

Nutritional considerations when using acute peritoneal dialysis for the treatment of acute kidney injury

Aim

The aim of this document is to:

- Provide practical considerations for the nutritional management of patients requiring acute PD for the management of AKI, particularly focusing on the associated energy gains in this patient group (including the treatment of COVID-19 patients).

This statement does not replace clinical judgement, local practices and evidence/guidelines for the nutritional management of critically ill patients.

Background

Peritoneal dialysis (PD) involves instilling hypertonic solutions into the abdominal cavity, in order to draw fluid and other solutes across the semipermeable peritoneal membrane from the circulation. PD solutions use glucose, amino acids or icodextrin as the osmotic agent. During the period the solutions are in the peritoneal cavity (dwell time), some of these substances can be reabsorbed into the circulation.

Glucose is used as the predominant osmotic agent in most PD solutions. Studies demonstrate that glucose is absorbed during the dwell times used in PD therapy when used in the management of End Stage Kidney Disease.

In patients on continuous ambulatory peritoneal dialysis (CAPD) with normal peritoneal transport capacity, it has been estimated that up to 60-80% of the daily dialysate glucose load is absorbed; this could add up to 100-200 grams/24 hour (400-800kcal/day) (Grodstein, 1981; De Santo, 1979; Khar et al. 2019).

PD has been used in some critical care units in the UK during the current COVID-19 pandemic for the acute management of acute kidney injury (AKI). This is partly due to a shortage of continuous renal replacement therapy (CRRT) consumables and machines, but also to overcome the issue of frequent filter clotting in patients with COVID-related coagulopathy (NHS England and NHS Improvement 2020).

In the acute setting, the fluid dwell times used for PD may be shorter (1-2 hours) especially in the initial period of dialysis. This has a potential impact on the amount of nutrition absorbed from the PD solution. Shorter dwell times may translate to less glucose absorption (especially if the initial dwell time is less than 2 hours). The patient may be receiving PD on an intermittent basis rather than continuously, therefore each instillation should be considered as a separate opportunity for absorption. It is important to remember that there is no standardised PD regimen, prescriptions are individualised and can change regularly and therefore close monitoring is required.

Energy Contribution

In patients who are critically ill, overfeeding can lead to the exacerbation of hypercapnia, hyperglycaemia, hypertriglyceridemia, fatty liver, uraemia and metabolic acidosis. The risk of adverse complications is likely to be the highest during the initial phase of critical illness (Casaer et al. 2011). Inevitably acute peritoneal dialysis is likely to provide a source of energy in the form of glucose. See Table 1.

Table 1. PD Solution details

Manufacturer	Brand	Glucose Content	Estimated Kcal/L (see notes for % absorbed during dwell in acute PD)
Baxter	Dianeal 1.36%	13.6 g/L	54
Baxter	Dianeal 2.27%	22.7 g/L	91
Baxter	Dianeal 3.86%	38.6 g/L	154
Baxter	Physioneal 1.36%	13.6 g/L	54
Baxter	Physioneal 2.27%	22.7 g/L	91
Baxter	Physioneal 3.86%	38.6 g/L	154
Baxter	Nutrineal	Zero (1.1% protein as osmotic agent)	0
Baxter	Extraneal (Icodextrin 7.5%)	0 g/l Glucose (75g/L Icodextrin)	0 glucose – see notes above regarding potential calorie contribution from plasma metabolism of absorbed oligosacharrides.
Fresenius Medical Care	Balance 1.5% (high and low Ca range)	15g/L	61
Fresenius Medical Care	Balance 2.3% (high and low Ca range)	22.73g/L	90.8
Fresenius Medical Care	Balance 4.5% (high and low Ca range)	42.5g/L	170

The Renal Nutrition Group (RNG) and the Critical Care Specialist Group (CCSG) of the British Dietetic Association (BDA) were asked to provide a guide of how to quantify the energy contribution from acute PD.

There is limited evidence to support a definitive recommendation of how to estimate the amount of glucose absorbed during this treatment. Therefore this document has been developed using evidence for the nutritional management of acute PD (Goes et al. 2013; Podel et al. 2000), critical illness (Singer 2019) and expert opinions.

The amount of glucose absorbed is depended on the time available for absorption, the volume instilled and the concentration of the glucose of bagged dialysate solution. See Table 2 (Heimbürger et al. 1992). In patients on CAPD, the glucose absorption from the dialysate may be estimated if the glucose concentration in the drained 24 hours dialysate is measured (Dombros et al, 2000). For example a 2 hour, 2L dwell, of a 2.27% solution may contribute 64 – 100 kcals of glucose. However this may be impractical in the acute setting.

