Knowledge of haemodialysis patients concerning methods of preventing hyperphosphataemia

Wiedza chorych hemodializowanych na temat metod zapobiegania hiperfosfatemii

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ABSTRACT

INTRODUCTION: The beginning of renal replacement therapy is generally connected with changing dietary habits. A positive phosphate balance is a major clinical problem, often observed in haemodialysis patients. The treatment of hyperphosphataemia is based primarily on dietary intervention and the use of phosphate binders – medications which bind phosphorus in the gastrointestinal tract. Properly conducted education of patients with CKD helps to perceive the risks resulting from an improper diet.

MATERIAL AND METHODS: The diagnostic survey method with author's own survey questionnaire was used in the study. The survey contained closed questions concerning the knowledge of dietary recommendations for haemodialysis patients enabling the maintenance of the recommended phosphatemia. Statistical analysis was performed with SAS 9.4 software (SAS Institute Inc., Cary, North Carolina, USA), assuming the statistical significance level p < 0.05. The following tests were applied: chi-squared test/Fisher's exact test, due to the small size of subgroups – the Kruskal-Wallis test for comparison of three groups, and the Mann-Whitney U test to compare the two groups.

RESULTS: Haemodialysis patients were aware of the need for restrictions on the consumption of products with a high phosphorus content, but had problems choosing those recommended when composing meals. The right set of meats was chosen by 44 patients (36%). Dairy consumption in a moderate amount was declared by 74 people (61%). 46 respondents (38%) reduced their egg yolk consumption. Out of the range of available cheeses, 92 respondents (76%) declared the consumption of mainly curd cheese. The right set of bakery products was indicated by 31 patients (26%), and 73 patients (60%) avoided carbonated beverages.

CONCLUSIONS: Patients' knowledge concerning the possibilities of preventing hyperphosphataemia was far from insufficient.

KEY WORDS

chronic kidney disease, hyperphosphatemia, dietary recommendations for patients under haemodialysis

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WSTĘP: Rozpoczęcie leczenia nerkozastępczego wiąże się zasadniczo ze zmianą stylu odżywiania. Istotnym problemem klinicznym, często obserwowanym u chorych hemodializowanych, jest dodatni bilans fosforanowy. Postępowanie w przypadku hiperfosfatemii opiera się przede wszystkim na interwencji dietetycznej i stosowaniu leków wiążących fosfor w przewodzie pokarmowym. Właściwie przeprowadzona edukacja chorych na PCHN ułatwia postrzeganie zagrożeń, jakie wynikają z niewłaściwej diety.

MATERIAŁ I METODY: W badaniu zastosowano metodę sondażu diagnostycznego z wykorzystaniem kwestionariusza ankiet własnego autorstwa. Sondaż zawierał pytania zamknięte dotyczące znajomości wskazówek dietetycznych zalecanych chorym hemodializowanym, pozwalających na utrzymanie zalecanej fosfatemii. Analizę statystyczną wykonano w programie SAS wersja 9.4 (SAS Institute Inc., Cary, North Carolina, USA), przyjmując poziom istotności statystycznej p < 0,05. Wykorzystano testy: Chi²/Fisher a z uwagi na małą liczebność w podgrupach, test Kruskala-Wallisa dla porównania trzech grup oraz test U Mann-Whitneya dla porównania dwóch grup.

WYNIKI: Chorzy hemodializowani byli świadomi konieczności stosowania ograniczeń w spożywaniu produktów z wysoką zawartością fosforu, lecz mieli problemy z wybraniem tych, które są zalecane przy komponowaniu posiłków. Właściwy zestaw mięs wybrało 44 chorych (36%). Spożycie nabiela w umiarkowanej ilości deklarowały 74 osoby (61%). Spożycie żółtka jaja kurzego ograniczyło 46 respondentów (38%). Z puli dostępnych serów spożyście główne twarogu deklarowało 92 badanych (76%). Właściwy zestaw pieczywa wskazali 31 pacjentów (26%), a napojów gazowanych unikało 73 chorych (60%).

WNISKI: Stan wiedzy chorych na temat możliwości zapobiegania hiperfosfatemii był dalece niewystarczający.
AIM OF THE STUDY

The aim of the study was to assess the knowledge of haemodialysis patients concerning dietary management in the prevention of hyperphosphataemia. The research problems were formulated in the form of the following questions:

1. What was the patient's knowledge concerning the prevention of hyperphosphataemia?
2. Is there a greater knowledge deficit in the group of patients with hyperphosphataemia than in the group of patients with a normal serum phosphate concentration?
3. Did women take more notice of dietary recommendations than men?
4. Did the time of renal replacement treatment affect the knowledge of the studied patients?

