Blood Glucose Overestimation Using Hemoglucostix in a Diabetic Patient on Icodextrin-based Peritoneal Dialysis

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Icodextrin is a newly available glucose-free peritoneal dialysis solution that can be used in diabetic patients with poor glycemic control. It is less readily absorbed from the peritoneal cavity and, hence, has the advantage of reduced glucose absorption. This new osmotic agent, however, is not metabolically inert. Absorption of icodextrin can result in accumulation of oligosaccharide metabolites that interfere with some laboratory tests. We report a patient suffering from spurious hyperglycemia after using this new osmotic agent. Various mechanisms of hemoglucostix are discussed to provide information to clinicians on one important potential complication of this new osmotic agent. [Hong Kong J Nephrol 2004;6(2):103–5]

Key words: hyperglycemia, icodextrin, peritoneal dialysis

INTRODUCTION

Diabetes mellitus is the commonest cause of end-stage renal failure, treated with renal replacement therapy, in Hong Kong. As 80% of our dialysis population receive peritoneal dialysis, the management of this dialysis population is a great burden on nephrologists. Poor sugar control is commonly encountered in daily clinical practice. We report a diabetic patient treated with peritoneal dialysis who had poor glycemic control.

CASE REPORT

A 70-year-old lady who suffered from end-stage renal disease secondary to diabetic nephropathy presented to the emergency department for acute retention of urine and dysuria. She had received peritoneal dialysis for 3 years. Icodextrin-based dialysate (Extraneal®, Baxter Healthcare Corp, Deerfield, IL, USA) had been used for the previous 6 months because of poor ultrafiltration and high serum glucose concentration. Ultrafiltration and blood sugar control improved with the use of icodextrin. Her fasting hemoglucostix readings at home ranged from 5 to 10 mM. Her diabetes mellitus was treated with a short-acting sulfonylurea and subcutaneous intermediate-acting insulin (Monotard®, Novo Nordisk A/S, Bagsvaerd, Denmark).

The patient had very unsatisfactory diabetic control at her current admission, with immeasurably high hemoglucostix readings. An extra 6 units of short-acting insulin were given subcutaneously after blood was taken for plasma glucose estimation. The laboratory plasma glucose concentration was 27 mM. The glucometer used in the admission ward was an Accu-Chek Advantage® (Roche Diagnostics, Basel, Switzerland), with a measuring range of 0.6–33.3 mM (Table). Blood glucose control was not improved and repeated hemo-
glucostix readings 6 hours later were immeasurably high. Another 6 units of short-acting insulin were given. The dosage of intermediate-acting insulin was escalated in view of her poor diabetic control. Two days later, the patient was advised to bring back her home glucometer for more accurate hemoglucostix monitoring. The model she used was a Precision QID® (Abbott Laboratories, Bedford, MA, USA). Unfortunately, she developed hypoglycemia that night secondary to the multiple extra doses of short-acting insulin. Her condition improved rapidly after dextrose infusion.

**DISCUSSION**

Dextrose is used as an osmotic agent in conventional peritoneal dialysis solutions to effect osmotic ultrafiltration. Glucose is readily absorbed from the dialysate, resulting in rapid dissipation of the osmotic gradient and high blood sugar levels, especially in patients with diabetes mellitus [1]. Icodextrin, a high-molecular-weight glucose polymer, is absorbed less readily from peritoneal dialysate. This results in the advantage of maintenance of the osmotic gradient after a longer dwell time in the peritoneum. Little or no free glucose is liberated within the peritoneal cavity following the administration of icodextrin and, hence, it is functionally a “non-glucose” osmotic agent [2].

After absorption into the systemic circulation via the lymphatic system, icodextrin polymers are metabolized into smaller oligosaccharides by plasma amylases. The predominant metabolites are maltose (2 glucose molecules), maltotriose (3 glucose molecules), and maltotetraose (4 glucose molecules) [1]. These metabolites of icodextrin accumulate in the systemic circulation due to a lack of circulating maltase.

