Comparison of icodextrin and glucose solutions for the daytime dwell in automated peritoneal dialysis

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Abstract

Background. The sustained ultrafiltration achieved by icodextrin is more suited for the daytime dwell in automated peritoneal dialysis (APD) than glucose solutions.

Methods. Seventeen patients receiving APD underwent assessment using three different solutions for the daytime dwell: 2.27% glucose, 3.86% glucose and 7.5% icodextrin. Patients were then observed on icodextrin for a 6 month period.

Results. Daytime ultrafiltration was greater for 3.86% glucose (median 0.10, IQR 0.01 to 0.32 l) and icodextrin (median 0.26, IQR 0.14 to 0.36 l) compared with 2.27% glucose (median −0.19, IQR −0.54 to −0.08 l), with 3.86% glucose and icodextrin not being significantly different. Positive ultrafiltration occurred in 17/17 patients with 2.27% glucose, 13/17 patients with 3.86% glucose and 16/17 patients with icodextrin (χ2, P<0.0001). The difference in ultrafiltration of icodextrin and 3.86% glucose correlated with the 4 h dialysate/plasma creatinine ratio in a PET test (r = 0.51, P<0.05). Daytime Kt/V urea was greater for 3.86% glucose (median 0.27, IQR 0.20 to 0.48 per week, P<0.01) and icodextrin (median 0.31, IQR 0.27 to 0.49 per week, P<0.0001) than for 2.27% glucose (median 0.22, IQR 0.15 to 0.38 per week), with the difference between 3.86% glucose and icodextrin not reaching statistical significance (P = 0.06). Daytime creatinine clearance was greater for 3.86% glucose (median 10.2, IQR 6.9 to 13.6 l/week/1.73 m2, P<0.02) and icodextrin (median 12.1, IQR 9.3 to 15.7 l/week/1.73 m2, P<0.005) than for 2.27% glucose (median 8.8, IQR 4.9 to 11.9 l/week/1.73 m2). Daytime creatinine clearance was greater for icodextrin than for 3.86% glucose (P<0.005). The effects of icodextrin were sustained for the 6 month observation period.

Conclusions. Icodextrin produced enhanced ultrafiltration and clearances compared with 2.27% glucose, without the exposure of the peritoneum to hypertonic glucose solutions.

Key words: automated peritoneal dialysis; dialysis adequacy; icodextrin; ultrafiltration

Introduction

Automated peritoneal dialysis (APD) is an important option for the treatment of end-stage chronic renal failure (ESCRF), accounting for an increasingly large proportion of patients receiving long term peritoneal dialysis [1]. APD is often useful in the treatment of CAPD failure where poor ultrafiltration results from high peritoneal membrane transport, as loss of osmotic activity due to glucose absorption is less of a problem with the short duration night-time dwells of APD [2]. However, the main and increasingly important indication for APD is as the initial mode of renal replacement therapy for chronic renal failure for social reasons, with the absence of daytime exchanges often being more suited to patient employment and lifestyle than CAPD [2].

A daytime dwell is commonly required in APD to allow achievement of adequate clearance [3]. However, glucose absorption during the long daytime exchange results in poor ultrafiltration during this period. This results in limitation of the dialysate volume drained after the daytime dwell, which will reduce its contribution to clearance and will also have an adverse effect on maintenance of satisfactory fluid balance. This glucose absorption may contribute to the adverse metabolic effects of peritoneal dialysis. The glucose polymer icodextrin has been used as an alternative osmotic agent in CAPD where it has been shown to produce sustained ultrafiltration over long (8–12 h) dwell periods [4]. This study was performed to compare icodextrin to different concentration glucose solutions for the long daytime dwell in APD and to determine the effect of longer term use of icodextrin in this situation.

