

TABLE 66-5 TYPES OF INSULIN\*

INSULIN TYPE	GENERIC NAME	PREPRANDIAL INJECTION TIMING (HR)	ONSET (HR)	PEAK (HR)	DURATION (HR)	BG NADIR (HR)
Rapid-acting	Lispro <sup>†</sup>	0-0.2	0.1-0.5	0.5-2	<5	2-4
	Aspart <sup>‡</sup>	0-0.2	0.1-0.3	0.6-3	3-5	1-3
	Glulisine <sup>§</sup>	0-0.25 (15 min before a meal or within 20 min after starting a meal)	0.15-0.3	0.5-1.5	1-5.3	2-4
Short-acting	Regular	0.5-1	0.3-1	2-6	4-8	3-7
Intermediate-acting	NPH	0.5-1	1-3	6-15	16-26	6-13
Long-acting	Glargine <sup>  **</sup>	Once daily <sup>§</sup> or twice daily (approx 12 hourly)	1.1-4	Little or no peak	10.8->24	Before next dose
	Detemir <sup>**</sup>	Once daily <sup>§</sup> or twice daily (approx 12 hourly)	1.1-4	Little or no peak	12-24	Before next dose
<b>HUMAN PREMIXED</b>						
NPH/regular	70/30	0.5-1	0.5-1	2-12	14-24	3-12
NPH/regular	50/50	0.5-1	0.5-1	2-5	14-24	3-12
<b>INSULIN ANALOGUE PREMIXED</b>						
NPL/lispro	75/25	0.25	0.15-0.25	1	14-24	—
NPA/aspart	70/30	0.25	0.15-0.3	2-4	24	—
NPL/lispro	50/50	0.25	0.15-0.25	1	14-24	—

BG, Blood glucose; NPA, neutral protamine aspart; NPH, neutral protamine Hagedorn; NPL, neutral protamine lispro.

\*Time profiles depend on several factors, including dose, anatomic site of injection, method (profiles in this table are for subcutaneous injections), duration of diabetes, type of diabetes, degree of insulin resistance, level of physical activity, presence of obesity, and body temperature. Some time ranges are wide to include data from several separate studies. Preprandial injection timing depends on premeal BG values and insulin type. If BG is low, it may be necessary to inject insulin and eat immediately (carbohydrate portion of meal first). If BG is high, it may be necessary to delay the meal after insulin injection and then eat the carbohydrate portion last.

<sup>†</sup>Insulin analogue with reversal of lysine and proline at positions 28 and 29 on the B chain of the insulin molecule.

<sup>‡</sup>Insulin analogue with substitution of aspartic acid for proline at position 28 on the B chain of the insulin molecule.

<sup>§</sup>Insulin analogue with substitution of lysine for asparagine at position 3 on the B chain and glutamic acid for lysine at position 29 on the B chain of the insulin molecule.

<sup>||</sup>Insulin analogue with substitution of glycine for asparagine at position 21 on the A chain and addition of two arginines to the carboxyl terminus of the B chain of the insulin molecule.

<sup>\*\*</sup>Administer at same time each day, unrelated to meals. Morning administration may result in greater glucose lowering and less nocturnal hypoglycemia.

\*\*Do not mix glargine or detemir with other insulins.

SMBG should be performed as frequently as practicable: fasting, preprandial, 2 hours postprandial, at bedtime, and occasionally at 2:00 to 3:00 AM. Values and times are saved in most meters for subsequent review. It is helpful for patients to manually record these data on a flow chart, and it is also possible to download meter data to a computer. SMBG records are most useful when annotated with relevant details on food intake, exercise, or the occurrence of symptoms. HbA<sub>1c</sub> determinations should be obtained every 3 months.

Most cases of T1DM should be managed with an *intensive insulin therapy regimen* involving multiple (three or more) daily subcutaneous injections or continuous subcutaneous insulin infusion (CSII) using an insulin pump. Multiple-injection regimens, also termed *basal-bolus therapy*, typically involve injections of a long-acting insulin analogue (such as glargine or detemir) once or twice daily to establish a stable basal insulin level. Regular insulin or a rapid-acting insulin analogue is additionally injected three or more times daily (before each meal and sometimes before snacks) to provide appropriate post-meal peaks in insulin levels. Usually, once glucose levels are stabilized on a regimen, the doses of long-acting insulin are kept constant from day to day. The rapid-acting insulin doses can be kept constant with efforts to ingest a fixed amount of carbohydrate and total calories at each meal. Alternatively, better control and greater flexibility can be achieved if rapid-acting insulin doses are adjusted according to the blood glucose level (measured before each meal) and the carbohydrate calories ingested with the meal. The long-acting insulin glargine and detemir analogues cannot be mixed in a single syringe with other insulins; for

this reason, basal-bolus regimens often require four or more daily injections.

For patients newly diagnosed with T1DM, a typical starting dose of insulin is a total of 0.2 to 0.4 U/kg/day, with the expectation that this will be increased to 0.6 to 0.7 U/kg/day over time. Approximately half of the total dose should be given as basal insulin. Depending on individual patient blood glucose responses, the basal glargine or detemir insulin may be administered as a single daily dose (in the morning or at bedtime), or two equally divided doses may be required. For a neutral protamine Hagedorn (NPH) basal regimen, two thirds of the dose should be given in the morning and one third at bedtime. This decreases the risk of nocturnal hypoglycemia and times the maximum NPH peak to approximately match the midday meal. The rapid-acting component of the daily insulin dose is distributed before meals according to meal size and content.

An insulin pump (CSII) represents the preferred method of insulin administration for many T1DM patients. These small, wearable devices contain a reservoir of rapid-acting insulin that is infused via an easily placed subcutaneous catheter. A microprocessor-controlled pump provides the basal insulin infusion and can be programmed to adjust basal rates at multiple points during the day according to predetermined patient needs. The patient further instructs the pump to make bolus insulin injections to cover meals, snacks, or needed corrections in hyperglycemia. Controlled studies have shown that modestly better blood glucose control can be achieved with CSII, compared to basal-bolus regimens with multiple daily injections. When used appropriately, CSII represents the most flexible means of