Hyperphosphataemia in chronic kidney disease

Clinical case scenarios for children and young people’s renal services

March 2013

NICE clinical guideline 157

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Introduction

NICE clinical case scenarios

Clinical case scenarios are an educational resource that can be used for individual or group learning. Each case scenario includes details of the person’s initial presentation, their medical history and their clinician’s summary of the situation after examination. The clinical decisions about management are then examined using a question and answer approach. Each question should be considered by the individual or group before referring to the answers.

These 2 clinical case scenarios have been put together to improve your knowledge on the management of hyperphosphataemia in chronic kidney disease (CKD) and its application in practice. They illustrate how the recommendations from Management of hyperphosphataemia in chronic kidney disease (NICE clinical guideline 157) can be applied to the care of children and young people (all people younger than 18 years) with stage 4 and 5 CKD, including those who are on dialysis (known as stage 5D).

The clinical case scenarios are available in 2 formats: this PDF, which can be used for individual learning, and a slide set that can be used for groups.

You will need to refer to the NICE guideline to help you decide what steps you would need to follow to manage each case, so make sure that users have access to a copy (either online at http://guidance.nice.org.uk/CG157 or as a printout). You may also want to refer to the corresponding NICE pathway on Management of hyperphosphataemia in chronic kidney disease.

Relevant recommendations from the NICE guideline are quoted in the text (after the answer), with the corresponding recommendation numbers. Information and details from the full guideline have been included in the answers and the 'Supporting information' boxes with reference to the source page number in the full guideline.

In practice, it is acknowledged when providing patients with information, clinicians will deliver this in a way that meets the patients' needs. In addition, it is noted that many patients will have broader needs that go beyond the scope of
these fictional cases and therefore, these cases should not be used as
treatment plans for any patients.

**Learning objectives**

After working through these clinical case scenarios, you will be able to:

- describe the need for improved management of hyperphosphataemia
- make informed clinical judgments about the management of serum
  phosphate with people with chronic kidney disease

**Hyperphosphataemia in chronic kidney disease**

**Definitions**

**Chronic kidney disease (CKD):** abnormal kidney function and/or structure; it is
long-lasting and often progresses over time.

**National Kidney Foundation kidney disease outcomes quality initiative’
(NKF-KDOQI):** This is a classification of CKD and is adopted by the ‘National
service framework for renal services’. It divides CKD into 5 stages according to
the extent of a person’s loss of renal function.

**Stage 4 CKD:** defined by a glomerular filtration rate (GFR) of 15–
29 ml/min/1.73 m².

**Stage 5 CKD:** defined by a GFR of less than 15 ml/min/1.73 m² (A GFR of over
90 ml/min/1.73 m2 is considered normal unless there is other evidence of
kidney disease).

**Stage 5D CKD:** When stage 5 CKD advances to end-stage renal disease
(ESRD), some people progress to renal replacement therapy (RRT) (Note: in
this guideline, those who choose not to participate in an active treatment
programme for their ESRD [which would generally include RRT, diet, pain
management, etc.], instead opting for ‘conservative management’, are
considered to be a subset of the stage 5 population who are not on dialysis). If
this involves dialysis, this stage is classified as CKD stage 5D.
Background
In people with CKD, as kidney dysfunction advances, there is a higher risk of mortality and some comorbidities become more severe. Hyperphosphataemia is one example of this, and occurs because of insufficient filtering of phosphate from the blood by poorly functioning kidneys. This means that a certain amount of the phosphate does not leave the body in the urine, instead remaining in the blood at abnormally elevated levels.

High serum phosphate levels can directly and indirectly increase parathyroid hormone (PTH) secretion, leading to the development of secondary hyperparathyroidism. Left untreated, secondary hyperparathyroidism increases morbidity and mortality and may lead to renal bone disease, with people experiencing bone and muscular pain, increased incidence of fracture, abnormalities of bone and joint morphology, and vascular and soft tissue calcification.

Standard management of hyperphosphataemia involves using both pharmacological and non-pharmacological interventions, as well as providing education and support.

