



Multidisciplinary education approach to optimize phosphate control among hemodialysis patients

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Abstract

Background Hyperphosphatemia is a common consequence in end stage renal disease. It is associated with increased cardiovascular risk and mortality, also development of hyperparathyroidism and mineral bone disease. A patient educational program involving physician, pharmacist and dietician was developed to manage hyperphosphatemia among hemodialysis patients. **Objective** To investigate the efficacy of the program in optimal phosphate control among hemodialysis patients. **Setting** Kuala Lipis Hospital, Malaysia. **Method** This was a non-randomized, single-arm community trial running for a period of 6 months. The program consisted of a small group seminar and individual counseling sessions. Two individual counseling sessions were conducted for each patient, focusing on diet and medication adherence, by an accredited dietician and pharmacist respectively. The group seminar was delivered by a multidisciplinary team involving a physician, pharmacist and dietician. Topics included basic knowledge of hyperphosphatemia, phosphate binder and dietary phosphate control. Eligible and consented patients had knowledge and medication adherence assessment, measurement of pre-dialysis serum calcium, albumin, phosphate, haemoglobin and alkaline phosphatase before and after the educational program. **Main outcome measure** Phosphate level, knowledge and medication adherence assessment. **Results** Fifty-seven patients completed the program and were included into final data analysis. The median (IQR) phosphate level (mmol/L) was 1.86 (1.45–2.24) before and decreased to 1.47 (1.21–1.91) and 1.49 (1.28–1.81) 3 months and 6 months after PEP ($p < 0.001$). The percentage of patients with uncontrolled phosphate level was reduced from 59.3 to 35.6% and 42.1% after the PEP ($p = 0.003$). The mean knowledge score almost doubled after the intervention, with a mean pre-score of 8.61 (95% CI 7.85–9.37) to mean post-score of 15.31 (95% CI 14.85–15.76). The adherence to phosphate binder also improved from 17.2 to 41.4% after PEP ($p = 0.007$). **Conclusion** A multidisciplinary patient education program is an effective approach to manage hyperphosphatemia among hemodialysis patients in Malaysia.

Keywords Education · Hemodialysis · Malaysia · Mineral bone disease · Multidisciplinary · Phosphate

Impacts on practice

- Collaboration between healthcare professionals to manage hyperphosphatemia may be more effective than individual consultations.
- The management of complicated clinical scenario such as hyperphosphatemia requires a multidisciplinary and patient-centered approach.

Introduction

Hyperphosphatemia is a common consequence in end stage renal disease (ESRD) patient. It is associated with increased cardiovascular risk and mortality in

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haemodialysis patients. Hyperphosphatemia also plays an important role in the development of hyperparathyroidism, mineral bone disease, vascular and valvular calcification. Malaysia Renal Replacement Guideline 2017 recommended to control the serum phosphate to approximately 0.8–1.6 mmol/L and serum intact parathyroid hormone (iPTH) to 2–5 times the upper limit of normal for the assay used [1]. Internationally, Kidney Disease: Improving Global Outcomes (KDIGO) guideline suggested maintaining serum phosphate toward the normal range for dialysis patients and the best patient survival was observed with the serum phosphate close to 1.42 mmol/L [2].

However, optimal phosphate control among hemodialysis patients has been challenging. Nationwide in Malaysia, the percentage of hemodialysis patients achieving phosphate level of below 1.3 mmol/L had been consistently below 20% in 2005–2015 [3], with little or no improvement across the years. Locally in hemodialysis unit (HDU) in Kuala Lipis Hospital in 2015, less than quarter of our population was at the target phosphate and iPTH range. Only 22% achieved serum phosphate 0.8–1.3 mmol/L, 37% had serum phosphate 1.3–1.8 mmol/L and 21% recorded target iPTH level of 150–300 ng/mL, highlighting the urgent need for a clinical intervention to curb with this issue.

In this study, a patient educational program (PEP) was developed, which involved physician, pharmacist, dietician and dialysis nurse in the management of hyperphosphatemia among hemodialysis patients. The intervention aimed to improve patient's knowledge about hyperphosphatemia, adherence to phosphate binder and dietary phosphate control.

Aims of the study

The primary objective of the study was to investigate the efficacy of the PEP in optimal phosphate control among hemodialysis patients. In specific, the study aimed to compare the biochemistry values, knowledge and medication adherence before and after the PEP.

