

Diabetes Therapy: Treatment of Diabetes Mellitus Type 1, Type 2 & Gestational Diabetes

[See online here](#)

Insulin Delivery Devices



Insulin syringe



Insulin pen



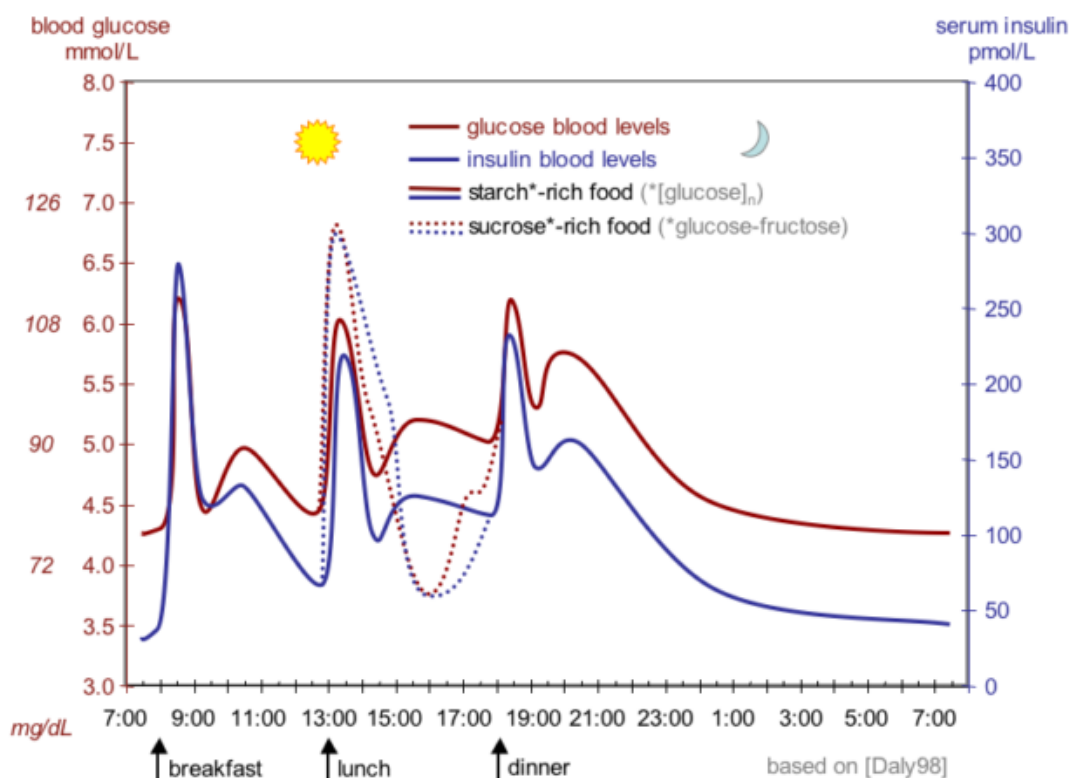
Jet injector



Insulin pump

Introduction

Patients with diabetes mellitus need to be comprehensively examined and instructed by their physicians. Only when the extent of the disease has been established can late complications be avoided, which, as a rule, lead to mortality in [diabetes mellitus](#). The treatment of diabetes requires good compliance for a successful outcome.



[Image](#): 'Idealized curves of human blood glucose and insulin concentrations during the course of a day containing three meals; in addition, effect of sugar-rich meal is highlighted.' By Jakob Suckale, Michele Solimena. License: [CC BY 3.0](#)

Treatment of Diabetes Mellitus Type 1

As little or no insulin is produced by patients in [diabetes mellitus type 1](#), the body should be supplied with **exogenous insulin**. Although a healthy diet and exercise can make a small contribution, the injection of insulin cannot be avoided.

In the case of **insulin therapy**, the need for insulin depends on the patient's daily activities as food, disease, and exercise affect insulin levels and must be considered in the dosage so that hypoglycemia or hyperglycemia does not result. Patients must be well-informed before they embark on subcutaneous insulin self-administration using an insulin pen. The greatest danger in insulin therapy is **hypoglycemia**. Insulin edema may also occur. Patients rarely produce allergies or antibodies to insulin.