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Methods and subjects

We studied 17 patients (15 male and 2 female) receiving APD with a daytime dwell. Patients with hypotension or tendency to dehydration which could possibly be exacerbated by enhanced daytime ultrafiltration and patients with problems due to raised intra-abdominal pressure (e.g. hernias and fluid leaks) were excluded. All other patients on APD were considered for entry into this study, without any selection related to clinical criteria or peritoneal membrane function. Patients on APD not entering the study (15 patients) were excluded for the following reasons: absent daytime dwell (5 patients), intercurrent medical problems (4 patients—2 cerebrovascular disease, 1 recent myocardial infarction, 1 vascular surgery), 3 patients declined, problems due to raised intra-abdominal pressure (2 patients) and poor compliance (1 patient). Median patient age was 48.5 years (range 26–69) and 2 had insulin-dependent diabetes mellitus. Causes of renal failure were glomerulonephritis (6 patients), chronic pyelonephritis/vesicoureteric reflux (3 patients), diabetic nephropathy (2 patients), hypertension (2 patients), unknown (2 patients), autosomal dominant poly cystic kidney disease (1 patient) and nephrectomy for renal tumour (1 patient).

APD was performed with the AMP 80/2 cyclor in 4 patients and the Homechoice cyclor (Baxter) in 13 patients. A total night-time exchange volume of 10–15 l was used (10 l in 4 patients, 12.5 l in 1 patient and 15 l in 12 patients) with a median night-time dialysis time of 9 h (range 8.5–10.2 h). Thus the median daytime dwell time was 15 h (range 13.8–15.5 h). Prior to the study the daytime exchange consisted of 2.27% glucose in all patients with dialysate volumes of 1.5 l in 14 patients and 2 l in 3 patients.

The study comprised two phases. The first part of the study consisted of a comparison of 2.27% glucose, 3.86% glucose and 7.5% icodextrin containing dialysis fluid for the daytime dwell. Patients underwent assessment while performing their standard APD regime with a 2.27% glucose daytime dwell, and then for 2 days periods with an identical regime but with the daytime exchanges consisting of 3.86% glucose and 7.5% icodextrin fluid, performed in random order. At the end of these periods of equilibration with the different solutions, day and night dialysate collections were performed along with blood tests (samples taken in the middle of the daytime cycle) to allow calculation of urea and creatinine clearances and ultrafiltration. Dialysate creatinine concentrations were corrected for a minor interference effect of glucose present in the fluid. Residual renal function was estimated as the mean of the urinary clearances of creatinine and urea measured from a single 24 h urine collection performed at the start of the study.

During the second phase of the study, patients were maintained on icodextrin for the daytime dwell and were followed up after 1, 3 and 6 months to assess clearances and ultrafiltration.

Most of the data was normally distributed, except for occasional measurements of total clearance or ultrafiltration which were skewed due to the contribution of the night cycle. Therefore, comparisons of paired means of measurements of drain volumes, ultrafiltration and clearances was by the non-parametric Wilcoxon signed-ranks test and the data expressed as median (interquartile range). Other, normally distributed data (e.g. other biochemistry and blood pressures) was expressed as mean (standard deviation) with the comparison of means of groups of measurement in the same subjects by the paired t-test. Correlation of daytime ultrafiltration and D/P creatinine (which were normally distributed) was performed using the Pearson correlation coefficient and linear regression analysis was performed. Comparison of numbers of patients with positive or negative daytime ultrafiltration with the three fluids was performed by the Chi squared test. The study was approved by the local research ethics committee and all patients gave written informed consent.