Ethics approval

The study was approved by Medical Research and Ethics Committee Malaysia (KKM.NIHSEC/P17-1812(5)). All participants provided written informed consent before enrolment and the study was conducted in accordance with the Declaration of Helsinki.

Method

Study population

This was a non-randomised, single-arm community trial. 72 patients were screened for eligibility into the study. Patients were considered eligible if they were more than 18 years old and were on regular hemodialysis at least 3 times per week. They were excluded from the study if they were unable to complete pre-knowledge assessment questionnaire due to cognitive issues. Patients who were clinically unstable, defined by history of at least one hospitalization in the previous 3 months, were also excluded from the study. Patients on other dialysis modalities, such as continuous ambulatory peritoneal dialysis and home dialysis were also excluded from the study.

Study design

Once patient consented to participation, their medical record was reviewed and pre-dialysis serum calcium, albumin, phosphate, haemoglobin and alkaline phosphatase (ALP) were transcribed into a data collection form. Dialysis dose, as quantified by urea reduction ratio (URR) and Kt/V were also recorded. They were also asked to complete a knowledge and medication adherence assessment prior to PEP.

The structure of the PEP consisted of a small group seminar and individual counseling sessions. Two individual counseling sessions were conducted for each patient, focusing on diet and medication adherence, by an accredited dietician and pharmacist respectively. The counseling sessions were largely driven by patient's individual questions and the content was individualized based on patient's phosphate level, lifestyle, socioeconomic status, and comorbidities. A meal plan was developed by dietician for each patient focusing on low phosphate diet. One seminar session contained a maximum of 20 people. Seminar was conducted in local language (Bahasa Malaysia) and was delivered by a multidisciplinary team involving a physician, pharmacist and dietician. Topics during the seminar included basic knowledge of hyperphosphatemia, phosphate binder and dietary phosphate control. During the seminar, a standard information booklet printed in local language was distributed to patients as home reference.

The whole intervention (group seminar and individual counseling sessions) ran for a period of 3 months. After the intervention, patients had their pre-dialysis serum calcium, albumin, phosphate, haemoglobin and ALP re-measured. Dialysis dose, as quantified by URR and Kt/V were also

recorded to ensure consistency with pre-intervention readings. Blood was taken from patients as part of the routine clinic follow-up and no extra blood was taken for the study purpose. Both knowledge and medication adherence assessment were carried out again using the same questionnaires as per pre-intervention.

The dosage of the phosphate binder did not change during the intervention period.

Measurement of outcomes

Outcomes measured were knowledge score, medication adherence, calcium, albumin, phosphate, haemoglobin and ALP; during pre- and post-intervention at month 3 and month 6.

Knowledge assessment

Patient's knowledge was assessed with a self-developed questionnaire by a physician and an accredited dietician. There was a total of 12 multiple-choice questions with some questions having more than one answer. A total of 3 domains were tested: 4 questions on the concept of hyperphosphatemia, 3 questions on phosphate binder and 5 questions on dietary phosphate control. The diet domain tested mainly the ability of patients to categorize food into high or low phosphate content. The full achievement score was 18.

A single investigator completed all the knowledge evaluation pre- and post-intervention to avoid information bias. The questionnaire was delivered verbally for patients with low literacy.

Medication adherence assessment

Adherence to phosphate binder was determined using the Simplified Medication Adherence Questionnaire (SMAQ) [4]. The questionnaire was made up of 6 questions: (1) Do you ever forget to take your medications?; (2) Do you always take the drugs at the indicated time?; (3) Do you ever stop taking the drugs if you feel ill?; (4) Did you forget to take the medication on the weekend?; (5) In the last week, how many times did you not take any dose?; (6) Since the last medication collection, on how many complete days did you not take the medication?

Patient was considered non-adherent if any of these conditions was met: They answered 'yes' to question (1), (3) or (4), 'no' to question (2), 'more than 2 times' for question (5), or 'more than 2 days' for question (6). Adherence assessment was carried out before the group seminar and re-assessed again after the seminar and counseling sessions.