MATERIALS AND METHODS

121 haemodialysis patients were observed, among whom 61 patients (including 39% of women) aged 50.6 ± 15.6 had at least a two-fold higher phosphate concentration in the last six months and 60 patients (including 38% of women) aged 62.9 ± 14.6, whose phosphate concentration in the last six months did not exceed the recommended standards. The study was conducted from March 2016 to May 2016 in two private dialysis centres. The management of both centres agreed to conduct the survey, the respondents participated in it voluntarily and were assured of their anonymity. The diagnostic survey method with the author's own survey questionnaire was used in the study. The survey contained closed questions concerning the knowledge of dietary recommendations for haemodialysis patients enabling the recommended phosphatemia to be maintained. Statistical analysis was performed with SAS 9.4 software (SAS Institute Inc., Cary, North Carolina, USA), assuming the statistical significance level $p < 0.05$. The following tests were applied: chi-squared test/Fisher’s exact test, due to the small size of subgroups – the Kruskal-Wallis test for comparison of three groups, and the Mann-Whitney U test to compare the two groups.
STUDY RESULTS

Characteristics of studied population

121 patients participated in the study, 38% of whom were women. The characteristics of the studied population are shown in Table I.

| Feature/Cecha                  | Group with hyperphosphataemia/Grupa z hiperfosfatemią | Group with normophosphataemia/Grupa z normofosfatemią |
|--------------------------------|------------------------------------------------------|------------------------------------------------------|
| Professional activity/Aktyność zawodowa | n (61) | % | n (60) | % |
| Working/Pracujący               | 9       | 15 | 5       | 8  |
| Unemployed/Bezrobotny           | 2       | 3  | 2       | 3  |
| Pensioner/Emeryt                | 15      | 25 | 36      | 61 |
| Disability pensioner/Rencista   | 35      | 57 | 17      | 28 |
| Education/Wykształcenie         |                                                   |                                                      |
| Primary/Podstawowe              | 5       | 8  | 12      | 20 |
| Vocational/Zawodowe             | 22      | 36 | 22      | 36 |
| Secondary/Średnie               | 26      | 43 | 16      | 27 |
| Higher/Wyszcze                  | 8       | 13 | 10      | 17 |

| Duration of renal replacement therapy declared by patients/Deklarowany przez chorych czas trwania leczenia nerkozastępczego | Group with hyperphosphataemia/Grupa z hiperfosfatemią | Group with normophosphataemia/Grupa z normofosfatemią |
|------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------|
|                                                                                                                   | n (61) | % | n (60) | % |
| 0 to 5 years/Od 0 do 5 lat                                                                                       | 24     | 39 | 25     | 42 |
| More than 5 to 10 years/Ponad 5 do 10 lat                                                                          | 26     | 43 | 23     | 38 |
| More than 10 years/Ponad 10 lat                                                                                    | 11     | 18 | 12     | 20 |

Kruskal-Wallis test: median value (lower quartile – upper quartile)/test Kruskala-Wallisa: mediana (dolny kwartyl – górny kwartyl)

Respondents' knowledge concerning dietary recommendations used in prevention of hyperphosphataemia

Although more than 70% of patients in the group with hyperphosphataemia were aware of the necessity to limit the consumption of products with high phosphorus content, the respondents had problems choosing the recommended products.

Out of the meat sets presented in the survey, the following are recommended: beef, pork loin, chicken. Such a set was selected by 25% of respondents. 10% considered red duck, turkey and goose to be safe. Giblets, smoked meat and fish were indicated by 3% of respondents. It is worth noting that as many as 62% of respondents admitted that they did not know which set was recommended for patients with hyperphosphataemia.

56% were not aware of which dairy products are recommended for patients undergoing renal replacement therapy. 11% considered that there was no need to introduce any restrictions in this respect, while 10% of patients considered dairy products to be strictly forbidden. Only
23% of respondents stated that dairy products, i.e. kefir, yoghurt, buttermilk or milk can be safely consumed up to one glass a day.

The necessity to reduce the consumption to one egg yolk per week was noticed by 34% of respondents. 3% of respondents believed that a minimum of one egg per day should be consumed, 7% limited the consumption of chicken egg white, but not yolk, and 56% of respondents did not know the answer to the posed question. The largest number of correct answers was observed for the recommendations concerning cheeses. 64% of respondents considered that of all the cheese types, both cottage cheese and curd cheese are safe. Only 2% stated that hard and blue cheese should be consumed and 34% of patients declared that they did not know the correct answer.

