidney diseases in children.

In 2020, the taskforce published clinical practice recommendations regarding the dietary management of calcium (Ca) and phosphate (P) in children with CKD stages 2-5 and on dialysis, describing the common Ca and P containing foods, the assessment of dietary Ca and P intake, the nutritional requirements for Ca and P and necessary modifications for children with CKD 2-5D.

This booklet aims to provide a practical guide on how to implement these recommendations in every day clinical practice and should be read in conjunction with the published paper (1).

The CPR was reviewed in September 2024 in view of new recommendations for Ca and P intakes from the Nordic Nutrition Recommendations (2023). There are no, or only small, changes in these new recommendations. Consequently, there is no need to change the 2019 suggested dietary intakes (SDIs) for Ca and P.

Recent publications highlight additional factors for the management of Ca and P. Nutritional adequacy and acid-base balance should be considered when providing dietary advice (2). The Ca content of processed foods can vary widely based on production methods and brand, often making nutrient composition tables inaccurate. The quality of diet may also be influenced by socioeconomic status (3). Metabolic acidosis can cause bone demineralization, leading to osteomalacia and rickets (4). Therefore, a plant-based diet with reduced acidic foods may be advised based on appetite, weight gain and growth.

1. McAlister, L. , Pugh, P., Greenbaum, L. et al. The dietary management of calcium and phosphate in children with CKD stages 2-5 and on dialysis–clinical practice recommendation from the Pediatric Renal Nutrition Taskforce. Pediatric Nephrology, 2020. 35: 501–518. doi.org/10.1007/s00467-019-04370-z

2. Sravani M, Collins S, Iyengar A. Assessment of Dietary Acid Load in Children with Chronic Kidney Disease: An Observational Study. Indian J Nephrol, 2024. 34:50-5. doi.org/ 10.4103/ijn.ijn_29_23

3. Rahman RK, Mattilda A, Iyengar A. Assessment of dietary phosphorus intake and implementation of parental phosphate education in pediatric chronic kidney disease. Indian J Nephrol, 2023. 33:188-94. doi.org/10.4103/ijn.ijn_149_21

4. Bakkaloglu SA, Bacchetta J, Lalayiannis A D et al. Bone evaluation in paediatric chronic kidney disease: clinical practice points from the European Society for Paediatric Nephrology CKD-MBD and Dialysis working groups and CKD-MBD working group of the ERA-EDTA. Nephrology Dialysis Transplantation, 2021. 36:413–425. doi.org/10.1093/ndt/gfaa210

https://www.espn-online.org/nutrition-taskforce/

Clinical questions

Question 1

How are Ca and P intakes assessed?

Methods of assessment

Question 2

What are the requirements for Ca and P?

Considerations

Question 3

How are Ca and P intakes managed?

Fluids

Food

Question 4

When is it necessary to adjust Ca and P intakes?

Monitoring

Question 5

How to manage P-binders?

Tips to optimise efficacy

Flow chart
summarising dietary management

Step 1: Dietary assessment

Estimation of dietary Ca and P intake

Simple

- A diet history of a typical 24-hour period
- Identify the main dietary sources of Ca and P
- Recognise processed foods containing P additives

Detailed

- A 3-day prospective diet diary / food intake record
- Estimate intake of Ca and P if required by reference to food composition tables

An estimate of total Ca and P intakes should consider contributions from diet, infant and enteral formulas, nutritional supplements, dialysate and medications, including P-binders

Step 2: Ca and P requirements

Compare intake to Suggested Dietary Intake (SDI) for age or height age (where height is <3rd centile)

Routine management

- Ca intake within and up to 2 x upper SDI value
- P intake within SDI
- Limit P additives

Infants Mineral depleted bones

- May require >2 x upper SDI value for Ca
- P intake within SDI
- Limit P additives

SDI for age

Age (years)	SDI Ca (mg)	SDI P (mg)
0 - <4 months	220	120
4 - <12 months	330-540	275 - 420
1 - 3 years	450 - 700	250 - 500
4 - 10 years	700 - 1000	440 - 800
11 - 17 years	900 - 1300	640 - 1250