Statistical analysis

The baseline laboratory values were calculated as mean value across the 6 months pre-intervention, providing stability in the baseline estimate. Descriptive statistic was presented using mean, median, standard deviation (SD), interquartile range (IQR) and proportion, as appropriate. Comparison of means for continuous variables was analyzed using paired t-test for normally distributed data and Wilcoxon test for non-normally distributed data. Friedman test was used to analyze changes in biochemistry values, followed by post hoc analysis with Wilcoxon signed-rank test with a Bonferroni correction applied. The changes in phosphate control and medication adherence, pre- and post-intervention were determined with McNemar test. A value of $p < 0.017$ was considered significant when Bonferroni correction applied and $p < 0.05$ was considered significant in all other cases. All analysis was conducted using IBM SPSS Statistics for Windows, Version 21 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

Results

Baseline data

A total of 57 patients completed the study and were included into the final data analysis (Fig. 1). As depicted in Table 1, the study population was made up of a group of hemodialysis patients with a mean (\pm SD) age of 54 (\pm 13) years, ranging from 18–83 years old. About two-third (57.9%) of the patients were female. Majority of the patients were Malays (82.5%), followed by Chinese

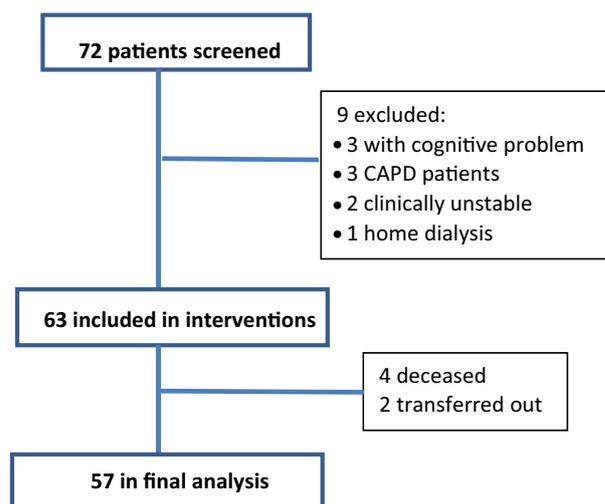


Fig. 1 Flow of patients through the study protocol. CAPD continuous ambulatory peritoneal dialysis

Table 1 Baseline characteristics of participants (N=57)

<i>Age</i>	
Mean (\pm SD)	54 (\pm 13)
Range	18–83
<i>Gender</i>	
Female	33 (57.9%)
Male	24 (42.1%)
<i>Race</i>	
Malay	47 (82.5%)
Chinese	7 (12.3%)
Indian	2 (3.5%)
Others	1 (1.7%)
<i>Etiology of ESRD</i>	
Diabetes Mellitus	26 (45.6%)
Hypertension	9 (15.8%)
Glomerulonephritis	3 (5.3%)
Others	7 (12.3%)
Unknown	12 (21%)
<i>Underlying medical conditions</i>	
Diabetes Mellitus	26 (45.6%)
Hypertension	53 (93%)
Previous IHD	8 (14%)
<i>No. of medicines</i>	
Median (IQR)	7 (2)
Range	3–13
<i>Type of phosphate binder</i>	
Calcium carbonate	54 (94.7%)
Sevelamer carbonate	2 (3.5%)
None prescribed	1 (1.8%)
<i>Years of dialysis</i>	
Median (IQR)	4 (5)
Range	1–16
<i>Access of dialysis</i>	
Brachial cephalic fistula	36 (63.2%)
Radial cephalic fistula	17 (29.8%)
Catheter	4 (7%)

ESRD end-stage renal disease, *IHD* ischaemic heart disease, *IQR* interquartile range

(12.3%) and Indians (3.5%). There was one patient of Thai descent (1.7%).

Median (IQR) year on hemodialysis was 4 (5) years, with a minimum of 1 year and maximum of 16 years. Majority of the patients had fistula access with only 4 (7%) of them underwent hemodialysis via catheter access. The main etiology of ESRD were diabetic nephropathy (45.6%) and hypertension (15.8%). Other causes of ESRD were glomerulonephritis, systemic lupus nephritis and polycystic kidney disease. 12 patients had an unknown cause of ESRD.

In terms of pharmacotherapy, the study population had median (IQR) of 7 (2) medications prescribed (range 3–13). The top phosphate binder prescribed was calcium carbonate

(94.7%). 2 patients were prescribed with sevelamer carbonate and 1 patient was not on any phosphate binder during the study period.