The studied patients had a problem indicating the bakery product with the lowest phosphate content. Only 28% of respondents knew that the lowest phosphate content was found in white wheat, sliced and rye bread. 7% of respondents indicated that soya bread or pumpkin should be chosen, and 65% of patients did not know what assortment of products to choose. Merely 28% were aware that the only allowed sweets were cakes with a low content of baking powder and chocolate-free cream wafers. 49% of the studied patients confirmed that carbonated beverages such as Coca-Cola, Fanta and beer should be eliminated from the diet. 61% were aware that food rich in preservatives is a very rich source of phosphorus.

In the group of patients with normophosphataemia, 48% of the respondents chose a safe set of meats. Only 7% considered it appropriate to eat duck, goose, turkey, but as many as 45% of respondents said they did not know the answer to the posed question. In the group of patients with normophosphataemia, awareness regarding the consumption of dairy products was much higher than in the group of patients with hyperphosphataemia. Only 35% of respondents did not know the answer. 7% of respondents declared that there is no need to introduce any restrictions, while 3% of respondents considered dairy products to be strictly forbidden. More than half of the respondents, namely 55%, stated that dairy products can be safely consumed up to one glass a day.

The necessity to limit the consumption of egg yolk to just one per week was noticed in the group with normophosphataemia by 58% of respondents, while 5% considered that at least one egg per day should be consumed. 12% limited the chicken egg white, but not yolk consumption, and 25% of patients did not know the recommendations for egg consumption with respect to hyperphosphataemia.

A higher percentage of correct answers was also reported for the recommendations concerning cheeses: 88% of those surveyed considered that of all cheese types, both cottage cheese and curd cheese are safe. Just 12% of them did not know the correct answer. The studied patients, similar to patients with hyperphosphataemia, had a big problem indicating the type of chicken egg white, but not yolk, and 56% of respondents believed that a minimum of one egg per week was noticed by 34% of respondents. 3% of patients declared that of all the cheese types, both cottage cheese and curd cheese are safe. Just 12% of them did not know the correct answer.

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of bread with the lowest phosphate content. Only 24% of respondents knew that the lowest phosphate content was found in white wheat, sliced and rye bread. 3% of respondents indicated that soya bread or pumpernickel should be chosen, 3% pointed to crispbread and sunflower seed bread as safe, and as many as 70% of respondents did not know what to choose.

Merely 27% of respondents were aware that the only allowed sweets were cakes with low content of baking powder and chocolate-free cream wafers.

72% of respondents confirmed that carbonated beverages such as Coca-Cola, Fanta, beer should be eliminated from the diet and as much as 77% was aware that foods rich in preservatives is a very rich source of phosphorus.

In most of the raised issues, the percentage of correct answers was significantly higher in patients with normophosphataemia than in those with hyperphosphataemia (Fig. 1, Tab.II).

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Out of the cheeses available on the market, selecting cottage cheese, curd cheese/Z dostępnych na rynku serów wybór produktów typu grani, ser twarogowy

Preferred white wheat, sliced or rye bread/Preferowane pieczywo jasne pszenne, tostowe lub żytnie

Selecting sweets without chocolate such as cream wafers, cakes with small amount of baking powder/Wybór słodyczy bez czekolady, t.j. wafelki śmietankowe, ciasta z niewielką ilością proszku do pieczenia

Avoiding carbonated beverages such as Fanta, Coca-Cola, beer/Unikanie napojów gazowanych, t.j. Fanta, Coca-cola, piwo

Avoiding foods rich in preservatives, canned and smoked foods/Unikanie żywności bogatej w konserwany

Table III. Respondents’ knowledge concerning basic dietary recommendations used to prevent hyperphosphataemia by gender

Table III. Wiedza badanych na temat podstawowych zaleceń dietetycznych stosowanych w zapobieganiu hiperfosfatemii z podziałem na płeć