For children and young people with stage 4 CKD, the NKF-KDOQI guidelines and European guidelines on the prevention and treatment of renal osteodystrophy recommend that serum phosphate be maintained within age-appropriate limits.

For children and young people with stage 5 CKD, including those on dialysis, it is recommended that serum phosphate levels be maintained at between 1.3 and 1.9 mmol/l for children aged 1–12 years, and between 1.1 and 1.8 mmol/l during adolescence.
Clinical case scenarios – children and young people’s renal services

Case scenario 1: Chung, newborn with hypoplastic kidney, needing a phosphate management plan

Presentation and medical history
Chung is a 3-day old baby being cared for on the neonatal unit. She was admitted to the neonatal unit at birth with a history of slow feeding, poor appetite, and blood results indicating raised creatinine, urea, potassium and phosphate levels. After assessment, she was diagnosed with hypoplastic kidney and the condition was classified as CKD stage 4–5.

Because of the poor feeding, Chung has a nasogastric tube inserted to support the intake of feeds.

Next steps for management

1.1 Question
What would be the first step to manage the hyperphosphataemia in Chung?
1.1 Answer
You would ensure that a specialist renal dietitian carries out a dietary assessment and provides individualised information and advice on dietary phosphate management.

Given this information and considering that Chung is receiving specialist neonatal care, it could be suggested that the specialist dietitian should carry out this assessment.

**Relevant recommendations**
A specialist renal dietitian, supported by healthcare professionals with the necessary skills and competencies, should carry out a dietary assessment and give individualised information and advice on dietary phosphate management. [1.1.1]

**Supporting information**
Given the broad, in-depth knowledge needed in formulating effective, individualised therapeutic options, the Guideline Development Group (GDG) felt that a specialist renal dietitian would be the most appropriate person to conduct a patient’s dietary assessment and offer them individualised advice. [pg 84]

It was felt that early contact with a dietitian is important for reducing patient misinformation. [pg 84]

Because of the specific nature of children’s dietary needs and habits, the GDG felt that a specialist renal dietitian, specifically a specialist renal dietitian for children and young people, would be the most appropriate person to conduct a child’s dietary assessment and offer the individualised advice. [pg 84]
Next steps for management

1.2 Question

Considering that Chung is a newborn, what individualised advice would you expect the specialist dietitian to give?
1.2 Answer

In infants and children, malnutrition is of much greater concern than hyperphosphataemia. There is a need to maintain growth and adequate nutritional status; therefore, you would support the specialist dietitian in developing a dietary management plan that balances phosphate intake with the required infant feed intake to maintain growth and nutrition.

For all infants, encouraging breast milk1 intake is beneficial because of the well-documented benefits. Additionally, breast milk is more beneficial to Chung, given its low phosphate content compared with other infant feeds. If breastfeeding is not possible or not appropriate, advice should be given to the parents on expressing breast milk, which could be administered down the nasogastric tube.

The individualised dietary management plan would also incorporate providing individualised information and advice to Chung's parents. It will be important to check that breastfeeding Chung is in line with her parents' wishes and breastfeeding support should be provided.

Relevant recommendations

- See recommendation [1.1.1] above.
- Give information about controlling intake of phosphate-rich foods (in particular, foods with a high phosphate content per gram of protein, as well as food and drinks with high levels of phosphate additives) to control serum phosphate, while avoiding malnutrition by maintaining a protein intake at or above the minimum recommended level. For people on dialysis, take into account possible dialysate protein losses. [1.1.3]

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1 Breast milk intake is encouraged for all infants. Please note that NICE is not specifically recommending breast milk for infants to manage hyperphosphataemia. This dietary management plan has been put together for this case scenario to illustrate an individualised dietary management plan as recommended in 1.1.1 that balances phosphate intake, while avoiding malnutrition as recommended in 1.1.3.
Supporting information
Because parents and/or carers provide food and drink to infants, children and young people, and because their dietary needs change as they get older, parents and/or carers should be educated, and the monitoring and revision of advice from the dietitian and healthcare professionals will need to be more frequent depending on the age of the child and their nutritional and clinical status. [pg 84]