For the treatment, there are different human insulin concentrations: U40 (40 IU/ml) and U100 (100 IU/ml):

- **Regular insulin:** injection (10–30 min before meal), active for about 5 hours, corresponds to the body's own insulin
- **Insulin analogs:** injection (0–10 min before meal), active for about 3 hours, genetically modified
 - Insulin analogs with a 24-hour action
 - Insulin for insulin pumps
- **Long-acting insulin:** active for about 10–12 hours by means of additives such as zinc or protamine
- **Combination insulin:** a combination of regular and long-acting insulin, rapid and continual action

Intensified insulin therapy

The insulin type used depends on the patient. As a rule, **intensified insulin therapy** is provided for patients with type 1 diabetes. In this case, **regular as well as long-acting insulin** is injected in order to imitate the natural insulin level. Long-acting insulin constitutes 40–50% of the total daily requirement and ensures a constantly low insulin level during the day and at night. A corresponding injection in the evening is usually sufficient. In rare cases, morning and evening injections are provided.

However, the regular insulin form, which accounts for the remaining 50–60% of the total daily requirement, is administered before meals, in order to cover the corresponding insulin requirement. The **bolus of regular insulin** is previously determined by blood sugar levels, and it is based on the carbohydrate content of the meal and corresponding activities. So, patients can individually adjust their insulin injections in accordance with their daily routines. However, such therapy requires extensive training because patients need to often measure blood glucose level and obligatorily inject insulin. Therefore, intensified insulin therapy is suitable only for mentally fit type 1 diabetic patients.

Conventional insulin therapy

As elderly patients often have a regular daily routine, and they find it difficult to handle an insulin pen, **conventional insulin therapy** is advisable for them. Only in the morning and evening times, **combination insulin** must be injected before meals: in the morning, two-thirds of the total daily requirement is injected and in the evening, the remaining one-third is administered. The evening injection can also be replaced by long-acting insulin when the fasting blood glucose level is too high. In conventional insulin therapy, insulin injections should always occur at the same time in order to avoid hypoglycemia.

Insulin pump therapy

Another alternative is the insulin pump therapy, which allows a more individual daily routine and better blood glucose control than intensified insulin therapy. The insulin pump is **mounted directly on the body and continuously injects regular insulin via the catheter** under the skin (**continuous subcutaneous insulin infusion = CSII**). Before meals, an administration of an **extra bolus** injection is provided on demand. The bolus can be adapted to the carbohydrate content of the diet. The insulin pump must be worn all day long. However, it is possible to take off the pump temporarily, but not for more than 1–2 hours.

Insulin pump therapy is especially suitable for patients with an irregular daily regime or for those who suffer from the **dawn phenomenon**. In the latter case, patients may suffer from hypoglycemia which often occurs in the morning. This can be remedied by pumping programming as it may increase an insulin injection level during sleep. A disadvantage of the insulin pump is that the catheter may slip out of the subcutaneous fatty tissue, which leads to a rapid increase in blood sugar. Therefore, insulin pump therapy is only suitable for **experienced type 1 diabetic patients**.

Transplantation

Instead of injecting insulin several times a day, there is a possibility of **pancreas or islet cell transplantation**. However, both surgical procedures are rarely carried out. Pancreas transplantation is usually considered in young diabetic patients with progressive renal insufficiency. The **kidney** is also subsequently replaced. These patients should take

immunosuppressive drugs in the case of pancreas or islet cell transplantation.

Dietary therapy

Type 1 diabetic patients may not influence insulin production via dieting but they can **control blood sugar levels**. Patients should be fully informed about healthy eating, as they must consider food intake in relation to insulin dosage. It should be noted that **physical activity lowers the blood sugar level** and must be considered in insulin dosage.

With regular insulin, there should be 6 meals, divided into 3 main courses and 3 snacks. However, when the patient is treated with insulin analogs, 3 meals a day are sufficient. This norm prevents excessive blood sugar fluctuations, and the blood glucose level remains relatively constant.

Treatment of Diabetes Mellitus Type 2

As [type 2 diabetic patients](#) suffer from a **relative insulin deficiency**, the primary therapeutic goal is to stimulate the production of insulin by dieting and exercise in order to stabilize metabolism. Forty to fifty percent of type 2 diabetic patients also become obese and may reduce their diabetes risk by maintaining a BMI of 19-25 kg/m². Nevertheless, it may be necessary to prescribe oral antidiabetic drugs in the treatment process. If drug therapy is unsuccessful, type 2 diabetic patients should be prescribed insulin. However, this is the last solution for this type of diabetes.

