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Notes on techniques

Follow a recipe to prescribe phosphate during hemodialysis☆

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ABSTRACT

The addition of phosphorus (P) to the dialysate (LD) in the form of enema Casen® is common practice in patients with hypophosphatemia. The estimation of the amount to be used and the identification of the problems that may occur are not well defined. As a result of our work we propose a practical approach of how to proceed to increase phosphate concentration in the hemodialysate. We present a reasoned formula to calculate how much enema has to be added and the problems that may arise.

Receta para prescribir fósforo durante hemodiálisis

Palabras clave:
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RESUMEN

La adición de fósforo (P) en el líquido de hemodiálisis (LD) mediante enema con fosfato de sodio (enema Casen®) se utiliza habitualmente en pacientes con hipofosforemia. El cálculo de la cantidad y los problemas que puede presentar no se describen en la literatura. Nuestro trabajo hace un abordaje práctico de cómo poner fósforo en LD con una fórmula

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razonada para calcular cuánto volumen de enema añadir en función del concentrado de diálisis utilizado y los problemas que pueden aparecer.

Introduction

At haemodialysis (HD) units we find patients with intermittent or persistent hypophosphatemia (hypoP), which may be symptomatic. The frequency, the causes and the consequences of hypoP in chronic HD patients are not well known.[1] During the past year, in our hemodialysis unit a 9.35% of serum phosphate values were less than 2.5 mg/dl. HypoP may induce: rhabdomyolysis, haemolysis,[2,3] leucocyte dysfunction, respiratory failure, impaired myocardial function, bone disease, etc.[4,5] and in the elderly HD patient, hypoP has been associated with an increase in mortality.[6]

There are dialysates (LD) containing phosphate (P) for continuous acute dialysis techniques,[7,8] but there are no commercial preparations for chronic HD. Phosphate can be added to the dialysis fluid in the form of Casen® enema, or other products with a high content of P,[9] but no publication shows a practical approach on how to supplement it. Our goal is to describe how to calculate the volume of enema to be added to the acid dialysis concentrate to achieve a given concentration of P in the LD, the validation of this procedure, and the problems that may be encountered with this manoeuvre.

Theoretical basis to obtain the formula

First: How is P added to the LD? It is most common to use Casen® enema (Casen-Fleet, S.L. laboratories) containing 13.9 g of anhydrous sodium dihydrogen phosphate and 3.2 g of anhydrous disodium hydrogen phosphate. In Spain, there are presentations of 80, 140 and 250 ml. Each ml contains 43 mg of P.

Second: To what solution should we added? Since bicarbonate powder cartridges are the most commonly used, P should be added to the acid concentrate.

Third: How do I calculate how much enema to add?

a. What is the dilution acid to water that I use? The standard dilutions are 1:35 or 1:45. In the case of 1:45, every litre of acid result in 45 l of LD.
b. What is the volume of the acid concentrate? In our case, we have: 3.5 l bottles (Fresenius 5008®) and 5 l bags (AK-200®). Therefore, using acid dilution of 1:45, 5 l will generate 225 l of LD (45 × 5) and using 3.5 l will end up in 157.5 l (45 × 3.5).
c. What is the target P concentration in the LD ($[P]_{LDobj}$)? If we want 1.5 mg/dl, the amount of P required will be the result of multiplying $[P]_{LDobj}$ by the total volume previously calculated of LD (1.5 × 2250 dl or 1.5 × 1575 dl) which results in 3375 or 2362.5 mg of P for the AK-200® and Fresenius® monitors, respectively.
d. What volume of enema contains such an amount of P? Since 1 ml of enema contains 43 mg of P, divide the amount of P by 43. If 3375 or 2362.5 are divided by 43, the result is that 78 and 55 ml of enema need to added to the 5 and 3.5 l acid containers, respectively.
e. The formula is:

$$\text{Venema} = \frac{V_{LD} \times LD \times [P]_{LDobj}}{43}$$

where Venema is the volume of enema in ml; V_{LD} is the volume of the acid concentrate (in dl); LD is the dilution factor of each specific monitor and $[P]_{LDobj}$ is the desired P concentration in LD (mg/dl). It is divided by 43, the amount of P in 1 ml of enema.

Validation of the formula

The monitors used were: Fresenius 5008® and Gambro AK-200®. The amount of enema required to achieve a $[P]_{LDobj}$ of 1.5, 2, 2.5, and 3.5 mg/dl was calculated with 2 acid concentrates: 3.5 l and bottles of 5 l bags, with 1:45 dilution (Table 1).

In AK-200®, we used another acid solution of 1 l containing citrate, to generate a Ca 3.3 mEq/l and K 2 mEq/l with a $[P]_{LDobj}$ = 1.5 mg/dl. Using the same formula, with a 1:45 dilution, the volume of enema added was 15 ml.

The concentration of P in LD ($[P]_{LD}$) was measured 80 times in 2 separate situations:

- Sixty-five determinations in the LD of patients receiving P during their dialysis, with enema added to the acid concentrate due to hypophosphatemia (<2.5 mg/dl), using a $[P]_{LDobj}$ = 1.5 or 2 mg/dl. All had a calcium concentration of 3 mEq/l, except those dialysed with a LD containing citrate. The potassium concentrate was: 1.5 mEq/l (in 39), 2 mEq/l (in 13) and 3 mEq/l (in 19).
- The remaining 15 were obtained from LD with $[P]_{LDobj}$ = 2.5 or 3.5 mg/dl. This LD was not used in patients.

The P was added to the acid concentrate before starting the monitor and it was shaken. The dialysis was prepared as usual. Twenty minutes after monitor indication that the LD was ready, samples were extracted. Any incidence during the preparation of the monitor, addition of P to the concentrate or sampling, was recorded.

Laboratory methods

Pre-analytic preparation of the samples was not necessary because the LD lacks cells. P, Na, K, and Mg were determined using the Dimension EXL (Siemens) analyser. Direct colorimetric methods were used to determine P (phosphomolybdate method) and Mg; indirect potentiometry for Na,