When developing the guideline, the GDG considered individualised approaches to be particularly important as different patients will have different diets, needs and preferences. These should be evaluated through dietary assessment, from which a treatment regimen can be developed. [pg 84]

Next steps for management

1.3 Question

Chung is now one week old and is being reviewed regularly. Over the past 4 days, she has been losing weight and the neonatal team are recommending an increase in calories. How would your team and the specialist renal dietitian address this issue?
1.3 **Answer**

As previously identified, malnutrition is of much greater concern than hyperphosphataemia in infants and children; there is a need to maintain growth and adequate nutritional status. Chung's mother is now unable to express adequate breast milk. Your team, in collaboration with the renal dietitian and Chung's parents, decide to 'top up' the breast milk feeds with a low phosphate renal-specific infant formula or a standard infant formula depending on all the current bloods results.

**Relevant recommendations**

There is not a specific NICE recommendation about top-up feeds with infant formula for infants in managing hyperphosphataemia. This dietary management plan has been put together for this case scenario to illustrate an individualised dietary management plan as in recommendation 1.1.1 that balances phosphate intake, while avoiding malnutrition as in recommendation 1.1.3.

**Next steps for management**

1.4 **Question**

Chung is now 10 days old, in the previous week, Chung's daily blood results show a trend to the upper limit of a normal phosphate. You consider at this stage that dietary management is optimised. What would you do next?
1.4 Answer

You would start calcium carbonate, a calcium-based binder, to be taken with feed. You choose calcium carbonate because it is available in a form that can be given easily to Chung via the nasogastric tube or orally.

Introduction of the calcium carbonate should be in the context of concurrent dietary management for Chung.

**Relevant recommendations**

- For children and young people, offer a calcium-based phosphate binder as the first-line phosphate binder to control serum phosphate in addition to dietary management. [1.1.5]
- Take into account patient preference and the ease of administration, as well as the clinical circumstances, when offering a phosphate binder in line with recommendations 1.1.5–1.1.12. [1.1.14]
- Advise patients (or, as appropriate, their parents and/or carers) that it is necessary to take phosphate binders with food to control serum phosphate. [1.1.15]

**Supporting information**

*Phosphate binders*

Early intervention to prevent or manage high phosphate levels was considered key to preventing downstream complications resulting from the poor management of serum calcium and PTH. The GDG therefore emphasised the importance of starting phosphate binder therapy early, and stressed that this should be in the context of concurrent dietary management of serum phosphate. [pg 103]

Evidence for the effectiveness of phosphate binders in children is limited. However, evidence was identified that showed both sevelamer hydrochloride and calcium carbonate to be effective in controlling serum phosphate. Calcium
carbonate was also associated with increased serum calcium levels. [pg 216]

Children need additional calcium for growing bones and to avoid the effects of secondary hyperparathyroidism that can arise in young patients with chronically low serum calcium. For these reasons, a calcium-based binder would be desirable as a first-line treatment in children. [pg 216]

The GDG did not feel there was sufficient evidence to distinguish between the use of calcium acetate and calcium carbonate in children. Therefore, they felt it appropriate to leave the choice between the 2 calcium-based binders to be made on a case-by-case basis, taking into account patient preference, the ease of administration and the specific clinical circumstances. [pg 216]

**Ease of administration**

Adherence to medication is important. Providing appropriate formulations will improve the ease of administration of these medications. The right formulation for a particular patient can substantially improve their ability to achieve (and sustain) adherence to a regimen. The appropriate binder formulation for each patient should be discussed with the parents or carers and, where appropriate, with the child or young person. This can be an important step in promoting adherence to a binder regimen. [pg 220]

Next steps for management

1.5 Question

Frequent review by your team and the dietitian identifies that an equilibrium has been achieved with calcium carbonate and optimal dietary management, balancing the need for calories, achievement of recommended fluid intake (full feeds) and minimising phosphate intake. Potassium has settled within normal limits and so, there is no immediate need for dialysis. Chung is discharged home.
Your team plan to regularly review Chung. At every routine clinical review, they will assess Chung's serum phosphate control. What should they take account of in this assessment?
1.5 Answer

At every routine clinical review with Chung and her parents, assess her serum phosphate control, taking into account: dietary phosphate management, phosphate binder regimen, adherence to diet and medication, and other factors that influence phosphate control, such as vitamin D or dialysis–dietary phosphate management.

