

## Chapter 1 : Insulin & Other Injectables: American Diabetes Association®

*Irrespective of whether you are changing from an oral dose of medication to insulin therapy or have had to inject insulin several times a day for a long time, with the Comfort-inâ„¢, you can inject insulin in a tissue preserving way and avoid possible scar formation from daily needle injections.*

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Abstract Injectable treatments, such as glucagon-like peptide-1 receptor agonists and insulin, are options for the pharmacologic treatment of type 2 diabetes. Numerous barriers lead to delay in initiating injectable treatment, which, in turn, may lead to inadequate glycemic control and increased risk of diabetes-related complications, underscoring the need to understand and address these barriers. Barriers to the initiation of injectable therapy, strategies to mitigate barriers, and information about needle attributes and their relation to needle pain are reviewed on the basis of published literature retrieval and our clinical experience. Barriers to the initiation of injectable therapy originate from both patients and practitioners. Advances in needle design have minimized the pain associated with injections, and recent data suggest that actual pain and bleeding associated with various needle gauges gauge to gauge are mild. Other barriers include concerns about the ability to handle injectable therapy, concerns about treatment side effects, and impacts on quality of life. Practitioners can help to mitigate barriers to injectable treatment for type 2 diabetes by understanding patient perceptions, improving education, and setting realistic expectations about therapy. Strategies for minimizing injection-associated fear and anxiety include a combination of assessment, appropriate needle selection, patient education, behavioral interventions, and monitoring. Guidelines also stress the importance of a patient-centered approach with regard to treatment choice and sequence of therapy. Herein, we discuss potential barriers to the initiation of injectable therapy in patients with T2D, including steps that can be taken to mitigate anxiety and fear, and how to improve patient acceptance and adherence. Factors influencing the initiation of injectable therapies in T2D Numerous factors act as barriers to the initiation of injectable therapy and may originate with either the practitioner or the patient. Practitioners may have a negative baseline assumption that the average patient with diabetes may not be capable of handling insulin. Also, some patients view the initiation of injectable therapy as a failure on their part to control their disease, rather than understanding the progressive nature of T2D. Contributing to this barrier is that practitioners struggle with a shortage of resources to properly educate patients about their disease 15 and may preferentially choose oral glucose-lowering medications over injectable therapies for matters of convenience. Negative perceptions of injectable therapy from patients may stem from familiarity with family members or friends with T2D who were receiving injectable therapies and went on to experience complications or even death. Patients also may have negative perceptions of insulin therapy that may be translatable to other injectable therapy. Factors influencing injection pain Because the fear of injection-related pain is a real barrier to successful initiation of injectable therapy, this section describes how various needle attributes may influence injection pain, including length, gauge diameter, bevel design, and other enhancements that reduce needle wall size microtapering. Injection-related pain, bleeding, and bruising in diabetes therapy is relatively common. Both needles were associated with low mean VAS scores for pain overall a rating of 7 [5 mm needle] versus a rating of 9 [8 mm needle] out of 10, and differences between the needles were not significant Figure 1.

### Chapter 2 : What Does Insulin Do

*Furthermore, choosing longer needles can negatively impact therapy in thinner patients. If patients inject insulin intramuscularly because their needle is too long, the drug's absorption will be accelerated, while its duration of action will be shortened.*