Biochemistry levels

The median (IQR) phosphate prior to intervention was 1.86 (1.45–2.24) mmol/L and decreased to 1.47 (1.21–1.91) mmol/L and 1.49 (1.28–1.81) mmol/L 3 months and 6 months after the intervention (N=57, $p < 0.001$) (Table 2). The reduction was both statistically and clinically significant. McNemar test also showed a significant relationship between the controlled and uncontrolled phosphate group, before and after the intervention ($p = 0.003$) (Fig. 2). Controlled phosphate group was defined as having phosphate level in the range of 0.8–1.6 mmol/L while uncontrolled group consisted of patients with phosphate level more than 1.6 mmol/L. Among the 57 patients who completed the intervention, 17 patients who were initially presented with uncontrolled phosphate level was successfully reverted to normal phosphate level after the intervention. The percentage of patients with uncontrolled phosphate level reduced from 59.3 to 35.6% and 42.1%, 3 months and 6 months after the intervention respectively (Fig. 2). Calcium-phosphate product decreased significantly after the intervention, with a median (IQR) value of 3.87 (3.13–4.92) mmol²/L² before, to 3.3 (2.44–4.23) mmol²/L² at 3-month and further decreased to 3.12 (2.56–3.84) mmol²/L² 6 months after intervention ($p < 0.001$) (Table 2).

Other laboratory parameters such as albumin, ALP, calcium and hemoglobin showed no significant changes before and after the intervention (Table 2).

Dialysis adequacy was defined as $Kt/V \geq 1.2$ and $URR \geq 65\%$. Majority of the patients achieved adequate dialysis dose in terms of Kt/V (98.3%) and URR (78–86.4%). There was no significant difference in dialysis dose before and after intervention (Kt/V , $p = 1$; URR , $p = 0.227$).

Knowledge assessment

Patient's knowledge on the concept of hyperphosphatemia, phosphate binder and dietary phosphate control improved significantly after the intervention ($p < 0.001$) [Table 3 (1)]. It was found that the mean knowledge score almost doubled after the intervention, with a mean pre-score of 8.61 (95% CI 7.85–9.37) and post-score of 15.31 (95% CI 14.85–15.76) (Fig. 3). The mean of score difference was 6.7 (95% CI 5.97–7.42) (Table 3). One patient showed the highest increase of 14 scores, from 2 (pre-intervention) to 16 (post-intervention). A subgroup analysis of the knowledge score focusing on dietary control also showed significant improvement statistically, from median (IQR) score of 3 (2) pre-intervention, to 5 (1) post-intervention ($p < 0.001$) (Table 3).

Table 2 Changes of selected laboratory parameters across time from pre-PEP to 3 months and 6 months after PEP

Variables	Pre-PEP	Month 3	Month 6	<i>p</i> values
Phosphate (mmol/L)	1.86 (1.45–2.24)	1.47 (1.21–1.91)	1.49 (1.28–1.81)	Pre versus month 3: <i>p</i> < 0.001 Pre versus month 6: <i>p</i> < 0.001 Month 3 versus month 6: <i>p</i> > 0.95
Calcium (mmol/L)	2.20 (2.05–2.31)	2.20 (2.06–2.31)	2.14 (2.03–2.28)	<i>p</i> = 0.06 across groups by Friedman test
Calcium * phosphate (mmol ² /L ²)	3.87 (3.13–4.92)	3.30 (2.44–4.23)	3.12 (2.56–3.84)	Pre versus month 3: <i>p</i> < .001 Pre versus month 6: <i>p</i> < 0.001 Month 3 versus month 6: <i>p</i> = 0.723
Albumin (g/L)	39.9 (36.58–41.6)	39.4 (36.75–42.15)	38.5 (35.95–41.2)	<i>p</i> > 0.95 across groups by Friedman test
ALP (IU/L)	122.5 (87.75–172.5)	115 (83–165)	121 (95.50–208)	Pre versus month 3: <i>p</i> = 0.533 Pre versus month 6: <i>p</i> = 0.057 Month 3 versus month 6: <i>p</i> = 0.005
Haemoglobin (g/dL)	10.4 (9.18–11.08)	10.7 (9.8–12)	10.2 (9.3–11.6)	<i>p</i> = 0.05 across groups by Friedman test

All values are expressed as median (IQR). Friedman test was conducted followed by post hoc analysis with Wilcoxon signed-rank test with a Bonferroni correction applied, resulting in a significance level set at *p* < 0.017

Fig. 2 Percentage of patients whose phosphate level is controlled (blue) and uncontrolled (red) pre and 3 months and 6 months after intervention. **p* value = 0.003, by McNemar test. Controlled phosphate level is defined as 0.8–1.6 mmol/L and uncontrolled phosphate level as > 1.6 mmol/L. (Color figure online)