The free reducing group of these icodextrin metabolites can react with certain enzyme systems in the test kit of some glucometers to produce a falsely elevated reading. Maltose interferes with glucose assays that utilize the glucose dehydrogenase with coenzyme pyrroloquinoline quinone (GDH PQQ) system [3]. This method of measuring glucose concentrations can significantly overestimate glycemia [4,5]. Wens et al evaluated discrepancies in six patients treated with once-daily icodextrin for a minimum of 7 consecutive days [4]. The overestimation of glycemia by GDH PQQ-based methods was 3.6 ± 1.4 mmol/L compared to the reference method (p < 0.01). Oyibo et al evaluated 25 end-stage renal failure patients treated with icodextrin and demonstrated that only 5% of glucometer values using the GDH PQQ system fell within 20% of the corresponding laboratory values [6]. A correction factor cannot be used because overestimation varies widely.

In our hospital, 10 (2.6%) of our renal patients on peritoneal dialysis are currently treated with icodextrin-based dialysate. Five suffered from ultrafiltration failure and five from poorly controlled diabetes mellitus. Home blood glucose monitoring by hemoglucostix is advised in patients with poorly controlled diabetes. The patient in this case used a system based on glucose oxidase at home with no problems, but the situation changed after the current admission when her blood glucose monitoring was changed to another system in the hospital. Although the effect of icodextrin on glucose testing has been previously reported, many clinicians remain unaware of the problem.

The measurement of plasma glucose level in our hospital laboratory is also based on a system that detects the oxidation of glucose molecules specifically (glucose hexokinase assay, Roche Diagnostics, Mannheim, Germany). Spent icodextrin solution has been sent to the laboratory to exclude cross-reactivity between other oligosaccharide molecules and the assay system.

The Table lists the common glucometer models that we usually introduce to our diabetic patients. Other hospitals may have their own list. We suggest that clini-

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Manufacturer</th>
<th>Enzyme system</th>
<th>Measuring range (mM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accu-Chek Advantage</td>
<td>Roche Diagnostics®</td>
<td>Glucose dehydrogenase</td>
<td>0.6–33.3</td>
</tr>
<tr>
<td>MediSense Optium</td>
<td>Abbott Laboratories®</td>
<td>Glucose dehydrogenase</td>
<td>1.1–27.8</td>
</tr>
<tr>
<td>Ascensia Elite</td>
<td>Bayer Diagnostics®</td>
<td>Glucose oxidase</td>
<td>1.1–33.3</td>
</tr>
<tr>
<td>Ascensia Entrust</td>
<td>Bayer Diagnostics®</td>
<td>Glucose oxidase</td>
<td>3.3–23.7</td>
</tr>
<tr>
<td>Medisense Precision QID</td>
<td>Abbott Laboratories®</td>
<td>Glucose oxidase</td>
<td>1.1–33.3</td>
</tr>
<tr>
<td>OneTouch Ultra</td>
<td>Johnson &amp; Johnson®</td>
<td>Glucose oxidase</td>
<td>1.1–33.3</td>
</tr>
<tr>
<td>SmartScan</td>
<td>Johnson &amp; Johnson®</td>
<td>Glucose oxidase</td>
<td>1.1–33.3</td>
</tr>
<tr>
<td>SureStep</td>
<td>Johnson &amp; Johnson®</td>
<td>Glucose oxidase</td>
<td>0–27.8</td>
</tr>
</tbody>
</table>

*Roche Diagnostics, a division of F. Hoffmann-La Roche Ltd, Basel, Switzerland; †MediSense Inc, Bedford, MA, USA; ‡Bayer HealthCare LLC, Tarrytown, NY, USA; §Johnson & Johnson Company, Milpitas, CA, USA.
Blood glucose overestimation using hemoglucostix

Cians refer to the product inserts included in the test strip packages or contact the manufacturers. Education of medical and nursing staff about the overestimation of blood glucose concentrations by GDH PQQ-based glucometers in peritoneal dialysis patients treated with icodextrin is important. Glucose oxidase-based glucometers should be available in the wards for monitoring hemoglucostix in this group of patients should they be admitted to hospital.

ACKNOWLEDGMENTS

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REFERENCES