In any discussion of diabetes, the word insulin is almost certain to come up. Thanks to years of medical research, however, endogenous insulin that produced by the pancreas can be replaced or supplemented by exogenous insulin produced in a laboratory. For people with Type 1 diabetes, injecting insulin or infusing it with an insulin pump is necessary for survival: Before the discovery of insulin in 1921, the life expectancy for a person diagnosed with what was then known as juvenile diabetes was less than a year. For some people with Type 2 diabetes, using insulin may be the best or only way to keep blood glucose levels in the recommended range, and maintaining blood glucose control is one of the most important things you can do to lower your risk of developing potentially devastating complications. But even if you never have to take insulin to control your diabetes, it is important to understand what insulin is and what it does in the body. Making an effort to lose excess weight, eat healthfully, exercise regularly, and take any prescribed drugs as instructed can prolong the life of your beta cells, so they continue to make the insulin you need. The role of insulin is a hormone that is released by the beta cells of the pancreas, a glandular organ located in the abdomen, in response to a rise in the level of glucose in the blood. Blood glucose levels rise when a person consumes carbohydrate-containing food or drinks, as well as during periods of physical and sometimes mental stress. While many hormones raise blood glucose levels, only insulin lowers them. The body needs a small amount of insulin at all times to keep blood glucose levels controlled between meals and overnight. In a person who does not have diabetes or who does have diabetes but whose pancreas still produces insulin, the pancreas constantly secretes this small amount of so-called background, or basal, insulin. A person whose pancreas does not produce insulin or does not produce enough can compensate by injecting an intermediate- or long-acting insulin or by using an insulin pump that is programmed to continuously deliver small pulses of short- or rapid-acting insulin. At mealtimes, blood glucose levels rise as carbohydrates are broken down to glucose and other simple sugars and enter the bloodstream. In people with Type 2 diabetes, a diminished first-phase insulin response is often the first sign of pancreatic insufficiency. Since the goal is to match the premeal insulin dose to the expected rise in blood glucose following the meal, and since the amount of carbohydrate in the meal predicts the rise in blood glucose, the current practice is to match the premeal insulin dose to the amount of carbohydrate in the meal. Your diabetes care team can help you determine your insulin-to-carbohydrate ratio by looking at your food records and your blood glucose monitoring records for before-meal and after-meal blood glucose levels. They will also take your overall insulin requirements into consideration. Types of diabetes In Type 1 diabetes, an autoimmune process destroys the insulin-producing beta cells of the pancreas, leaving it unable to make insulin. People with Type 1 diabetes must therefore inject or infuse insulin for survival. While some people appear to have a genetic predisposition to develop Type 1 diabetes, exactly what sets off the autoimmune destruction of the beta cells is unknown. In Type 2 diabetes, some degree of insulin resistance is typically present. However, treatments other than insulin therapy are usually tried first for Type 2 diabetes. In most cases, insulin resistance can be improved with moderate weight loss, so treatment recommendations generally include lifestyle adjustments such as changes in diet and increased physical activity. Oral and injectable blood-glucose-lowering medicines are also often used in the treatment of Type 2 diabetes. These oral and injectable medicines are not insulin. If dietary changes, increased physical activity, and oral medicines are unable to keep blood glucose levels adequately controlled, insulin therapy may be added to the diabetes treatment regimen or substituted for the oral drugs. Diabetes and pregnancy In any pregnancy, the need for insulin dramatically increases around the 16th week of gestation. From then on, more and more insulin is necessary to maintain normal blood glucose levels as the pregnancy progresses. In women with Type 1 diabetes who are pregnant, careful blood glucose monitoring to adjust insulin doses is necessary over the course of the pregnancy. In women with Type 2 diabetes, insulin is