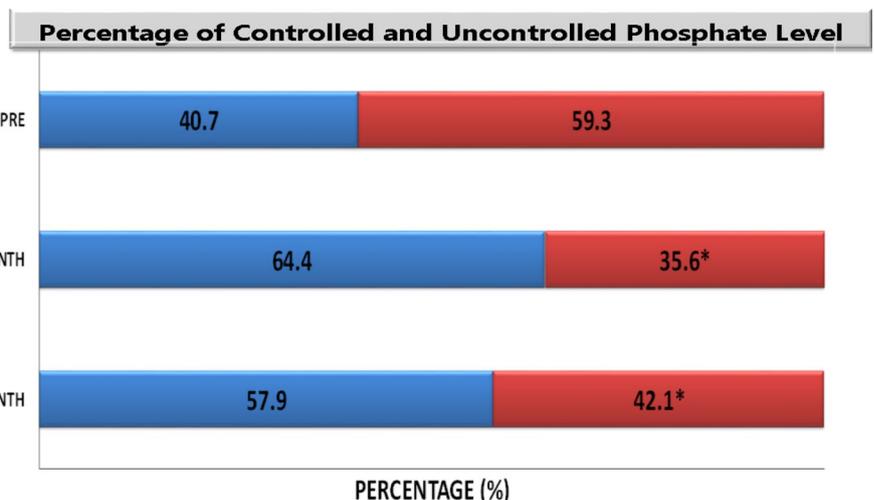


Table 3 Changes of (1) overall knowledge score and (2) diet knowledge score before and after PEP among participants

(1) Overall Knowledge Score	Mean of score difference (95% CI)	t-Stats (df) ^a	<i>p</i> value ^a
Pre-intervention	6.70 (5.97–7.42)	18.411(58)	< 0.001
Range 2–14			
Mean (SD): 8.61 (2.92)			
Post-intervention			
Range 9–18			
Mean (SD): 15.31 (1.76)			
(2) Diet Knowledge Score		Z-statistic ^b	<i>p</i> value ^b
Pre-intervention	Post-intervention	-5.813	< 0.001
Range 0–5	Range 2–5		
Median (IQR) 3 (2)	Median (IQR) 5 (1)		

^aPaired *t* test

^bWilcoxon Signed Rank test

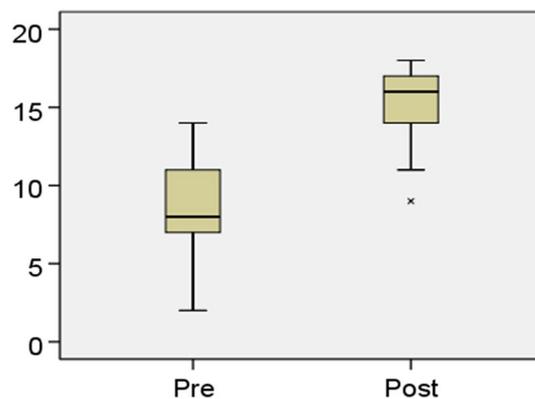


Fig. 3 Knowledge score distribution before and after PEP. Mean score difference is 6.7 (95% CI 5.97–7.42; *p* < 0.001, paired *t* test)

Medication adherence

56 patients were on phosphate binder during the study period. There was a significant improvement in the adherence to phosphate binder after the intervention ($p=0.007$). Before the intervention, non-adherence was reported at 82.8%, which decreased to 58.6% after the intervention (Fig. 4). 19 patients who were non-adherent to phosphate binder initially, reported adherence after the intervention. 34 patients showed no change in medication adherence status after the intervention.

Discussion

Hyperphosphatemia is a common consequence among ESRD patients. Following the deterioration of renal function in ESRD patients, excretion of phosphate diminishes. Decreased phosphate excretion will increase the secretion of parathyroid hormone, which helps in reducing reabsorption of phosphate from the proximal tubule of the kidney. However, in ESRD, the blunted urinary phosphate excretion can no longer keep pace with the obligatory intestinal phosphate absorption, resulting in significant hyperphosphatemia in ESRD patients [5, 6]. Persistent hyperphosphatemia in ESRD patients can lead to the development of secondary hyperparathyroidism, mineral bone disease, vascular and valvular calcifications, which can cause cardiovascular events in ESRD patients [2].