Flow chart
continued

Step 3: Management

Infant

- Breast feeding /Expressed breast milk (EBM) is preferred
- Whey-dominant infant formula

Child

- Limit high P fluids e.g. cow's milk
- If tube fed, use a standard pediatric formula
- If P intake needs to be reduced, consider combining pediatric formula with whey-dominant infant formula or reduced P renal-specific formula

Limit dietary P

- Maintain P within SDI
- During weaning, gradually replace breast milk/ formula with a mixed diet
- Educate on dietary P sources and bioavailability, favoring non-processed foods
- Limit P additives

Maintain adequate Ca intake

- Assess intake of Ca from all sources (diet, breast milk, formula, medication)
- Increase to within the SDI (if required)

Step 4: Monitor and review

Hyperphosphatemia or high PTH	Persistent hypophosphatemia	Persistent hypocalcemia and high PTH	Hypercalcemia
Limit P intake within the SDI	Increase P intake >2 x SDI may be needed	Increase Ca intake >2 x SDI for a short period	Mild / moderate or severe / acute

See page 15 for further details

Discussion between doctor and dietitian to manipulate Ca and P sources (diet and supplements) and vitamin D

Step 5: Advice on the use of P-binder medication (if required)

Support management of P-binder medication to optimise efficacy and avoid excessive Ca intake

Step 1: Dietary assessment

A retrospective diet recall of a typical 24-hour period will rapidly identify the main dietary sources of Ca and P

A 3-day prospective diet diary/food intake record may be used when more detailed information is required

All sources of Ca and P should be considered: diet, infant and enteral formulas, nutritional supplements, dialysate and medications, including P-binders

True dietary intake of Ca and P may be underestimated as food composition tables do not account for Ca and P additives

Guide to the Ca content of foods

Food	Portion size	Ca mg per portion
Milk and dairy products		
Human breast milk (mature)	100ml	34
Whey-dominant infant formula	100ml	55
Standard pediatric enteral formula	100ml	60
Cow's milk	100ml	120
Custard or rice pudding	120g	140
Hard cheese	30g	240
Soft cheese (e.g. brie, mozzarella)	30g	120
Yogurt	80g (small pot)	90
Dairy free yogurt*	125g	130
Egg		
Egg, cooked	50g (1 egg)	28
Soya products		
Calcium-set tofu**	50g (2 tablespoons)	60
Cereal (grain) and cereal products		
Bread - white fortified / wholemeal	33g slice	58/35
Fortified breakfast cereals	30g portion	80-146

*Check individual products for degree of fortification
**Variable Ca content depending on production methods

Food	Portion size	Ca mg per portion
Fruits and vegetables		
Broccoli	3 florets	35
Curly kale	100g	150
Okra	8	90
Chickpeas / red kidney beans	3 tablespoons	45/40
Hummus	100g (½ tub)	45
Baked beans	150g small tin	80
Apricots	4	45
Currants	2 tablespoons	50
Figs, dried / ready to eat	5	230
Orange	1	75
Calcium fortified orange juice	100ml	120
Fish		
Sardines, canned in oil	40g (½ can)	200
Salmon, canned in brine	100g (½ can)	110
Nuts and seeds		
Almonds / brazil nuts / walnuts / hazelnuts	6-20	30-60
Sesame seeds	1 tablespoon	65
Peanut butter	2 tablespoons	20

Please refer to country specific food composition tables where possible. Only foods with an appreciable Ca content are listed.

Compositional data sourced and adapted from Public Health England: McCance and Widdowson's The Composition of Foods Integrated Dataset 2019.