Results

Ultrafiltration

The median volume of dialysis fluid infused in during the daytime dwell was 1.5 (IQR 1.5–1.5) litres. The volumes drained after the daytime dwell were compared with the infused volume (Table 1). The dialysate volume drained out after the daytime dwell was significantly lower for 2.27% glucose (1.36 IQR 1.06 to 1.68 l) $P<0.02$, similar for 3.86% glucose (1.62 IQR 1.54 to 1.82 l) $P=ns$ and greater for icodextrin (1.76 IQR 1.65 to 2.14 l) $P<0.005$ compared with the infused volume. Comparisons between the drained volumes for the daytime dwell within the 3 solutions showed that the volumes for 3.86% glucose ($P<0.01$) and icodextrin ($P<0.001$) were greater than for 2.27% glucose, with no significant difference between 3.86% glucose and icodextrin. The resulting daytime ultrafiltration volumes were thus greater for 3.86% glucose (0.10 IQR 0.01 to 0.32 l) $P<0.01$ and icodextrin (0.26 IQR 0.14 to 0.36 l) $P<0.001$ than for 2.27% glucose ($−0.19$ IQR $−0.54$ to $−0.08$ l) (Table 1). The difference between 3.86% glucose and icodextrin was not statistically significant, but the sample size was not adequate to confirm or exclude a significant difference of this magnitude with reasonable power. The majority of patients had net fluid absorption from the daytime dwell with 2.27% glucose, but most achieved net fluid removal with 3.86% glucose and all but one achieved positive daytime ultrafiltration with icodextrin (Table 2) $\chi^2 P<0.0001$. The impact of daytime ultrafiltration with the different fluids on overall 24 h ultrafiltration by APD is shown in Table 1, with 3.86% glucose and icodextrin use for the daytime dwell resulting in a significant improvement in the overall ultrafiltration compared with 2.27% glucose. The median contributions of the daytime dwell to total 24 h ultrafiltration were 8.5% for 2.27% glucose, 5.8% for 3.86% glucose and 14.8% for icodextrin.

Although there was no significant difference demonstrated between the mean daytime ultrafiltration volumes with 3.86% glucose and icodextrin, it was hypothesised that icodextrin may be particularly effective in patients with high peritoneal permeability, where the benefit of high concentration glucose solutions would be limited by high rates of glucose absorption. The differences in daytime ultrafiltration volumes between icodextrin and 3.86% glucose were correlated with the 4 h dialysate/plasma creatinine ratio from the PET test with a significant relationship ($r=0.51$, $P<0.05$) being demonstrated (Figure 1). Linear
Table 1. Effect of different daytime fluids on day drained volume, day and overall 24 h ultrafiltration (values median and IQR, litres)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Daytime drain volume</th>
<th>Daytime ultrafiltration</th>
<th>Night time ultrafiltration</th>
<th>Total 24 h ultrafiltration</th>
<th>Day ultrafiltration as % of total ultrafiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.27% glucose (G227)</td>
<td>1.36 (1.06 to 1.68)</td>
<td>-0.19 (−0.54 to −0.08)</td>
<td>1.50 (1.06 to 1.73)</td>
<td>1.41 (0.95 to 1.62)</td>
<td>−8.5 (−33.3 to 10.5)</td>
</tr>
<tr>
<td>3.86% glucose (G386)</td>
<td>1.62 (1.54 to 1.82)</td>
<td>0.10 (0.01 to 0.32)</td>
<td>1.52 (1.16 to 1.82)</td>
<td>1.68 (1.42 to 2.08)</td>
<td>5.8 (0.9 to 17.4)</td>
</tr>
<tr>
<td>Icodextrin (ICO)</td>
<td>1.76 (1.65 to 2.14)</td>
<td>0.26 (0.14 to 0.36)</td>
<td>1.30 (1.14 to 1.54)</td>
<td>0.10 (0.01 to 0.32)</td>
<td>14.8 (6.0 to 22.4)</td>
</tr>
</tbody>
</table>

Table 2. Numbers of patients achieving net fluid removal from the daytime dwell with the different dialysis solutions ($\chi^2 P < 0.0001$)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number positive ultrafiltration</th>
<th>Number negative ultrafiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.27% glucose</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>3.86% glucose</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Icodextrin</td>
<td>16</td>
<td>1</td>
</tr>
</tbody>
</table>

