PART 2

Self management of insulin-dependent diabetes mellitus

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This article is a continuation of ‘Self management of insulin-dependent diabetes mellitus’ (A.J.A. SPARRIUS S A Family Practice Vol 2 No 1)

Insulin dosages and the monitoring thereof

Insulin

The beta cells in the islets of Langerhans in the pancreas secrete insulin in response to the blood glucose level. Human insulin is manufactured in the form of proinsulin, which consists of two peptide chains linked by a connecting peptide - a total of 81 amino acids. Prior to release in the pancreatic vein, the proinsulin is separated into the insulin molecule and the connecting peptide. The half-life time of insulin in the blood circulation is approximately 7 -10 minutes, since insulin is inactivated in the liver and kidney. After oral glucose ingestion, the insulin level begins to rise within 3 - 5 minutes, with peak levels of approximately 6 -8 times the basal levels reached in 30 - 60 minutes and a return to basal levels after 3 - 4 hours.

Although insulin is not the only mechanism responsible for glucose homeostasis, it is the prime factor which accomplishes this important function. Insulin is measured in units with a non-diabetic secreting approximately 25 - 50 units per day.

Porcine insulin differs from human insulin in only one amino acid and is therefore less antigenic in man. Two types of insulin are generally available on the market: A proinsulin-free mixture of porcine and bovine insulin, and a monocomponent insulin of even higher purity, usually containing only porcine insulin. Monocomponent insulin is preferred since it has fewer side effects. The concentration of insulin refers to the number of units per millilitre. Various insulins generally available in the RSA are shown in the table.

<table>
<thead>
<tr>
<th>Description</th>
<th>Trade Name</th>
<th>Type</th>
<th>Onset/End</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular (short-acting)</td>
<td>Actrapid</td>
<td>Porcine insulin</td>
<td>½ - 7</td>
<td>2½ - 5</td>
</tr>
<tr>
<td>Semilente</td>
<td></td>
<td>Mixture of 25% porcine and 75% bovine insulin</td>
<td>1 - 22</td>
<td>4 - 12</td>
</tr>
<tr>
<td>Lente (intermediate-acting)</td>
<td>Lantard</td>
<td>Porcine insulin</td>
<td>1½ - 15½</td>
<td>4½ - 9½</td>
</tr>
<tr>
<td>Monotard</td>
<td></td>
<td>Mixture of 30% porcine and 70% bovine insulin</td>
<td>2½ - 24½</td>
<td>6½ - 14½</td>
</tr>
<tr>
<td>Ultratard</td>
<td></td>
<td>Porcine insulin</td>
<td>2½ - 22</td>
<td>6½ - 14½</td>
</tr>
</tbody>
</table>

Monocomponent insulins from NOVO Industries (M.I.M.S., Vol. 20, No. 9, Sept. 1980)

* Other manufacturers supply a similar range of insulin.

A typical daily requirement for an insulin-dependent diabetic is 0.7 - 1 units/kg bodyweight. Since the pancreas releases insulin in response to the blood glucose level, and since the insulin-dependent diabetic is totally dependent on outside insulin, the objective of any insulin therapy is to mimic nature exploiting the insulin action profiles shown in the table. Note that these action profiles are guidelines only, and may change from patient to patient.

Diet

The dietary principles for a non-obese insulin-dependent patient are as follows: (All kilojoule values are rounded off)

For children, the total number of daily kilojoules required is given by 4 200 for the first year of age, plus 420 kJ for each additional year. (The formula is valid up to age 12 to 14 years).

For adults, the following formula can be used: Let the desirable bodyweight by N (kg), then basic kilojoules 92 N (kJ).

<table>
<thead>
<tr>
<th>Activity requirements</th>
<th>Formula</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary occupation</td>
<td>27.6 N (kJ)</td>
<td>46 N (kJ)</td>
</tr>
<tr>
<td>Moderate activity</td>
<td></td>
<td>92 N (kJ)</td>
</tr>
<tr>
<td>Strenuous activity</td>
<td></td>
<td>92 N (kJ)</td>
</tr>
</tbody>
</table>

These kilojoules are provided by protein (17 kJ/gm), carbohydrates (16 kJ/gm) and fat (37 kJ/gm). For growing children the daily requirement is 3 to 4 gm protein/kg bodyweight. A carbohydrate-to-fat mass ratio of approximately 2 : 1 is commonly used, although the fat content may be reduced for low-fat diets.