Use the table below to document common food sources of calcium in your country

Food	Portion size	Ca mg per portion

Guide to the Ca content of Ca-based P-binders

Ca-based:

	% Ca
Calcium carbonate ($CaCO_3$) Commonly available as 250mg, 500mg, 1.25g, 2.5g tablets	40
Calcium acetate Commonly available as 475mg or 950mg tablets	25
Mg and Ca carbonate combination tablets Variable tablet strength	Variable

For example:

1.25g $CaCO_3$ x 1 tds of elemental provides 1500mg of elemental Ca

Non-Ca based:

Sevelamer hydrochloride (800mg tablet) **Sevelamer carbonate** (800mg tablet or 2400mg sachet)	0

Other Ca-free P-binders that are available, but not recommended for use in children, include lanthanum carbonate and aluminium hydroxide.

Newer medications, such as iron-based P-binders, are being evaluated in research studies.

Food	Portion size	P mg per portion (40-60% BA)
Human breast milk	100ml	15
Whey-dominant infant formula	100ml	32
Cow's milk	100ml	100
Yogurt	125ml	100-200
Fromage frais	60g	70
Ice cream	100g (2 scoops)	100
Cheese, hard (cheddar, edam, gouda, emmental)	1 thin slice (25g)	120-160
Cheese, soft (camembert, mozzarella)	30g	80
Processed cheese	25g	250
Cottage cheese	1 tablespoon (40g)	50-70
Egg (whole)	50g (1 egg)	100
Egg white	30g (from 1 egg)	4
Soya milk (not Ca-enriched)	100ml	10-50 / 50-100
Tofu (depending on production and cooking method)	2 tablespoons (50g)	50-135
Lamb, pork, beef, fish, chicken (fresh, raw)*	100	130-220
Beef burger / sausage / chicken nuggets	1 / 1 / 6	100
Processed cold meat (ham, chicken roll)	1 slice (25g)	80
Fish fillet (small) / fish fingers / prawns	50g / 2 / 10	100
Salmon	½ salmon steak	100
Scampi	3 pieces	100
Baked beans	2 tablespoons (80g)	70
Nuts	1 small bag (25g)	120
Pulses	2 tablespoons (80g)	60
Bread – white / wholemeal	1 slice (30g)	30 / 60
Bran type breakfast cereals	1 small bowl (30g)	100-200
Wheat based breakfast cereals (wheat biscuits / cookies)	1 biscuit / cookie (20g)	50
Milk chocolate	1 bar (50g)	110
Chocolate covered biscuit / cookie	1 biscuit / cookie	20-40
Cola-based drinks	1 can (330ml)	100

Please refer to country specific food composition tables where possible.

Table adapted from McAlister, L. et al. (2020).
Compositional data sourced and adapted from Public Health England: McCance and Widdowson's The Composition of Foods Integrated Dataset 2019.

KEY:

no P-additives

may contain / likely to contain P-additives

contains P-additives

*may contain enhancers which include P

P-additives 90-100% BA

Use the table below to document common food sources of phosphate in your country

Food	Portion size	P mg per portion (40-60% BA)	P additives (90-100% BA)

- Use country specific tables for Ca and P content of foods where possible. White bread and flour in the UK is fortified with Ca; values in the tables account for this added Ca content.
- Whole, semi-skimmed and skimmed milks have the same Ca and P content.
- Plant milks (including organic milk alternatives) and non-milk based puddings (e.g. soya yogurts) may be fortified with $CaPO_4$.
- P additives may be used in manufactured foods to act as a raising agent, extend shelf life, maintain color and moisture or enhance the flavor. Their use can increase P content by more than 50%.
- A diet using mainly fresh home-cooked foods (non-processed) will contain a higher proportion of natural P which has a lower bioavailability, potentially reducing the dietary P load.
- Ultra-processed foods may contribute to an inflammatory state and chronic disease.
- Reduce the portion size of foods naturally high in P such as milk, cheese, yogurt, meat and fish.
- Replace some of the naturally occurring animal-based P foods with plant-based foods such as beans, lentils, tofu and nuts. The P in these foods has a lower bioavailability.
- Remember: manufacturers are not currently required by law to include P content in the nutritional information on packaging.
- Look for "phos" in the ingredients list of processed foods. This indicates the presence of P additives. The table below shows the names of EU approved additives and their E numbers which may be found on an ingredient label.