The association between hyperphosphatemia, cardiovascular events and mortality had been demonstrated in several studies. The Dialysis Outcomes and Practice Patterns Study (DOPPS), a prospective cohort study in 25,588 ESRD patients on hemodialysis, reported an increased risk of cardiovascular mortality with serum phosphate concentration of 5.1–5.5 mg/dL, and an increase in all-cause mortality at serum phosphate concentration over 6.0 mg/dL [7]. In another prospective cohort of 10,044 patients who were beginning hemodialysis, serum phosphate concentration of greater than 5.5 mg/dL was associated with an increased risk of death compared to phosphate concentration of

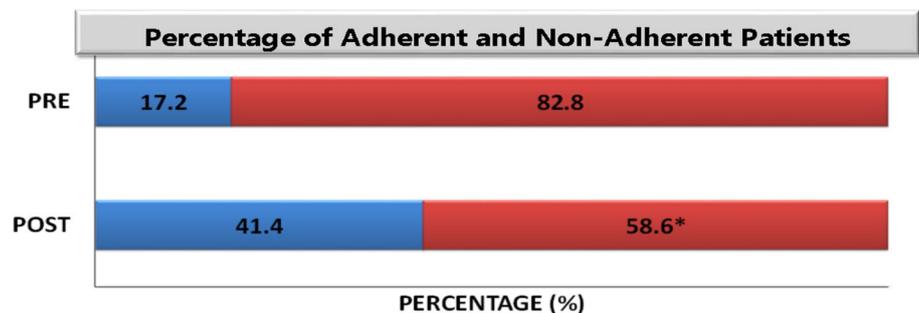
3.5–4.5 mg/dL [8]. Therefore, optimal phosphate control in ESRD is paramount to reduce both morbidity and mortality.

The treatment of hyperphosphatemia in ESRD includes intensified dialysis, phosphate binder and dietary phosphate control. In order to achieve optimal phosphate control, patient's understanding about the disease is also important. A lack of patient's insight about disease and treatment can jeopardise phosphate control. It was found that as much as 42% dialysis patients were unsure of high phosphate food and 46% of them were unaware of consequences of elevated phosphate [9]. To conclude, all four elements (knowledge, intensified dialysis, phosphate binder and dietary phosphate control) need to present together in optimal phosphate control.

While dialysis intensity can be controlled by physician, the rest of the elements relied fully on patient's involvement and co-operation. Patient education had been proposed in numerous studies [10–16] for better patient engagement and to encompass the other three elements (knowledge, medication and diet) in the management of hyperphosphatemia. Studies done previously involved only a single profession in conducting the education program, for example solely by dietician or solely by nurse. In our study, physician, dietician and pharmacist joined forces to provide the education program, for more holistic approach in hyperphosphatemia management. The small group seminar emphasized giving general information regarding the clinical consequences of hyperphosphatemia, the roles of phosphate binder and low phosphate diet in optimal phosphate control. Standard booklet printed in local language was given out to patients for knowledge reinforcement at home. During the one-to-one counselling sessions with pharmacist and dietician, it further enhanced patient's understanding of the disease and adherence by prompting them to ask questions and involved actively in disease management.

After the PEP, there were both statistical and clinically significant improvement in phosphate level, calcium-phosphate product, knowledge score and adherence to phosphate binder. There was no significant change in calcium, albumin, ALP and haemoglobin level pre and post-intervention. The consistent calcium level was because there was no change in both doses of vitamin D and phosphate binder throughout

Fig. 4 Percentage of patients who are adherent (blue) and non-adherent (red) to medication pre and post intervention. * p value = 0.007, by McNemar test. (Color figure online)



the intervention period. Also, the dietary counselling emphasised on low phosphate diet, and gave less focus on other important dietary advices such as low calcium, high protein and iron diet. On the other hand, ALP is a non-specific biomarker for bone turnover which can also be found in liver, small intestine, kidneys, the placenta and leukocytes [17]. Thus, it was not expected to vary much across time. The knowledge score improved significantly from pre-intervention mean score of 8.61 (95% CI 7.85–9.37) to post-intervention mean score of 15.31 (95% CI 14.85–15.76). The effort in imparting knowledge to dialysis patients via small group seminar, one-to-one counselling and booklet in local language translated into great improvement in patient's knowledge score.