Relevant recommendations

At every routine clinical review, assess the patient’s serum phosphate control, taking into account:

- dietary phosphate management
- phosphate binder regimen
- adherence to diet and medication
- other factors that influence phosphate control, such as vitamin D or dialysis.

[1.1.16]
Supporting information

It is important to continuously and regularly monitor the treatment regimen used to manage a patient’s serum phosphate and adjust the regimen when a patient’s phosphate control is not at the desired level. [pg 241]

The multidisciplinary health professionals and teams that support a child’s ongoing dietary management should be similarly aware of the specific needs of children with CKD, and the ways in which these change over time. [pg 84]

Because infants, children and young people’s dietary needs change as they get older, parents and/or carers should be educated, and the monitoring and revision of advice from the dietitian and healthcare professionals will need to be more frequent depending on the age of the child and their nutritional and clinical status. [pg 84]

People learn and respond to interventions in different ways and have different approaches to dietary education; management may therefore need to be explored over the course of a patient’s treatment. [pg 84]
Case scenario 2: Harry, aged 13 years with focal segmental glomerulosclerosis receiving peritoneal dialysis and currently on calcium carbonate; his phosphate and calcium levels are increasing

Presentation and past medical history
Harry is a 13-year old boy with focal segmental glomerulosclerosis receiving peritoneal dialysis.

Harry has a good appetite and has a dietary phosphate management plan developed by a specialist renal dietitian who reviews him regularly.

Harry also takes calcium carbonate to manage his phosphate.

Harry presents with his mum to his routine outpatient clinic appointment, which is with you.

When you review his recent series of blood results, taken over the past 8 weeks, you notice a trend of increasing serum phosphate. In the previous 4 weeks, you also notice that his serum calcium level has been increasing towards the upper limit of normal for his age.

Next steps for management

2.1 Question
NICE clinical guideline 157 identifies that for children and young people with stage 4 CKD, the NKF-KDOQI guidelines and European guidelines on the prevention and treatment of renal osteodystrophy recommend that serum phosphate be maintained within age-appropriate limits. For children and young people with stage 5 CKD, including those on dialysis, it is recommended that serum phosphate levels be maintained at between 1.1 and 1.8 mmol/l during adolescence. Before considering a change to Harry’s phosphate binder regimen, what would you do first?
2.1 Answer

You consider that a possible reason for these results is poor adherence to his diet and calcium carbonate. You would therefore enquire about Harry’s adherence to the phosphate binder regimen taking into account ease of administration.

If there is any indication of an adherence issue, you would review Harry's phosphate binder and discuss other calcium-based binders that he may find easier to take.

Request a review by the specialist renal dietitian to:

- provide information and advice about controlling intake of phosphate-rich foods to control serum phosphate, while avoiding malnutrition by maintaining protein intake at or above the minimum recommended level, taking into account possible dialysate losses
- look to identify if there could be an explanation for the increasing phosphate and calcium levels.

You would support the renal dietitian in these activities.

Ensure that the information and advice Harry and his mum receive are tailored to their individual needs and preferences.

**Relevant recommendations**

- A specialist renal dietitian, supported by healthcare professionals with the necessary skills and competencies, should carry out a dietary assessment and give individualised information and advice on dietary phosphate management. [1.1.1]
- Advice on dietary phosphate management should be tailored to individual learning needs and preferences, rather than being provided through a generalised or complex multicomponent programme of delivery. [1.1.2]
- Give information about controlling intake of phosphate-rich foods (in particular, foods with a high phosphate content per gram of protein, as well...
as food and drinks with high levels of phosphate additives) to control serum phosphate, while avoiding malnutrition by maintaining a protein intake at or above the minimum recommended level. For people on dialysis, take into account possible dialysate protein losses. [1.1.3]