E 338	Phosphoric acid	E 452	Polyphosphates
E 339	Sodium phosphates	E 541	Sodium aluminium phosphates
E 340	Potassium phosphates	E1410	Monostarch phosphate*
E 341	Calcium phosphates	E1412	Distarch phosphate*
E 343	Magnesium phosphates	E1413	Phosphated distarch phosphate*
E 450	Diphosphates	E1414	Aceylated distarch phosphate*
E 451	Triphosphates	E1442	Hydroxyl propyl distarch phosphate*

*these modified starches contribute very little P to the diet

- Foods which may contain P additives; their presence may be brand-related:

Fresh meat and poultry	Fresh, raw meat and poultry could contain enhancers which include P additives
Processed meat and poultry	Processed meat and poultry, sausages, burgers, breaded products (such as chicken nuggets)
Fish	Frozen processed and unprocessed fish and breaded fish products (such as fish fingers)
Baked items	Cakes, biscuits, flour tortillas, crumpets, naan bread
Dairy	Dried milk products, milk desserts and yogurts, evaporated milk, cream, ice cream, sterilised and ultra-high temperature (UHT) milk, processed cheese (especially sliced or spreadable products)
Potato products	Frozen, chilled and dried products such as chips and waffles
Powdered food items	Sauces, instant dessert mixes (e.g. pancake mixes), instant pasta dishes, instant noodles
Drinks	Dark-colored fizzy drinks, chocolate and malt-based drinks

Step 2: Ca and P requirements

Use the Suggested Dietary Intake (SDI) for formulating dietary prescriptions and assessing the adequacy of dietary intake in individuals

SDI for age

Age (years)	SDI Ca (mg)	SDI P (mg)
0 - <4 months	220	120
4 - <12 months	330-540	275 - 420
1 - 3 years	450 - 700	250 - 500
4 - 10 years	700 - 1000	440 - 800
11 - 17 years	900 - 1300	640 - 1250

For children with poor growth (<3rd centile / <-2 SD), reference to the SDI for height age (the age that corresponds to their height when plotted at the 50th centile on a growth chart) may be appropriate