| Dietary recommendations/Zalecane wskaźówki dietetyczne | Men/Mężczyźni | Women/Kobiety | P*Chi² | P*Fisher’s |
|-------------------------------------------------------|--------------|--------------|--------|-----------|
| Composing meals by selecting meat such as beef, chicken, pork loin/   Komponowanie posiłków – wybór mięs takich, jak wołowina kurczak, schab | n = 74 | 25 | 34 | 19 | 40 | NS | NS |
| Consumption of milk, buttermilk, yoghurts interchangeably up to one glass a day/Spozywanie mleka, maślanki, jogurtów zamiennie do szklanki dziennie | n = 47 | 26 | 35 | 21 | 45 | NS | NS |
| Unlimited consumption of chicken egg white and egg yolk consumption limited to one per week/Spozywanie białka jaja kurzego bez ograniczeń, natomiast ograniczenie żółtka jaj do jednego tygodniowo | n = 74 | 32 | 43 | 24 | 51 | NS | NS |
| Selecting cottage cheese, curd cheese/Wybór serka typu grani, sera twarogowego | n = 47 | 53 | 72 | 39 | 83 | NS | NS |
| Preferred white wheat, sliced or rye bread/Preferowane pieczywo jasne pszenne, tostowe lub żytnie | n = 74 | 18 | 24 | 13 | 28 | NS | NS |
| Selecting sweets without chocolate such as cream wafers, cakes with small amount of baking powder/Wybór słodyczy bez czekolady, t.j. wafelki śmietankowe, ciasta z niewielką ilością proszku do pieczenia | n = 47 | 22 | 30 | 11 | 23 | NS | NS |
| Avoiding carbonated beverages such as Fanta, Coca-Cola, beer/Unikanie napojów gazowanych, jak Fanta, Coca-cola, piwo | n = 74 | 45 | 61 | 28 | 60 | NS | NS |
| Avoiding foods rich in preservatives, canned and smoked foods/Unikanie żywności bogatej w konserwany, konserw oraz żywności wędzonej | n = 47 | 51 | 69 | 32 | 68 | NS | NS |

* Dependent variable: gender – chi²/Fisher’s test/Zmienna zależna: pleć – test Chi²/Fishera

Table IV. Respondents’ knowledge concerning basic dietary recommendations used to prevent hyperphosphataemia depending on duration of renal replacement therapy

Table IV. Wiedza badanych na temat podstawowych zaleceń dietetycznych stosowanych w zapobieganiu hiperfosfatemii z uwzględnieniem czasu trwania leczenia nerkowozastępczego

| Dietary recommendations/Zalecane wskaźówki dietetyczne | 0–5 years/lat | > 5–10 years/lat | > 10 years/lat | P*Chi² | P*Fisher’s |
|-------------------------------------------------------|--------------|----------------|--------------|--------|-----------|
| Composing meals by selecting meat such as beef, chicken, pork loin/Komponowanie posiłków – wybór mięs takich, jak wołowina kurczak, schab | 13 | 27 | 19 | 39 | 12 | 52 | NS | NS |
| Consumption of milk, buttermilk, yoghurts interchangeably up to one glass a day/Spozywanie mleka, maślanki, jogurtów zamiennie do szklanki dziennie | 17 | 35 | 19 | 39 | 11 | 48 | NS | NS |
| Unlimited consumption of chicken egg white and egg yolk consumption limited to one per week/Spozywanie białka jaja kurzego bez ograniczeń, natomiast ograniczenie żółtka jaj do jednego tygodniowo | 19 | 38 | 24 | 49 | 13 | 56 | NS | NS |
The knowledge concerning dietary recommendations in the prevention of hyperphosphataemia was comparable among men and women (Tab. III).

There was no effect of the duration of renal replacement therapy on the knowledge of basic dietary recommendations in the prevention of hyperphosphataemia (Tab. IV).

Respondents’ knowledge concerning use of phosphate binders

The vast majority of patients admitted that they regularly took preparations binding phosphorus in the gastrointestinal tract; 83% of respondents took calcium carbonate, 3% of patients took calcium acetate, while 7% of respondents took calcium supplements with vitamin D and 7% admitted that they did not use any medication binding phosphorus in the gastrointestinal tract (Tab. V).

Preparations binding phosphorus in the gastrointestinal tract reduce the absorption of phosphates only when taken with the first bite of a meal. Such an answer was Wiedza badanych na temat stosowania leków wiąjących fosfor

Zdecydowana większość chorych regularnie przyjmowała preparaty wiążące fosfor w przewodzie pokarmowym, w tym: 83% badanych stosowało węglan wapnia, 3% chorych octan wapnia, natomiast 7% ankietowanych zażywało suplementy wapnia w składzie z wit. D. 7% badanych nie stosowało żadnego środka mającego na celu wiązanie fosforu w żołądku (tab. IV).

Preparaty wiążące fosfor w przewodzie pokarmowym zmniejszają wchłanianie fosforanów jedynie wtedy, gdy są zażywane wraz z pierwszym kęsem posiłku. Takiej odpowiedzi udzieliło 67% badanych, zaś 8% respondentów uznało za zasadne łączenie wiązaczów fosforu z innymi lekami, a zdaniem 3% respondentów sposób zażywania leków nie miał wpływu na ich działanie.