Clearances

Clearances, measured as $Kt/V$ for urea and creatinine clearance (adjusted to body surface area) per week using the three different solutions for the daytime dwell with the same night time regime were compared (Table 3). For the contribution of the daytime dwell, $Kt/V$ urea was greater for 3.86% glucose (0.27 IQR 0.20 to 0.48 per week, $P < 0.01$) and icodextrin (0.31 IQR 0.27 to 0.49 per week, $P < 0.001$) than for 2.27% glucose (0.22 IQR 0.15 to 0.38 per week), with the difference between 3.86% glucose and icodextrin not quite reaching statistical significance ($P = 0.06$). The total dialytic $Kt/V$ was greater for icodextrin than 2.27% glucose and 3.86% glucose, with no difference between the two glucose solutions.

For creatinine clearance the contribution of the daytime dwell was greater for 3.86% glucose (10.2 IQR 6.9 to 13.6 l/week/1.73 m$^2$, $P < 0.02$) and icodextrin (12.1 IQR 9.3 to 15.7 l/week/1.73 m$^2$, $P < 0.0005$) than for 2.27% glucose (8.8 IQR 4.9 to 11.9 l/week/1.73 m$^2$). The daytime creatinine clearance was significantly greater for icodextrin than for 3.86% glucose ($P < 0.005$). The total dialytic creatinine clearance was greater for icodextrin than 2.27% glucose and 3.86% glucose, with no difference between the two glucose solutions (Table 3).

Fig. 1. The differences in daytime ultrafiltration volumes between icodextrin and 3.86% glucose were significantly correlated with the 4 h dialysate/plasma creatinine ratio from the PET test ($r = 0.51, P < 0.05$). Regression analysis gave the relationship:

$$\text{UF (icodextrin)} - \text{UF (3.86% glucose)} = 1.56 \left( \frac{D}{P} \text{creatinine} \right) - 0.97$$

with significance $P < 0.05$ and $r^2 = 0.26$, where UF is ultrafiltration in litres and $D/P$ creatinine refers to the 4 h PET result.

Other biochemical effects

Serum sodium fell significantly on treatment with icodextrin from 141.9 (2.4) mmol/l to 137.7 (2.4) mmol/l $P < 0.0001$ Serum osmolality (measured directly) did not significantly change (317.7 s.d. 6.8 for 2.27% glucose and 315.9 s.d. 8.6 for icodextrin) and there were no associated symptoms. However, the calculated osmolal gap increased from 5.6 (6.1) to 10.7 (5.1), $P < 0.02$. Peritoneal protein loss from the daytime dwell did not differ for 2.27% glucose (2.7 g s.d. 0.9), 3.86% glucose (2.6 g s.d. 0.8) or icodextrin (2.8 g s.d. 1.1). No other significant effects of treatment with
icodextrin were noted in biochemical parameters including serum calcium and phosphate concentrations or liver function tests.

**Six month follow up on regular icodextrin**

Ten patients continued on treatment with APD using icodextrin for the daytime dwell for a period of at least 6 months (of the other 7 patients, 1 had received a renal transplant and one converted to haemodialysis because of catheter problems before 6 months follow up and 5 had not been on treatment with icodextrin for 6 months at the time of completion of the study). The daytime ultrafiltration and contributions to weekly Kt/V and creatinine clearance were sustained over this 6 month period (Table 4). During this study, no adverse effect of the use of icodextrin were noted. There was only a single episode of peritonitis (culture negative) responding to treatment with antibiotics (an incidence which would not be unexpected—at the time of analysis, the cumulative treatment time with icodextrin was equivalent to 72 patient months).

During the first month symptomatic hypotension occurred in 5 of 14 subjects to a degree requiring reduction in number of antihypertensive agents or dosage. Despite this reduction in medication, there was a significant reduction in systolic blood pressure from 142.4 (23.9) mmHg to 122.9 (17.7) mmHg P < 0.005 and a tendency for diastolic blood pressure to be reduced from 82.8 (9.8) mmHg to 76.8 (10.1) P = 0.075. During this time, body weight tended to reduce from 74.2 (16.1) kg to 73.4 (16.4) kg (P = 0.06).