Medication adherence has always been challenging among hemodialysis patients. Reported medication adherence in literatures was highly variable, with 14–40% hemodialysis patients were found to be non-adherent to their medicines (9, 10, 13). In comparison, our study population quoted doubled cases of non-adherence (82.8%), but was successfully reduced to 58.6% after the intervention. Patient education had been proven to be effective across studies (13–14) not just in improving adherence, but also increased understanding of the correct use of phosphate binder (44–72%) [14]. Despite the general improvement in medication adherence score, half of the patients in our centre still had problem with medication adherence after the intervention. This was because some of them were prescribed with a phosphate binder of higher frequency than their meal frequency. Since phosphate binder is effectively to be taken during meals and not the prescribed frequency, this group of patients were thereby wrongly labelled as “non-adherent”.

Other than phosphate binder, dietary phosphate restriction is another core component in optimal phosphate control among dialysis patients [18]. Diet counselling has a role in the management of hyperphosphataemia because it can help patients in smarter food choice. Once equipped with the diet knowledge, patients can avoid excessive intake of phosphate from food especially those of inorganic sources, which are proven to be of higher intestinal absorption than organic phosphate [19, 20]. Our study showed significant increase in dietary knowledge score post-intervention. The median (IQR) score in pre-intervention was 3 (2) and improved to 5 (1) post-intervention ($p < 0.001$). A prospective intervention study done by Adamasco et al. [16] on 43 haemodialysis patients also showed positive result not just in serum phosphate reduction, but a decrease in dietary intake as well. Phosphate and calcium intake decreased significantly (by 100 mg on average) after the dietary intervention. In our study, we failed to quantify the changes in dietary intake, which is an area worth exploring in future follow-up study. Despite the significant increase in dietary knowledge score, poor compliance with dietary restriction

was still a well-known problem in clinical practice. To gain a better chance of compliance, dietary modification should be recommended in small increment over time without sudden dramatic changes.

There were several similar studies which demonstrated that patient education can help patients to achieve better phosphate control by improving their knowledge, adherence to medication and diet restriction. A 12-month interventional study of Gardulf et al. [12] on 43 Chronic Kidney Disease (CKD) Stage 4 and 5 patients showed significant decreased mean phosphate level after structured education program and remained low at 12 months follow up. The study also demonstrated increased patient's self-reported knowledge regarding food intake, calcium/phosphate balance and self-dosing phosphate. In a randomized controlled trial of 56 haemodialysis patients, those who attended one-to-one teaching session by renal dietician showed significant phosphate reduction, from mean pre-dialysis phosphate of 1.96 mmol/L decreased to 1.6 mmol/L (difference, -0.36 mmol/L; 95% CI, -0.54 to -0.16 , $p = 0.02$) after 3 months of intervention [11]. Another dietician-led education program in a single-center haemodialysis population also showed significantly reduced phosphate level and improved patient's general knowledge of phosphate and phosphate binder [15]. In summary, despite the difference in effect magnitude and length of follow-up, all the studies showed patient education resulted in positive outcomes in both serum phosphate reduction and improvement in knowledge.

One major limitation in this study was the possible Hawthorne effect. Hawthorne effect was first described by Henry A. Landsberger in 1950s, whereby people modify their behaviour if they are under supervision for examples in a study, even in the absence of an external factor [21]. It may be arguable that Hawthorne effect played a role in the improvement in phosphate level and medication adherence. However, it should also be noted that the knowledge of the patients improved greatly by almost twofolds, which fulfilled one of our PEP objectives to empower patients in better self-care by imparting knowledge. Despite that, management of hyperphosphatemia is multifactorial, thus it is hard to attribute the reason for clinical improvement to improvement in medication adherence, better knowledge, smarter dietary choice or Hawthorne effect. Moreover, we as healthcare professionals should always take an interest in patients we care for at all time. In the end, clinical improvement is what really matters, be it from the effect of increase in knowledge, medication adherence or better diet selection.

Other study limitations prevailed. Firstly, the study was done in a single-centre haemodialysis unit, thus the sample size was small. Secondly, the study investigated the effect of the PEP up to 6 months and the long-term beneficial effect of the program was unknown. Due to the short duration of

study, other important clinical outcomes such as frequency of hospitalization and mortality benefit were not explored.

Conclusion

The management of hyperphosphatemia in dialysis patients is challenging with multidimensional barriers and difficulties. In our study, with the effort of multidisciplinary team in educating dialysis patients via patient education program, showed significant improvement in knowledge, medication adherence and phosphate level.

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Conflicts of interest The authors declare that they have no conflict of interest.

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