5% badanych było przekonanych, że preparaty wiążące fosfor należy spożywać po posiłku, natomiast 17% nie potrafiło wskazać sposobu zażywania leków wiążących fosfor w przewodzie pokarmowym (tab. VI).

Table V. Use of preparations binding phosphorus in the gastrointestinal tract

| Preparation used to bind phosphorus in the gastrointestinal tract/Preparat stosowany w celu wiązania fosforu w przewodzie pokarmowym | Group with hyperphosphataemia/Grupa z hiperfosfatemią | Group with normophosphataemia/Grupa z normofosfatemią |
|---|---|---|
| Calcium carbonate/Węglan wapnia | 48 | 79 |
| Calcium acetate/Octan wapnia | 2 | 3 |
| Calcium supplement with vit. D/Suplement wapnia z wit. D w składzie | 5 | 8 |
| Non-calcium-based medications/Leki niewapniowe | 0 | 0 |
| Declaration of not using any of above listed substances/Deklaracja niestosowania żadnego z podanych środków | 6 | 10 |
| cd. tab. IV | | |
Phosphorus is an element contained in food products, both of plant and animal origin. In a healthy person, the serum phosphate concentration is usually within normal limits [7]. Deteriorating glomerular filtration results in an increased serum phosphorus concentration [8]. The factors that contribute to the incidence of cardiovascular complications are not only hypertension or diabetes mellitus, but also irregularities in calcium-phosphate metabolism. There is a positive correlation between hyperphosphatemia (> 5 mg/dl), hypercalcemia (> 9.5 mg/dl) and increased mortality in haemodialysis patients. Hyperphosphatemia contributes to tissue calcification, which significantly accelerates the ageing process of blood vessels [8,11]. This subject seems particularly relevant in the light of reports that hyperphosphatemia increases the risk of death in haemodialysis patients.

### DISCUSSION

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emodialysis patients on average by 12%, and together with hypercalcemia and an elevated PTH concentration by over 17% [10].

Influence of diet and phosphate binders on serum phosphorus concentration

Dietary management plays an important role in the treatment of CKD patients. It is advisable to monitor a number of nutrients and to follow specific recommendations. According to a study conducted by Judith Beto et al. in a group of 22989 dialysis patients, fewer complications and better nutritional status were observed in patients who regularly took drugs binding phosphorus in the gastrointestinal tract and controlled the quality of consumed meals. The study also revealed that the amount of absorbed phosphates depends on the use of food preservatives. The more the product was modified, the larger the amount of absorbed phosphorus was. Therefore, the quality of selected meals plays a significant role in preventing hyperphosphataemia [12,21]. It is difficult to remove excess phosphates during haemodialysis. The diet of a haemodialysis patient provides approximately 1200–1400 mg of phosphorus during the 48-hour break between haemodialysis procedures. A single dialysis session removes on average from 600 to 800 mg of phosphorus; therefore, the recommendations regarding restrictions on the intake of this element are highly justified [13]. Unfortunately, as has been demonstrated, the subjects in both groups had problems selecting nutrients so as to compose a meal with a limited amount of phosphates. Due to the high phosphate content in food, a diet alone may not be sufficient. In order to restore the phosphate balance, it is usually necessary to apply substances binding phosphorus in the gastrointestinal tract and thus hinder its absorption. Phosphate binders administered orally together with food form insoluble complexes excreted by the digestive tract. However, an important element is how the medicine is taken administration. Taking them on an empty stomach or after a meal results in significant absorption of the preparation, while phosphorus binding is limited. To fully benefit from the action of the applied substance, it should be taken with the first bite of a meal [15]. The effectiveness of the applied drugs depends primarily on proper use of the preparation and its phosphorus binding strength. The following phosphate binders are currently available on the market: calcium carbonate and acetate, as well as non-calcium-based compounds, i.e. sevelamer hydrochloride and lactate carbonate. Calcium-based preparations may cause hypercalcaemia and result in tissue and vascular calcification; therefore it is advisable to monitor serum calcium levels during therapy. Aluminium preparations, though effective in reducing phosphorus absorption, may only constitute a short-term replacement therapy. Prolonged use of aluminium results in the accumulation of this element and the development of aluminium encephalopathy [14].