Dietary therapy

An appropriate diet in diabetes is more **important in type 2 diabetes** than in type 1 because normoglycemia must be achieved. To achieve this, the following basic rules of a healthy diet must be considered by every patient:

- The daily energy requirement should not be exceeded. (In light physical work: weight in kg x 32 = kcal).
- Food consumption must be divided into several small meals.
- **50-60% carbohydrates** (1 XE (bread unit) = 12 g carbohydrate equivalent), low in sugar and white flour (monosaccharides), high fiber
- **30% fat** (one-third saturated [fatty acids](#), one-third unsaturated fatty acids, one-third polyunsaturated fatty acids), cholesterol-poor
- **15% protein** (in renal failure correspondingly less)
- Avoidance of sugary sodas and juices (**cyclamate, aspartame, saccharin are allowed**)
- Avoidance of alcohol (it inhibits gluconeogenesis in the liver and leads to hypoglycemia)

Medical Nutrition Therapy (MNT)

- MNT is recommended for all patients with type 1 and type 2 diabetes mellitus.
- The main goals of MNT can be summarized as follows:
 1. Achieve and maintain weight goals
 2. Achieve appropriate blood pressure, lipid, and glycemic goals
 3. Delay or prevent type 2 diabetes mellitus

Physical Activity Per the American Diabetes Association Recommendations in 2016

- Exercise should exceed 150 minutes of moderate-intensity aerobic activity spread over 3 or more days per week
- Resistance training 2 or more times per week
- Do not sit without activity for more than 90 minutes

Type 2 Diabetic Patients with Diabetic Complications and Physical Activity:

- Patients with retinopathy should avoid vigorous aerobic or resistance training
- Patients with autonomic neuropathy should undergo a full cardiac evaluation before starting an intense aerobic exercise
- Patients with peripheral neuropathy should wear appropriate footwear and examine their feet daily after exercise

Oral drug therapy

Oral antidiabetic drugs may be prescribed if dietary therapy and plenty of exercise are not sufficient to reduce blood sugar levels and stimulate the production of insulin.

Currently, there are 7 substance groups as follows:

- **Alpha-glucosidase inhibitors** such as acarbose and miglitol (inhibit sugar-cleaving enzymes in the small intestine)
- **Biguanides** such as metformin (delay the absorption of carbohydrates from the intestine, inhibit gluconeogenesis in the [liver](#), promote glucose uptake into the muscles, and curb appetite)
- **Glitazones** such as pioglitazone may only be prescribed in exceptional cases (increase the sensitivity of the peripheral cells to insulin, in combination with biguanides or sulphonylureas)
- **Glinides** such as repaglinide (initiate a short-term increase in the insulin secretion of beta cells)
- **Incretin analogs** such as exenatide (imitate the effects of natural incretins, regulate insulin secretion)
- **Incretin amplifiers** such as linagliptin (prevent degradation of incretins by dipeptidyl peptidase-4 (**DPP4**); thereby, increasing incretin concentration)
- **Sulfonylureas** such as glyburide (stimulate insulin secretion of the pancreas, can be combined with insulin)

Insulin therapy

Frequently, oral drug therapy is combined with insulin for type 2 diabetic patients. Oral combination therapy with biguanides (metformin) and sulfonylureas is the best method. Here, a single injection of insulin a day is sufficient. Either combination insulin in the morning or long-term insulin in the evening may be injected.

If **combination therapy** is unsuccessful, conventional insulin therapy can be effective. If it also yields no effect, intensified insulin therapy is the next option in order to lower the blood sugar level.

American Diabetes Association 2016 Guidelines for the Pharmacologic Treatment of Type 2 Diabetes

- Those who do not achieve and maintain glycemic control with lifestyle modifications alone should be prescribed metformin
- Those newly diagnosed with type 2 diabetes who have severe symptoms or a markedly elevated HbA1C at the time of presentation should receive insulin therapy
- If oral hypoglycemic monotherapy does not achieve glycemic control over 3 months, add a 2nd oral agent or consider GLP-1 receptor agonist or start basal insulin
- The following contraindications need to be addressed in any patient who is going to receive metformin:
 1. Serum creatinine \geq 1.5 mg/dL in males and 1.4 mg/dL in females
 2. History of hypersensitivity to metformin
 3. Diabetic ketoacidosis
- When insulin therapy is needed, delay is unnecessary. Eventually, any type 2 diabetic patient will require insulin.

Treatment of Gestational Diabetes



[Image](#): "A kit used by a woman with gestational diabetes" by Jessica Merz. License: [CC BY 2.0](#)

Women who develop diabetes during pregnancy should first attempt to decrease their blood sugar levels via **appropriate dieting, physical exercise, and weight control**. Oral antidiabetic drugs are contraindicated during gestation. Insulin therapy is the last option if other alternatives are ineffective.

References

<http://www.ndei.org/ADA-2013-Guidelines-Criteria-Diabetes-Diagnosis.aspx.html>

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