There was no significant change in peritoneal membrane function as estimated by a standard PET test over the 6 month period in these subjects with 4 h dialysate plasma glucose 3.86% glucose Icodextrin was equivalent to 72 patient months). Standard osmotic agent for peritoneal dialysis and the icodextrin was noted in biochemical parameters including serum calcium and phosphate concentrations or liver function tests.

**Discussion**

It is well recognized that the daytime dialysate dwell makes an important contribution to total dialytic clearance in APD and is essential in most patients (especially larger patients and those with little residual renal function) to enable currently recommended clearance targets to be achieved [3]. Glucose is currently the standard osmotic agent for peritoneal dialysis and the rapid ultrafiltration achieved over short time periods is ideally suited to the short night time cycles of APD. However, glucose absorption over the long daytime dwell time in APD results in reduced effectiveness of moderately hypertonic solutions in achieving net

**Table 3. Dialytic clearances estimated as Kt/V urea (per week) and creatinine clearance (litres/week/1.73 m²) using the three different solutions for the daytime dwell (values median and IQR)**

<table>
<thead>
<tr>
<th></th>
<th>2.27% glucose (G227)</th>
<th>3.86% glucose (G386)</th>
<th>Icodextrin (ICO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime Kt/V</td>
<td>0.22 (0.15 to 0.38)</td>
<td>0.27 (0.20 to 0.48)</td>
<td>0.31 (0.27 to 0.49)</td>
</tr>
<tr>
<td></td>
<td>P &lt; 0.01 vs (G227)</td>
<td>P &lt; 0.001 vs (G227)</td>
<td>P = 0.06 vs (G386)</td>
</tr>
<tr>
<td>Total dialytic Kt/V</td>
<td>1.66 (1.26 to 2.27)</td>
<td>1.73 (1.45 to 2.32)</td>
<td>1.82 (1.38 to 2.48)</td>
</tr>
<tr>
<td></td>
<td>ns vs (G227)</td>
<td>ns vs (G227)</td>
<td>ns (P = 0.06) vs (G386)</td>
</tr>
<tr>
<td>Total Kt/V (+ residual function)*</td>
<td>2.25 (1.96 to 2.75)</td>
<td>2.19 (2.06 to 2.74)</td>
<td>2.33 (2.07 to 2.88)</td>
</tr>
<tr>
<td></td>
<td>ns vs (G227)</td>
<td>ns vs (G227)</td>
<td>P &lt; 0.05 vs (G386)</td>
</tr>
<tr>
<td>Daytime creatinine clearance</td>
<td>8.8 (4.9 to 11.9)</td>
<td>10.2 (6.9 to 13.6)</td>
<td>12.1 (9.3 to 15.7)</td>
</tr>
<tr>
<td></td>
<td>P &lt; 0.02 vs (G227)</td>
<td>P &lt; 0.001 vs (G227)</td>
<td>P &lt; 0.005 vs (G386)</td>
</tr>
<tr>
<td>Total dialytic creatinine clearance</td>
<td>43.0 (33.1 to 60.9)</td>
<td>45.8 (35.7 to 53.8)</td>
<td>49.6 (40.2 to 71.9)</td>
</tr>
<tr>
<td></td>
<td>ns vs (G227)</td>
<td>ns vs (G227)</td>
<td>P = 0.005 vs (G386)</td>
</tr>
<tr>
<td>Total creatinine clearance (+ residual function)*</td>
<td>60.9 (53.2 to 83.7)</td>
<td>59.4 (51.7 to 83.7)</td>
<td>64.4 (56.2 to 92.3)</td>
</tr>
<tr>
<td></td>
<td>60.9 (53.2 to 83.7)</td>
<td>60.9 (53.2 to 83.7)</td>
<td>64.4 (56.2 to 92.3)</td>
</tr>
</tbody>
</table>

*Calculated from total dialytic clearance (as measured at the end of the study period for each daytime solution) plus the residual renal function calculated at the start of the study as described in the methods section.

