Optimal peritoneal dialysis: choice of volume and solution

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Traditionally, peritoneal dialysis is performed using a volume of 2 l of fluid, containing glucose as an osmotic agent and lactate as a buffer. Currently, both the volume to be applied and the composition of the dialysis solution are subject to discussion. An interesting contribution with respect to the value of pH-neutral dialysis solutions is reported in this issue of Nephrology Dialysis Transplantation [1].

Volume

Historically, 2 l of dialysis fluid are administered for the dwell during peritoneal dialysis in adult patients. This will vary from 1.5 l in the very small adult to 2.5 l in the very large adult. In paediatrics, logically, more attention has been paid to the amount of fluid to be applied from the early days of peritoneal dialysis [2].

Originally, volumes were derived from the classical amount of 2 l in the standard adult person. Thus, amounts administered were ~40 ml/kg body weight or 1200 ml/m² body surface area (BSA). It was shown that scaling per BSA both made children more comparable with adult patients, and made ultrafiltration more predictable [3]. This is thought to be due to the better relationship of peritoneal surface area with BSA than with body weight [4].

The question regarding the optimal amount of fluid to be applied in peritoneal dialysis is not solved by this kind of calculation. Important information may be obtained by measurement of the peritoneal area coming into contact with the dialysis fluid, the peritoneal blood flow and the intraperitoneal pressure (IPP).

Peritoneal area

In rodents, it was shown that only ~25–30% of the total peritoneal cavity came into contact with the dialysis solution [5]. It was also shown that parietal and visceral peritoneum were not contributing equally to peritoneal transport [6]. In children, an increase of peritoneal exchange area was observed if the fill volume was raised from 800 to 1400 ml/m² [7]. In a recent study in humans, using computed tomographic scans of the peritoneal space after the addition of contrast medium to the dialysis solution, the peritoneal surface area in contact with the dialysate significantly increased from 0.57 to 0.67 m², if the volume was increased from 2 to 3 l [8]. There was a concomitant increase of mass transfer area coefficient. An important finding in the paper published in this issue is the observation that the peritoneal area available for exchange is also influenced by the composition of the peritoneal dialysis fluid [1]. Using pH-neutral solutions, this was decreased compared with acidic dialysis solutions.

Peritoneal blood flow

Blood flow limitation was shown to decrease small solute clearances in an animal model, but this phenomenon can also be expected to be present in humans [9].

Intraperitoneal pressure

The positive relationship between intraperitoneal volume and pressure was shown a long time ago [10]. Differences in fluid kinetics between individual dialysis solutions have a relationship to IPP [11], as well as differences in pH [7]. These differences may at least partly relate to pain experiences of the patients [12]. The measurement of IPP in combination with the determination of the peritoneal area available for exchange may allow creation of an optimal individualized prescription of the dialysis regimen [2,7,13].
Composition

The standard buffer applied in peritoneal dialysis solutions is lactate. The main disadvantage of currently provided peritoneal dialysis solutions is the low pH (~5.5), which is necessary to prevent caramelizeation of glucose during sterilization. Lactate-containing acidic solutions have detrimental effects on peritoneal mesothelial cells and macrophages, and may give rise to pain sensations in patients. Currently, lactate is completely or partially replaced by bicarbonate, and pH is elevated into the physiological range in the newly developed solutions by using double-bag technology. It is believed that particularly the normal pH is responsible for the better results obtained with respect to peritoneal cellular function both in vitro and in vivo [12,14–19]. A significant reduction in systemic load of advanced glycation end-products (AGEs) was reported using these solutions largely free of glucose degradation products [20]. A more effective correction of acidosis and better preservation of peritoneal cell mass (measured using the marker CA 125) was observed using a pH-neutral solution [21]. Using pH-neutral dialysis solution in a peritoneal equilibration test, no differences from the conventional solutions were seen with respect to solute and fluid transport [22]. In the paper in this issue, it is shown that, next to the absence of infusion pain, IPP was lower and vasodilatory effects were less using pH-neutral solution [1]. This might explain the somewhat lower ultrafiltration observed in a Spanish study, of which the results still have to be confirmed [23]. No differences in ultrafiltration were observed in another published study [22].

Conclusion

The use of pH-neutral peritoneal dialysis solutions is advocated wherever available, but particularly in patients with relatively short dwell periods (e.g. children on nightly intermittent peritoneal dialysis), since optimal pH of the standard dialysate within the peritoneal cavity is only reached after 2h [22]. This forms the backbone of the guidelines for the choice of solutions in paediatric peritoneal dialysis, which were published recently [24,25].

The volume of dialysis fluid to be administered should be individually determined, taking into account measurement of the peritoneal surface area available for exchange and the IPP. Guidelines on this recommendation have also been published recently [26].

The paper by Fischbach et al., reported in this issue of Nephrology Dialysis Transplantation, provides clear arguments in favour of the application of pH-neutral peritoneal dialysis solutions wherever possible [1].

Conflict of interest statement. None declared.

References

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