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konkretnych zaleceń. Jak wynika z badań Judith Beto i wsp. przeprowadzonych w grupie 22 989 chorych dializowanych, mniej powiakień i lepszy stan odżywienia obserwowano u pacjentów, którzy regularnie stosowali leki wciągające fosfor w przewodzie pokarmowym i kontrolowali jakość spożywanych posiłków. Badanie wykazało także, że ilość wchłaniana fosforanów jest zależna od stosowania środków konserwujących żywność. Im bardziej modyfikowany był produkt, tym większa była pula wchłanianego fosforu. Stąd też jakość dobieranych posiłków odgrywa istotne znaczenie w zapobieganiu hiperfosfatemi [12,21]. Usuwanie nadmiaru fosforanów podczas zabiegu hemodializy jest trudne. Dieta chorego hemodializowanego dostarcza średnio ok. 1200–1400 mg fosforu w ciągu 48 godzinnej przerwy pomiędzy zabiegami. Pojedyncza sesja dializacyjna usuwa natomiast średnio od 600 do 800 mg fosforu, zatem zalecenia dotyczące ograniczeń w przyjmowaniu tego pierwiastka są jak najbardziej zasadne [13].

Niestety, jak wykazano, badani w obu grupach miała problem z doborem składników pokarmowych tak, by skomponować posiłek z ograniczoną ilością fosforanów. Z uwagi na ich wysoką zawartość w pożywie, samo zastosowanie diety może okazać się niewystarczające. Aby przywrócić równowagę fosforową, zwykle wymagane jest zastosowanie środków wciągających fosfor w przewodzie pokarmowym i utrudniających tym samym jego wchłanianie. Związki te podawane doustnie wraz z pokarmem tworzą nierozpuszczalne kompleksy wydalane przewodem pokarmowym. Istotnym elementem jest jednak sposób przyjmowania leku. Przyjmowanie ich na czczo bądź po posiłku powoduje znaczne wchłanianie preparatu, natomiast wciąganie fosforu jest ograniczone. Aby w pełni wykorzystać działanie zastosowanego środka, należy go zażyć wraz z pierwszym kęsem posiłku [15].

Skuteczność stosowanych środków zależy przede wszystkim od właściwego zażywania preparatu oraz jego siły wciągania fosforu. Obecnie na rynku dostępne są następujące preparaty wciągające fosfor: węglan i octan wapnia oraz związki niewapniowe, tj. chlorowodoryk, hydrowodoryk, węglan laktanu. Środki na bazie wapnia mogą powodować hiperkalcaemię oraz skutkować kalkylacyjną tkanki i naczyni, stąd też podczas terapii wskazane jest monitorowanie stężenia wapnia w surowicy. Preparaty glinowe, mimo iż skutecznie zmniejszają wchłanianie fosforu, mogą stanowić tylko krótkotrwałą terapię zastępczą. Długotrwałe stosowanie glinu prowadzi do kamułowania się tego pierwiastka i rozwój encefalopatii glinowej [14].

Badani z obu grup w zdecydowanej większości deklarowali zażywanie preparatów wciągających fosfor w przewodzie pokarmowym. Jedynie 10% z nich nie przyjmowało żadnego z preparatów. Wiodącym środkiem był węglan wapnia, którego stosowanie deklarowało prawie 90% badanych w grupie z normofosfatemią i niecałe 80% chorych z hiperfosfatemią.
The vast majority of respondents from both groups declared the use of preparations binding phosphorus in the gastrointestinal tract. Only 10% of them did not take any of the preparations. The leading substance was calcium carbonate, the use of which was declared by almost 90% of patients with normophosphataemia and less than 80% of patients with hyperphosphataemia.

The respondents were aware of the recommendations, however, significant differences observed between the groups are noteworthy. In the group of patients with normophosphataemia, three-quarters of the subjects knew how to use the preparations properly, whereas in the group with hyperphosphataemia only every second subject was tested, which could result in increased serum phosphorus concentrations.

Use of dietary recommendations aimed at preventing hyperphosphataemia

Maintaining a proper serum phosphorus concentration is closely related to an appropriate diet, the use of preparations binding phosphorus in the gastrointestinal tract and effective dialysis. The main objective of dietary treatment is a low phosphate intake (preferably up to 700 mg/day) while maintaining an adequate protein intake [9].

Phosphorus is an element present in almost every kind of food. Inorganic phosphorus, which is primarily used as a food preservative, is often found in contemporary diets. Organic phosphorus is mainly present in protein products of plant and animal origin. It is worth noting that the presence of phytin casing in products of plant origin is responsible for the low bioavailability of phosphorus in these products (20–40%), as opposed to phosphorus of animal origin, which is 40–60% absorbed. On the other hand, inorganic phosphorus is absorbed 100%, which is why its excessive consumption often leads to hyperphosphataemia [16].