Aims for Ca and P intake in CKD

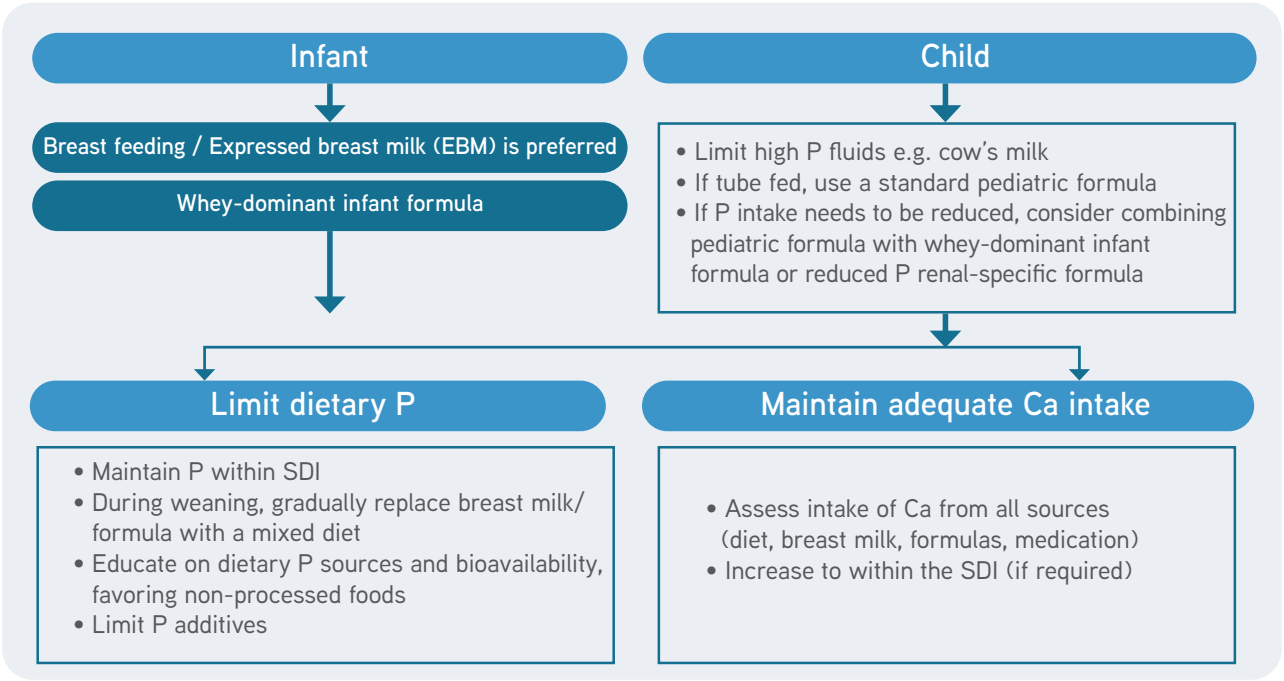
Routine management

- Ca intake within and up to 2 x upper SDI
- Maintain P intake within SDI
- Limit P additives

Infants Mineral depleted bones

- May require >2 x upper SDI value for Ca
- P intake within SDI
- Limit P additives

Step 3: Management



Practical points (dos and don'ts)

Drinks/fluids

- As breast milk and whey-dominant infant formula are low in P they are both suitable for infants with CKD.
- Renal-specific infant formulas (required for some infants to reduce potassium intake) may have a lower content of Ca and P. This may adversely reduce a child's mineral intake (particularly Ca). Using a standard whey-dominant formula alongside a renal-specific formula can improve Ca intake (e.g. mixing ½ standard formula and ½ renal-specific formula).
- Limit high P fluids for children e.g. cow's milk and cola-based drinks.
- Add an equal part of water to full-fat cow's milk to create a larger volume of milk to drink or use on breakfast cereals. Continuing to use a whey-dominant infant formula throughout the first and second years of life can be suggested if milk intake is high.
- Unfortified plant milks are an alternative to cow's milk, however, their use may reduce energy, protein and calcium intake.
- Suitable drinks include water, fruit juice, fruit squash or occasional light-colored fizzy drinks.
- If tube fed, consider using a whey-dominant infant formula (whilst ensuring adequate energy and protein intakes) for younger children. For older children use a standard pediatric formula (carefully monitoring biochemistry). A P-binder may need to be given with feeds.

Food

- Weaning solids should be low in P e.g. fruit, vegetables (including potatoes) and cereal products (e.g. baby rice, oats, wheat cereal - check there is no added milk powder in the ingredient list).
- When an infant is taking solids regularly, a higher P food can be gradually introduced, monitoring serum P, e.g. allowing a small yogurt. Choose natural P sources rather than those with P additives.
- Suggest use of small amounts of strong cheese (e.g. mature cheddar) or lower P cheeses such as full-fat cream cheese, cottage cheese or mozzarella. Check processed cheese for P additives.
- Use tomato-based sauces, rather than cheese or white sauce.
- Egg yolk is naturally rich in P (compared to egg white). A simple way to reduce P intake is to replace some of the egg yolk in dishes with egg white e.g. for scrambled eggs, instead of using 2 whole eggs use 1 whole egg and 1 egg white.
- Choose jelly and fruit for desserts, rather than milk-based products such as custard and yogurt.
- Replace chocolate spread and chocolate with jam, honey, marmalade or syrup, jelly sweets, boiled sweet, gums, mints, marshmallows.
- Reduce intake of chocolate biscuits, chocolate cake, crumpets or pikelets as they may contain P additives. Suggest choosing plain biscuits, shortbread, jam tarts, doughnuts instead.
- Educate on P bioavailability. Limit foods containing P additives (up to 100% bioavailabilty compared to 40-60% bioavailability of the natural P found in fresh ingredients). For example, use cold home cooked roast meat instead of packaged products; drink water, lemonade or squash instead of a cola-based drinks; choose fresh fish instead of fish fingers.
- Check any manufactured foods for P additives. Remember manufacturers are not required in all countries to list P on the ingredients/nutrient list. Recommend choosing fresh, unprocessed foods as much as possible.
- Although some snack products like breadsticks, corn snacks, crisps, popcorn and prawn crackers are low in natural P, they may contain P additives.
- The bioavailability of organic P and Ca from cereal products, nuts, seeds and pulses may be low, due to the presence of phytate.
- A 'healthy eating' dietary pattern should be encouraged, taking into consideration any necessary restriction of high P foods and drinks.
- First target processed foods with P additives. A reduction in dairy foods is the next step to further reduce dietary P. Other high protein foods, such as fresh meat and fish without P additives, do not usually need to be restricted unless their intake is excessive.