- At every routine clinical review, assess the patient’s serum phosphate control, taking into account:
  - dietary phosphate management
  - phosphate binder regimen
  - adherence to diet and medication
  - other factors that influence phosphate control, such as vitamin D or dialysis. [1.1.16]

**Related recommendations**

- For children and young people, offer a calcium-based phosphate binder as the first-line phosphate binder to control serum phosphate in addition to dietary management. [1.1.5]

**Supporting information**

**Diet**

Because of the specific nature of children’s dietary needs and habits, the GDG felt that a specialist renal dietitian, specifically a specialist renal dietitian for children and young people, would be the most appropriate person to conduct a child’s dietary assessment and offer the individualised advice. The multidisciplinary health professionals and teams that support a child’s ongoing dietary management should be similarly aware of the specific needs of children with CKD, and the ways in which these change over time. [pg 84]

Because parents and/or carers provide food and drink to infants, children and young people, and because their dietary needs change as they get older, parents and/or carers should be educated, and the monitoring and revision of advice will need to be more frequent depending on the age of the child and their nutritional and clinical status. [pg 84]
In children, the GDG felt that malnutrition is of much greater concern than hyperphosphataemia. Progressive CKD is often associated with decreases in spontaneous dietary protein intake and dialysis with a loss of protein from the body. This is a priority for treatment given the need to maintain growth and adequate nutritional status. For these reasons, as well as the lack of paediatric evidence available, the GDG did not recommend a diet based on protein restriction for children. Recommended intakes are instead age-specific according to reference nutrient intakes. [pg 38, 55]

According to the consensus of the GDG, based on their clinical knowledge and experience, advising patients to reduce their intake of phosphate-rich foods is good clinical practical [pg 38]. Usual practice is to advise a reduction in certain types of food: generally those with a high phosphate to protein ratio, such as some dairy products and nuts, or food and drinks with high levels of phosphate additives, such as cola drinks or processed foods. The emphasis is more on the phosphate content of food and drinks rather than focusing on the restriction of protein. [pg 40]

**Information and advice principles**

The GDG considered individualised approaches to be particularly important as different patients will have different diets, needs and preferences. [pg 84]

In addition to dietitian input, appropriately trained, multidisciplinary healthcare professionals/teams can play an important role in a patient’s ongoing dietary management through education, reinforcing nutritional advice and providing support on a more day-to-day basis. [pg 84]

**Phosphate binders**

The GDG also felt that it is important to include information relating to phosphate binder use, giving the specific example of the need to take binders with high-phosphate snacks and not simply with meals, as well as the need to match binder dose with the phosphate load in the snack or meal. [pg 84]

Adherence to medication is important. Providing appropriate formulations will improve the ease of administration of these medications. The right formulation
for a particular patient can substantially improve their ability to achieve (and sustain) adherence to a regimen. The appropriate binder formulation for each patient should be discussed with the parents or carers and, where appropriate, with the child or young person. This can be an important step in promoting adherence to a binder regimen. [pg 220]

If considering the use of non-calcium-based binders because of high serum calcium levels in patients on calcium-based binders, it is important to review possible causes of high calcium, such as dialysate calcium content, vitamin D, calcium supplements, dietary calcium or certain over-the-counter preparations (for example indigestion remedies), before making any changes to the choice of binder. In some cases, it might be easier to make small changes to these sources of elemental calcium than changing (and ensuring adherence to) the phosphate binder regimen. For example, it may be the case that a patient is on a high dose of vitamin D, and a reduction in this may be the most appropriate course of action. [pg 218]

### 2.2 Question

Feedback from your assessments and the dietitian’s, indicate that Harry is happy to take the calcium carbonate and is adherent to his diet and phosphate binders. You cannot identify any other causes for the increasing phosphate and calcium levels and the likely cause is worsening renal function.

Harry returns to your clinic and further blood results indicate that his phosphate is still high and his calcium level has risen above his age-adjusted upper limit of normal.