It seems that highly processed food is a factor significantly hindering the maintenance of homeostasis in calcium-phosphate metabolism in patients with CKD [9]. The analysis showed that the most preservatives are present in soft drinks such as Coca-Cola, Fanta, etc. [16]. Current legislation obliges food producers to indicate on the label the agents used for preserving food products. In addition, the food labelling in Europe makes it easy to identify phosphate-containing preservatives, for example, the series from E 340 to 349 [16].

The role of education of CKD patients has been shown, among others, by Kalantar-Zadeh et al., who proved that educating patients in avoiding products with preservatives contributed to lowering the serum phosphate concentrations of these patients. Studies have revealed that patients undergoing education were much more likely to pay attention to the chemical composition of consumed food, with particular emphasis on food preservation agents [9].

In this study, the surveyed respondents were aware that modified products are a rich source of phosphorus. However, when analysing particular groups of respondents, badani byli świadomi wskazanych zaleceń, aczkolwiek na uwagę zasługują zaobserwowane istotne różnice pomiędzy grupami. Wśród chorych z normofosfatemią trzy czwarte badanych wiedziało, jak właściwie stosować preparaty, natomiast w grupie z hiperfosfatemią już tylko co drugi badany, co mogło skutkować zwiększonimi stężeniami fosforu w surowicy.

Zastosowanie wskazówek dietetycznych w celu zapobiegania hiperfosfatemii

Utrzymanie właściwego stężenia fosforu w surowicy jest ściśle związane ze stosowaniem odpowiedniej diety, środków wiążących fosfor w przewodzie pokarmowym oraz efektywnej dializoterapii. Głównym celem leczenia dietetycznego jest małe spożycie fosforanów (najlepiej do 700 mg/dobę) przy zachowaniu odpowiedniego spożycia białka [9].

Fosfor jest pierwiastkiem obecnym niemal w każdym rodzaju żywności. Fosfor nieorganiczny, występuje przede wszystkim jako dodatek konserwujący żywność, często spotykany we współczesnej diecie. Fosfor organiczny towarzy przede wszystkim produkтом białkowym pochodzenia roślinnego i zwierzęcego. Na uwagę zasługuje fakt, że obecność osłonki fitowej w produktach pochodzenia roślinnego odpowiada za małą biodostępność fosforu w tych produktach (20–40%), w odróżnieniu do fosforu pochodzenia zwierzęcego, który wchłania się w 40–60%. Fosfor nieorganiczny wchłania się natomiast w 100%, dlatego jego nadmierna konsumpcja często prowadzi do hiperfosfatemii [16].

Wydaje się, że czynnikiem istotnie utrudniającym chorągę na PChN utrzymanie homeostaz w zakresie gospodarki wapniowo-fosforanowej jest bogato przetwarzona żywność [9]. Analiza wykazała, że najwięcej środków konserwujących znajduje się w napojach bezalkoholowych, tj. Coca-coli, Fancie itp. [16]. Obecne przepisy zobowiązują producentów żywności do wypisania na etykietach środków użytych do konserwowania produktów żywnościowych. Oznakowanie żywności w Europie umożliwia łatwą identyfikację konserwantów zawierających fosforany – dotyczy to np. serii od E 340 do 349 [16].

Role edukacji chorych na PChN wykazali m.in. Kalantar-Zadeh i wsp., którzy dowiedzieli, że edukacja chorych w zakresie unikania produktów z dodatkiem konserwantów przyczyniła się do obniżenia stężeń fosforanów w surowicy tych pacjentów. Badania wykazały, że przeszkołenia chorzy znacząco częściej zwracali uwagę na skład chemiczny spożywanych potraw, ze szczególnym uwzględnieniem środków stosowanych do konserwowania żywności [9].

W prezentowanej pracy badani respondenci byli świadomi, że produkty modyfikowane stanowią bogate źródło fosforu, przy czym analizując poszczególne grupy chorych można było zauważyć znacząco większe deficyt wiedzy właśnie u osób z zaburzeniami gospodarki wapniowo-fosforanowej. Połowa badanych z hiperfosfatemią była świadoma szkodliwości spoży-
dents, a significantly larger knowledge deficit could be observed in the patients with calcium-phosphate disorders. Every second respondent with hyperphosphataemia was aware of the adverse effects of carbonated beverages, whereas in the group of patients with normophosphataemia three-quarters of the respondents already possessed this knowledge.