In order to prevent glucose loads onto the body, the total number of kilojoules is spread equally between breakfast, lunch, dinner and the three snacks (mid-morning, mid-
afternoon and late-night), i.e. 25% each. The time delay between food intake and peak blood glucose value for various types of foods is as follows: Simple carbohydrate (sugars): 15 - 30 minutes; complex carbohydrates: 30 - 60 minutes; fats and starches: 90 minutes; proteins: 3 hours. By manipulating the types of food taken during each meal or snack, the absorption delays can be used to further equalise the blood glucose level. For example, the late-night snack should contain a lot of protein to prevent nocturnal hypoglycemia.

The number of kilojoules in each meal or snack is made up of a few exchange food changes. The food exchange method is based on six basic exchange lists: Milk, vegetables, fruits, bread, meat and fat. Some basic lists are further subdivided, e.g. low-fat, medium-fat and high-fat meat exchange lists. Each list contains various types of foods and a portion size for each, so that a portion of each type of food contains a fixed amount of carbohydrates, protein and fat.

The diet then consists of a number of exchanges for each meal, e.g. lunch having one exchange of each of the following: Milk, fruit, bread, medium-fat meat and fat (1 300 kJ). The patient may select a portion of whichever type of food, within the specified exchange list, he fancies to make up a certain exchange. For example, a medium-fat meat exchange contains 322 kJ and consists of 8 gm coconut milk (as a substitute for cream) and 2 medium-fat meat exchanges, with 1 fat exchange to be omitted elsewhere. One 8 gm slice of Ry-king turns out to be equivalent to 1 vegetable exchange. Reference 15 is an excellent cookbook based upon the food exchange method.

To further smooth out glucose peaks, check the 24-hour absorption profile. This consists of the superposition of triangular curves (the peaks which are the kilojoules provided and correspond to the absorption delay) for each carbohydrate, protein or fat component for each food exchange at each meal or snack.

Other dietary objectives, e.g. for low-sodium or low-fat diets can be easily incorporated into the above principles.

Tables of ideal weight and height as a function of age and sex are important in monitoring the growth of children.

In the case of vomiting during sick days, calories can be provided using liquids, e.g. regular cold drinks or fruit juices. Fortunately these dietary principles are not critical, e.g. the exact kilojoule distribution and relative proportions of fat, protein and carbohydrate can be deviated from significantly without a catastrophic collapse in diabetic control.

Monitoring
Proper control of diabetes requires that the blood glucose level be kept within strict limits and this invariably means that the patient must be regularly monitored. There are four basic monitoring tests, depending on whether urine or blood is used and whether spot or averaged values are measured.

1. Urine testing. This test is done on a second-voided urine specimen obtained by passing urine from a full bladder, waiting 10 - 15 minutes for the bladder to partially refill and using the second urine specimen for testing. A Keto-Diastix (Ames Company) reagent strip is dipped into the specimen. After fixed time intervals, colour changes are used to estimate glucose and ketone concentrations. Heavy glycosuria implies hyperglycemia, whereas a combination of heavy glycosuria and ketonuria implies impending ketoadidas. These urine tests are considered spot checks of glycosuria, even though they represent values averaged over ½ to 1 hour.

2. Twenty-four-hour urine test. This very useful and easy test based on urinalysis ascertain average control over 24 hours. A 24-hour urine specimen is collected by discarding the first-voided specimen and saving all further specimens for 24 hours, including first voiding the next morning. The glucosuric concentration is measured. Using the measured volume of the 24-hour specimen, the amount of glucose (in grams) lost in a 24-hour period can be calculated. Expressed as a percentage of the total carbohydrate intake, this is used to assess diabetic control.

3. Blood glucose measurement. Blood glucose monitoring in the home environment consists of drawing a drop of capillary blood, normally from a fingertip, placing this on a plastic strip (e.g. Ames' Dextrostix) and using colour changes to obtain a semi-quantitative estimate of the blood glucose value, or using a reflectance meter to obtain a quantitative estimate. Blood glucose monitoring has become very popular in recent years. Its accuracy and validity is beyond doubt. Blood glucose measurements are spot estimates.

4. Glycosylated hemoglobin. Glycosylated hemoglobins consist of derivatives of glucose covalently bound to hemoglobin A. Their rate of synthesis depends on the blood glucose concentration caused by food ingestion, exercise or insulin therapy. It is thus a quantitative and reliable index of long-term diabetic control.

The popularity of monitoring glycosuria for spot estimates is mainly based on the ease of urinalysis methods. It is well known that the use of glycosuria as an estimate of the blood glucose level (which after all is the relevant parameter) has serious weaknesses. These are that the renal threshold for glucose is not known, differs from person to person, varies with age and that the glycosuria level lags the blood glucose level by several hours. Studies have shown that there is not much correlation between glycosuria and blood glucose values. It appears that glycosuria values can be seriously misleading, should be treated with due caution and whenever possible be verified with blood glucose measurements.

It is very important to keep detailed records of all measurements taken to monitor the patient.