**Table 4. Daytime ultrafiltration (litres) and contribution of daytime dwell to weekly Kt/V (per week) and creatinine clearance (litres/week/1.73 m²) was maintained over a 6 month period (10 subjects) (values median and IQR)**

<table>
<thead>
<tr>
<th></th>
<th>Start</th>
<th>1 month</th>
<th>3 months</th>
<th>6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrafiltration</td>
<td>0.34 (0.24 to 0.46)</td>
<td>0.23 (0.16 to 0.42)</td>
<td>0.29 (0.23 to 0.38)</td>
<td>0.41 (0.14 to 0.52)</td>
</tr>
<tr>
<td>Kt/V</td>
<td>0.36 (0.27 to 0.46)</td>
<td>0.36 (0.28 to 0.43)</td>
<td>0.35 (0.32 to 0.46)</td>
<td>0.37 (0.36 to 0.43)</td>
</tr>
<tr>
<td>Creatinine clearance</td>
<td>13.0 (9.9 to 15.2)</td>
<td>12.15 (10.3 to 13.3)</td>
<td>12.2 (11.1 to 14.7)</td>
<td>12.7 (12.3 to 13.8)</td>
</tr>
</tbody>
</table>
ultrafiltration at all from the daytime dwell, which may have an adverse effect on patient fluid balance. This may be a particular problem in patients with high peritoneal membrane transport characteristics, who may have converted from CAPD to APD because of resulting ultrafiltration failure. The daytime dwell is also likely to contribute to the adverse effects of glucose-based dialysis fluids, including hyperlipidaemia [5], hyperglycaemia, hyperinsulinaemia and accumulation of body fat [6]. Glucose solutions also result in the formation of advanced glycosylation end-products (AGEs) which may have adverse effects relating to peritoneal structure and the development of vascular disease, and this may be a particular concern if using very hypertonic glucose solutions for the long daytime dwell [7].

Icodextrin is a glucose polymer which has been developed as an alternative osmotic agent for peritoneal dialysis [8]. It has been shown to produce gradual sustained ultrafiltration for the long overnight dwell period in CAPD (8–12 h duration) which is superior to weaker glucose solutions and at least as good as the most hypertonic glucose solutions [4]. It uniformly achieves net fluid removal over these time periods in CAPD. Icodextrin, due to its high molecular weight and reflection coefficient, causes ultrafiltration by colloid osmosis, with passage of water through the small pore system, unlike glucose which is believed to act on ultra small transcellular pores [9–11]. Icodextrin has been shown to prolong technique survival for CAPD in patients with CAPD failure due to poor ultrafiltration [12] and it may be effective in managing the temporary loss of ultrafiltration with glucose solutions that may accompany peritonitis. Some icodextrin is absorbed and is metabolized to smaller oligosaccharide breakdown products, especially the disaccharide maltose [13]. This is usually metabolized to glucose by the enzyme maltase which is present in the normal kidney and is absent in chronic renal failure. Thus there is a degree of accumulation of these metabolites, reaching a steady state at 2 weeks, with removal by dialysis during non-icodextrin exchanges. Increasing experience with icodextrin (up to 5 years in some CAPD patients) has shown no adverse effects from this maltose accumulation, which rapidly reverses on stopping icodextrin use [13]. Icodextrin is iso-osmolar and therefore may be more biocompatible than hypertonic glucose solutions. Furthermore, in in-vitro studies icodextrin has been shown to result in a lower level of AGE production than glucose solutions [14].