In the past, it was recommended to limit protein intake in order to compensate for hyperphosphataemia. Currently, it is well known that such management results in protein malnutrition, which significantly worsens the clinical condition of the patient. Contemporary dietary recommendations strive to encourage patients to consume protein products with a low phosphorus content and to avoid processed food with preservatives [9].

The analysis of food in terms of phosphate content presented by D’Alessandro et al. revealed that the highest amounts of phosphorus in food products are found in egg yolk, hard cheeses, nuts, some fish and meat [16]. Analysis of the amount of phosphorus (in milligrams) per gram of protein showed that protein products vary significantly in their phosphate content. It was concluded that protein products containing up to 12 mg of phosphorus/1g of protein are the most beneficial for the health of CKD patients.

Taylor et al. suggested that egg white is a good source of protein with a high biological value and low phosphorus content (< 2 mg/g). In a pilot study conducted among haemodialysis patients, meat was replaced with chicken egg white, which resulted in a reduced serum phosphate concentration while maintaining a proper albumin concentration [19]. In the group of patients with hyperphosphataemia, few respondents were aware of the fact that the consumption of chicken egg white is a “safe” source of protein; only one in three respondents gave the right answer. The respondents from the group with normophosphataemia showed better knowledge of the subject – over half of the respondents knew the protein levels that protein products containing up to 12 mg of phosphorus/1g of protein are the most beneficial for the health of CKD patients.

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At the very bottom of the pyramid there are phosphorus-free ingredients, i.e. olive oil, egg white, vegetables and fruit. These products may be consumed without any restrictions. The only exception are diabetes because of the glucose content. Patients with hyperka-
laemia should use methods of eliminating potassium from food [16].

The second level mainly includes plant foods that are richer in phosphorus, but due to the presence of phytin, their absorption is limited. These products include cereals (white bread, pasta, rice, corn flakes) or legumes (peas, broad beans, soya). The suggested intake of the above-mentioned foods is 2–3 portions per day. This level also contains dairy products, i.e. yoghurt, kefir, buttermilk, milk, the recommended consumption of which is up to 1 serving per day. The knowledge of the respondents from both groups was poor. The respondents did not know what kind of baked goods are most recommended for hyperphosphataemia. Merely every fourth respondent in both represented groups indicated white wheat bread as the preferred one. One in four respondents with hyperphosphataemia and every second respondent in the group with normophosphataemia indicated that it was safe to consume up to one glass of milk or yoghurt per day.

The third level includes selected foods of animal origin with a relatively low phosphorus content. These include lamb, rabbit meat, pork loin, chicken, beef or fish such as trout, tuna, cod, hake, and sole. It is recommended to select farmed fish carefully because of the unknown way they are fed by breeders. The suggested consumption of the above products is 1 portion per day. The fourth level contains high-protein products with a moderate phosphorus content, including turkey, squab, shrimp, salmon, giblets, curd cheese, and mozzarella. They should not be consumed more often than once a week [16].

When analysing the data obtained in the survey, it was noted that only one in four respondents in the group with hyperphosphataemia would choose meats with a moderate phosphorus content to compose their meal. In the group with normophosphataemia, almost half of respondents were able to indicate which meat products can be consumed safely. The fifth level consists of products rich in phosphorus, such as nuts, hard cheese, blue cheese, egg yolk. Their intake should be limited to 2–3 times a month.

Bearing in mind the way of preparing food, it is advisable to use the pyramid to guide the selection of foods and meals. The top of the pyramid includes products containing phosphates, i.e. carbonated beverages, processed cheese, processed meat and fish. It is not recommended to consume these products.

In the group of patients with hyperphosphataemia, more than half of the respondents indicated hard cheeses as not recommended products, while in the group of patients with normophosphataemia, almost 90% of respondents knew which of the cheeses consumed may adversely affect calcium and phosphate metabolism. Considering the method of food preparation, the authors of the pyramid recommend cooking as the preferred method due to additional food demineralization [9,16].

Controlling phosphorus intake is a complex and difficult task. The presented food pyramid makes it easier for patient to select foods and compose a menu in order to maintain phosphate intake within the range of 700–1000 mg/day, while preventing malnutrition.
CONCLUSIONS

1. Patients’ knowledge the possibilities of preventing hyperphosphatemia is insufficient and needs to be supplemented.
2. Significant differences between the knowledge of patients with hyperphosphatemia and the group with normophosphatemia were observed. Patients with normophosphatemia more often responded correctly in terms of meat selection, the way to consume eggs, dairy products, cheese as well as the consumption of carbonated beverages.
3. Neither gender nor the duration of renal replacement therapy had an impact on the knowledge of dietary recommendations concerning phosphorus consumption.

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