What will you do now?
2.2 Answer

Harry remains hyperphosphataemic despite adherence to a calcium-based phosphate binder, and his serum calcium is above the age-adjusted upper limit of normal. In consultation with the children and young people’s renal multidisciplinary team and in discussion with Harry and his parents, Harry is prescribed sevelamer hydrochloride in substitution for some of the calcium-based binder. Although this use of sevelamer hydrochloride is common in UK clinical practice, at the time of publication (March 2013), sevelamer hydrochloride did not have a UK marketing authorisation for use in children for this indication. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. See the General Medical Council’s Good practice in prescribing medicines – guidance for doctors for further information. Harry and his parents should provide informed consent, which should be documented.

You would need to consider the pill burden of 2 phosphate binders on Harry and the potential influence of this upon adherence. You may want to provide Harry with a choice of medicine and show him the range available within the phosphate binders you have recommended so that he can see size, taste etc.

You and the multidisciplinary team continue to review Harry regularly to assess his serum phosphate control.

Relevant recommendations

- For children and young people who remain hyperphosphataemic despite adherence to a calcium-based phosphate binder, and whose serum calcium goes above the age-adjusted upper limit of normal, consider either combining with, or switching to, sevelamer hydrochloride, having taken into account other causes of raised calcium. [1.1.7]
- If a combination of phosphate binders is used, titrate the dosage to achieve control of serum phosphate while taking into account the effect of any calcium-based binders used on serum calcium levels (also see
recommendations 1.1.6, 1.1.7 and 1.1.10–1.1.12). [1.1.13]

- Take into account patient preference and the ease of administration, as well as the clinical circumstances, when offering a phosphate binder in line with recommendations 1.1.5–1.1.12. [1.1.14]
- Advise patients (or, as appropriate, their parents and/or carers) that it is necessary to take phosphate binders with food to control serum phosphate. [1.1.15]

### Related recommendations

- At every routine clinical review, assess the patient’s serum phosphate control, taking into account:
  - dietary phosphate management
  - phosphate binder regimen
  - adherence to diet and medication
  - other factors that influence phosphate control, such as vitamin D or dialysis. [1.1.16]

### Supporting information

**Non-calcium-based phosphate binders**

Because of insufficient evidence and consensus in practice, the GDG did not specify a threshold of serum calcium that should infer the use of a calcium-based binder in combination with sevelamer hydrochloride. Clinicians should use clinical judgement to determine acceptable levels considering trends observed across a series of measurements and taking account of the relative levels of other biochemical markers that are known to impact serum calcium. [pg 217]

There are concerns over the use of the only licensed non-calcium-based binder for use in children, aluminium hydroxide (no evidence for its use in children; toxicity; and its licence not for longer-term indications). A paediatric trial showed sevelamer hydrochloride to be as effective at lowering serum phosphate as calcium carbonate and was associated with a lower serum calcium level. Therefore, the GDG recommended sevelamer hydrochloride over aluminium
hydroxide. [pg 217]

There are no recommendations about sevelamer carbonate because of a lack of evidence. [pg 217]

The GDG felt that serum PTH levels would not drive changes in binder regimen in children. [pg 217]

**Principles of prescribing phosphate binders**

Adherence to medication is important. Providing appropriate formulations will improve the ease of administration of these medications. The right formulation for a particular patient can substantially improve their ability to achieve (and sustain) adherence to a regimen. The appropriate binder formulation for each patient should be discussed with the parents or carers and, where appropriate, with the child or young person. This can be an important step in promoting adherence to a binder regimen. [pg 220]

It is important to provide information relating to phosphate binder use [pg84]. For example, because the phosphate-binding action occurs in the stomach, it is important that these medications are taken with food and not on an empty stomach. [pg 260]
Other implementation tools

NICE has developed the following tools to help organisations implement the clinical guideline on Hyperphosphataemia in chronic kidney disease: These are available on the NICE website (www.nice.org.uk/guidance/CG157).

- Costing report and template
- Clinical audit support for adult and children and young people’s renal services
- Baseline assessment tool
- Clinical case scenarios for adult renal services
- Educational slide set and clinical case scenarios for adult renal services

A practical guide to implementation, How to put NICE guidance into practice: a guide to implementation for organisations, is also available.

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