The ultrafiltration profile achieved with icodextrin would be ideally suited to the long daytime dwell of APD. An initial study showed an effective ultrafiltration with icodextrin with improved Kt/V during the daytime dwell in APD compared with a dry daytime peritoneal cavity [15]. A subsequent randomized prospective trial has shown enhanced ultrafiltration and clearance using icodextrin as the daytime dwell in APD compared with variable concentrations of glucose (mean 2.25–2.41%) [16]. This study shows that icodextrin achieves superior ultrafiltration from the APD day dwell compared with our previously routine use of 2.27% glucose, resulting in a mean difference of 500 ml greater ultrafiltration volume per day. Icodextrin produced net fluid removal in all but one patient (and even in this single patient the drain volume was probably spurious as he has subsequently been demonstrated to reliably achieve positive ultrafiltration with icodextrin). The results tended to be better than for 3.86% glucose but this was not statistically significant and a far larger study (60–80 patients) would be required to confirm or exclude a significant difference of the magnitude observed. However, the positive correlation of the difference in ultrafiltration between icodextrin and 3.86% glucose with the 4 h dialysate/plasma creatinine ratio suggests that icodextrin may at least be superior in subjects with higher peritoneal membrane transport.

It is also important that results with icodextrin are achieved without exposure of the patient or peritoneal membrane to glucose for a relatively long period of time, whereas it is necessary to use particularly hypertonic solutions to achieve comparable results with glucose. The increased drained dialysate volume achieved with icodextrin was shown to result in an enhanced total dialytic weekly creatinine clearance and Kt/V.

The fall in serum sodium observed was asymptomatic and of the same magnitude as previously reported for both APD and CAPD [4,17]. The increased osmolar gap was again compatible with accumulation of icodextrin metabolites of a similar degree to that previously observed in both APD and CAPD [17]. It is a potential concern that accumulation of maltose and other metabolites from the longer daytime dwell in APD would be greater than from CAPD, but this does not seem to occur; possibly due to greater clearance by the rapid nocturnal cycles [17].

The longitudinal observations showed that the effects of icodextrin in APD are maintained over a 6 month period, without any reduction in ultrafiltration or change in PET test results. The reduction in blood pressure and need for antihypertensive medication is of great potential interest. Cardiovascular disease in a major cause of the increased mortality in ESRF and blood pressure is likely to be an important factor in this [18]. Evidence in haemodialysis suggests that hydration may play an important role in hypertension in dialysis patients and strict control of fluid status may result in control of blood pressure in haemodialysis with increased survival [19]. This area has not been studied in great detail yet in peritoneal dialysis, but it is possible that control of fluid state may prove to be as important a part of ‘adequate dialysis’ as small solute clearances [20]. The non-randomized nature of the follow up part of this study precludes useful analysis of longer term blood pressure data, where additional factors changing over time (such as diminishing residual renal function and alterations of night-time cycles) are likely to obscure the effects of icodextrin in the small number of patients followed up for 6 months.
In summary, icodextrin appears to be an ideal osmotic agent for the long daytime dwell period of APD. Compared with glucose-based solutions it achieves superior ultrafiltration, resulting in a beneficial effect on fluid balance and small solute clearances. It also avoids exposure of the peritoneal membrane to hypertonic glucose solutions for greater than 50% of the time. The potential benefits of this regime relating to long term preservation of peritoneal membrane function, metabolic abnormalities of peritoneal dialysis and cardiovascular function warrant further study.

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References

15. Cooper A, Henderson IS, Jones MC. Daytime dwell with 7.5% icodextrin in automated peritoneal dialysis (APD). J EDTNA-ERCA 1995; 21 [Suppl 1]: 21
17. Posthuma N, ter Wee PM, Donker AJM, Oe PL, van Dorp W, Peers EM, Verbrugh HA. Serum disaccharides and osmolality in CCPD patients using icodextrin or glucose as daytime dwell. Perit Dial Int 1997; 17: 602–607
20. Coles GA. Have we underestimated the importance of fluid balance for the survival of PD patients? Perit Dial Int 1997; 17: 521–526

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