P swapping list

To achieve a reduction in dietary P, some families find a list of dairy-based foods containing similar quantities of P useful. A daily allowance of these foods that can be swapped for each other makes the diet more flexible and can improve compliance.

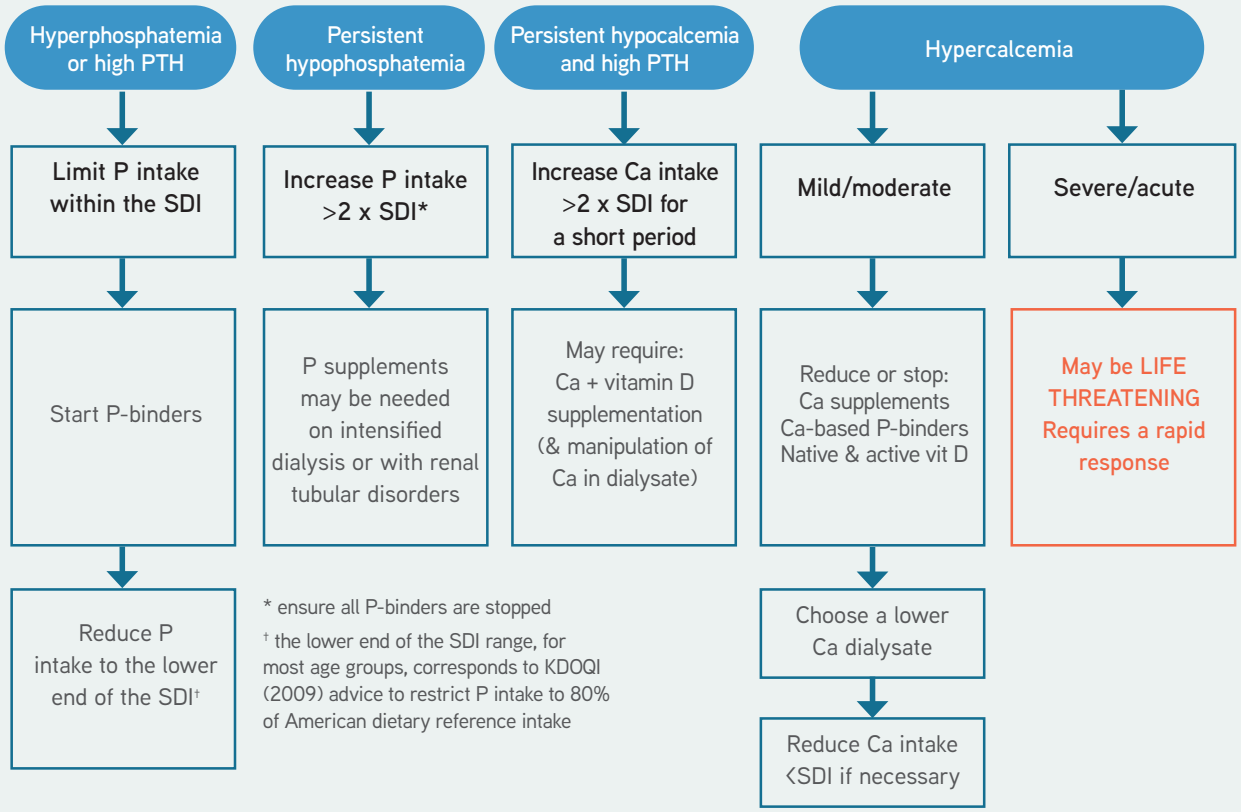
The following contain approximately 100mg P:

- 100ml milk
- 1 pot fruit yogurt (120g) or soya yogurt (120g)
- ½ pot natural yogurt (60g)
- 1 pot fromage frais (85g)
- 150g crème fraiche
- 1 pot custard or rice pudding (125g)
- 2 scoops ice cream (120g)
- 1 small chocolate covered biscuit bar (50g)
- 1 thin slice or 1 heaped tablespoon cheddar cheese (20g)
- 1 small portion camembert or brie (30g)
- ½ mini pizza (50g)
- 1 egg

Step 4: Monitor and review

Doctor and dietitian to assess together

Frequency of review depends on: trends in serum Ca and P, stage of CKD and any changes in diet, dialysis and medications



Practical points (dos and don'ts)

Hypercalcemia

- Identify key sources of Ca in the diet (refer to table on page 7).
- Reduce dairy portion sizes.
- Find replacements for milk (including non-calcium fortified plant milks) if required.
- A specialized low Ca formula can be used for infant feeding or as a tube feed in children. It can also be used as a drink to improve nutritional intake. When prepared using deionised/distilled water, the Ca content of the reconstituted formula is further reduced.
- Some renal specific formulas and juice-based oral nutritional supplements are low in Ca. Use with due attention to overall mineral balance and nutritional adequacy.
- Reduce intake of other high Ca foods (e.g. fish, beans, nuts, Ca–fortified foods and drinks).
- Reduce or stop Ca supplements, Ca-based P-binders and native & active vitamin D.

Step 5: Advice on use of P-binder medication (if required)

Supporting management of P-binder medication to optimise efficacy and avoid excessive Ca consumption

Practical points (dos and don'ts)

- P-binder dosing should be tailored to the amount of P in the diet from both food and formulas. Remember to dose for P-containing snacks.
- Some foods such as vegetables, fruit and cereals products (such as rice, bread, crisps, cakes and biscuits) may be low in P so, if not eaten with a high P food, may not need to be taken with a P-binder. However, food labels should be checked for possible inclusion of P additives.
- Products for nasogastric or gastrostomy feeding also require an appropriate dose of P-binders. The P-binders can either be given mixed into the formula, or at the beginning, during and end of the feed period.
- Some P-binders may cause formula ingredients to settle out. In this case they need to be given separately, mixed with water, and administered at the beginning or end of the feed period.

Calcium carbonate

High Ca load; usually well tolerated with few gastrointestinal side effects; requires an acidic pH in the stomach to dissociate into Ca and carbonate, hence must not be given with antacids or H2-receptor blockers; disperses easily when crushed and added to formulas; inexpensive.

Calcium acetate

Less Ca load than $CaCO_3$; few gastrointestinal side effects, but may not be well tolerated in infants; forms a suspension when mixed in formulas; can thicken some formulas or cause ingredients to settle out;inexpensive.

Mg and Ca carbonate combination tablets

Less Ca load than $CaCO_3$ alone; gastrointestinal side effects including diarrhea from the magnesium content; magnesium may have a protective effect on development of vascular calcification.

Sevelamer hydrochloride or sevelamer carbonate

Ca-free; may be difficult to administer in young children; expensive. Tablet is too hard to crush but will form a gel when mixed with warm water and allowed to stand. Powdered form is available for sevelamer carbonate in sachets. Can block feeding tubes if these are not flushed thoroughly after administration. Pre-treatment of formula with sevelamer and removal of precipitant prior to administration is practised in some units, although its effect on binding other minerals or fat soluble vitamins is not known, but may inadvertently bind calcium.

Note: All binders must be given 1-2 hours before or after oral iron supplements

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