Table 2. Dwell time and estimated glucose absorbed (adapted from Heimbürger et al. 1992).

Dwell time in minutes (hours)	Approximate amount of glucose absorbed % of initial intraperitoneal amount
30 (1/2)	15 – 25
60 (1)	25 – 40
120 (2)	35 – 55
180 (3)	45 – 65
240 (4)	50 – 70
360 (6)	60 – 80

In the acute setting, Podel et al (2000) attempted to measure the amount of glucose absorbed in 9 patients treated in critical care with acute PD. They recommended using a pragmatic approach and suggested based on their work that 40%- 50% of glucose provided by the PD regime would to be absorbed during acute PD (Podel et al. 2000). It is important to note that this study was based on 9 patients.

Goes and colleagues (2013) evaluated the metabolic implication of glucose absorption, protein losses and catabolism in a prospective cohort study over 18 months. They evaluated 208 sessions of high volume PD performed in 31 patients with AKI-and estimated glucose absorption at 35% +/- 10.5% per session (Goes et al. 2013).

Another consideration is the inflammatory response. Although glucose absorption does not appear to be impacted by systemic inflammation, this has not been studied extensively in the critical care setting (Cho et al, 2010). The clinical condition of the patient, the cause of AKI, inflammation and co- morbidities, are factors that should be taken into account during the formulation of nutritional prescription to avoid metabolic complications such as overfeeding (Goes et al 2013).

Use of Icodextrin

Icodextrin is a starch derived glucose polymer used as an alternative osmotic agent to glucose in PD. It is absorbed from the peritoneum via the lymphatic system in very low quantities (20-40%), even over a long dwell times (8-12 hours). It is metabolised by circulating amylase into oligosaccharides and maltose. The exact calorie contribution from absorbed icodextrin has not been determined. Limited evidence based on pharmacokinetic studies (and not in patients who are critically ill), suggests a maximum calorie contribution of approximately 150kcal for an 8-hour dwell time (Gokal, 2002) and that absorption of icodextrin is less than 10% in dwells time less than 2 hours (Olszowska, 2019). As maltose can only be converted to glucose in the renal tubules and the subsequent glucose resorption will be impaired in AKI, we would suggest using a pragmatic approach and considering calorie contribution from Icodextrin negligible.

Protein loss requirements

The loss of protein during PD is low (Yoowannakul et al, 2018) and is likely to be even lower in acute short dwells time. However, protein requirements are likely to be affected by the degree of the inflammatory response, as well as patients underlying clinical condition (William et al. 2017; Todorovic and Mafrci 2018). Goes et al. (2013) showed that high PD volume did not increase hypermetabolism and protein losses in patients with AKI treated with acute PD (Goes et al 2013).

The RNG and CCSG of the BDA would recommend:

- 1) Consider the following factors that will affect glucose absorption: dwell time, dialysate glucose concentration, how long the acute PD is needed for and presence of insulin resistance during the inflammatory response.
- 2) In view of the limited evidence, it is very difficult to estimate the amount of glucose absorbed, therefore we would suggest using a cautionary approach:
 - a. Estimate 35% (or using a range 25-45%) of glucose provided to be absorbed, but this is based on very limited evidence and may be not applicable to all patients. Exclude calories from Icodextrinas these are negligible.
 - b. Monitor the patient clinical condition, blood glucose levels and nutritional status closely. Adjustments to the nutrition plan should be made for non-nutritional calories e.g. propofol and glucose from PD, as per usual practice to avoid overfeeding.
 - c. Patients with diabetes will need closer monitoring of their blood glucose levels as well as individualisation of their insulin regimen, to take into account both PD and the nutritional regimen.
- 3) Energy and protein targets should be set as per local AKI and critical care practice. We recommend using the guidance in “Think Kidney 2017” (Williams et al. 2017), ESPEN 2019, and the Kidney and Critical Care sections of the Pocket Guide to Clinical Nutrition 2018 (Todorovic and Mafrici 2018).
- 4) Consider a goal of 1.3g protein kg/body weight (with adjustment for extreme of body mass index) delivered progressively over the first few days of critical illness. Protein supplementation/ high protein formulas may need to be considered in patients who are unable to meet protein targets due to the significant contribution of non-nutritional calories.
- 5) For those patients on the intensive care unit (ICU) with COVID 19, refer to guidance developed by the CCSG (BDA CCGS 2020).

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