usually the drug of choice to manage blood glucose levels during pregnancy and also requires adjustments, as needed, throughout the pregnancy. Women with Type 2 diabetes who are taking oral blood-glucose-lowering medicines prior to pregnancy are urged to plan their pregnancy and, typically, to begin using insulin prior to conception. While a few studies have examined the use of oral diabetes drugs during pregnancy, many health-care providers feel they do not yet know enough about the effect of these medicines on the fetus to advocate their use at this time. The high blood glucose levels that occur in gestational diabetes are usually first recognized around the 24th to 28th week of pregnancy. They are due to increased insulin resistance, which is generally caused by the pregnancy hormones as well as the weight gain that normally occurs in pregnancy. However, if blood glucose levels remain too high, insulin is currently the drug of choice for treatment for gestational diabetes. Synthetic insulin that is used in diabetes treatment is not and never was extracted from human pancreases although earlier forms of insulin were, in fact, extracted from pig and cow pancreases. Human insulin is manufactured using recombinant DNA technology often called genetic engineering in a laboratory; it is identical in structure to what a human pancreas produces. Insulin analogs, which are structurally different from human insulin, are also manufactured in labs using similar processes. Although genetically engineered human insulin is identical to the natural product, insulin that is injected into the fatty tissue under the skin does not act the same as insulin secreted from the pancreas directly into the bloodstream. Because these differences make it difficult to control blood glucose levels with injected insulin, much research has gone into altering synthetic insulin so that it behaves more like the insulin that is secreted by a pancreas. The rapid-acting insulin analogs are one of the results of this research. Insulin is now available in a variety of types that are categorized according to action time. These types include ultra-rapid-acting insulin, rapid-acting insulin, short-acting insulin, intermediate-acting insulin, long-acting insulin, and ultra-long-acting insulin. Insulin can also be purchased in mixtures of intermediate-acting and either rapid-acting or short-acting insulins. Insulin human inhalation powder brand name Afrezza is currently the only ultra-rapid-acting insulin on the market. The medicine is strongest peaks within 12 to 15 minutes of administration, with insulin returning to baseline levels after about minutes. This insulin is taken at the beginning of each meal. The rapid-acting insulin analogs currently available include insulin aspart NovoLog, insulin lispro Humalog, and insulin glulisine Apidra. Rapid-acting insulin typically starts working in 5 to 15 minutes, peaks in 45 to 90 minutes, and diminishes in activity 3 to 5 hours after injection. Because it starts working so quickly, rapid-acting insulin is generally taken within 15 minutes of eating either within the 15 minutes before a meal or as much as 15 minutes after starting to eat. If timed correctly and accurately matched to the amount of carbohydrate in the meal, a dose of rapid-acting insulin before a meal can help keep blood glucose levels in target range after the meal. All of the rapid-acting insulin preparations are approved for use in insulin pumps. In the case of pump therapy, rapid-acting insulin is used not just for bolus doses at mealtimes but also as basal insulin around the clock. Regular, or short-acting, human insulin usually starts working about 30 minutes after injection, is strongest peaks 2 to 4 hours after injection, and decreases in activity 5 to 7 hours after injection. People who use Regular insulin are typically advised to take it approximately 30 minutes before eating a meal so that the rise in the level of insulin in the bloodstream matches the rise in blood glucose level. Intermediate-acting human insulin, or NPH, generally starts working in 1 to 2 hours. It peaks in 6 to 14 hours, and its activity decreases 16 to 24 hours after injection. In some cases, intermediate-acting insulin may be recommended at bedtime to help control overnight and early morning blood glucose levels. In either situation, the insulin would be providing a basal-type effect. Long-acting insulins, sometimes called basal insulins, are typically given once daily and include the insulin analogs glargine Lantus, Toujeo, Basaglar and detemir Levemir. Their effects last for up to 24 hours. Glargine and detemir should never be mixed with another type of insulin. Insulin degludec Tresiba is a once-daily basal insulin analog with a half-life of 25 hours and a duration of action of at least 42 hours. Premixed insulin preparations contain intermediate-acting insulin that is mixed with either rapid- or short-acting insulin in varying percentages. All of the insulin analogs require a prescription from a physician for purchase. Human insulin does not require a prescription for purchase in some states; however, a prescription is usually necessary for insurance coverage. Challenges of insulin therapy Insulin may be a lifesaver for people with Type 1 diabetes and may offer the best chance of achieving optimal

blood glucose control for many with Type 2, but it can be a challenge to use. Hypoglycemia can occur as the result of skipping or delaying a meal, taking more insulin than is necessary to control blood glucose levels, engaging in unusual or more frequent physical activity than normal, and consuming alcohol. People who use insulin should be aware of the signs and symptoms of hypoglycemia, as well as how to treat it. For people who had lost a lot of weight because of their diabetes, the weight gain may be welcome, but for many, it is not. A registered dietitian can help you determine what and how much to eat to maintain a healthy weight and optimal blood glucose control. Symptoms of a local reaction at the injection site include slight swelling, itching, and redness. Local reactions can occur as the result of preservatives used in the insulin not the insulin itself, the material used in the needle, products used to cleanse your skin prior to injection, or using an injection technique that injures the skin. Determining the cause is important. Let your diabetes care team know if any of these symptoms occur. Symptoms of a more serious, systemic allergic reaction include shortness of breath or wheezing, fast heart rate, clamminess, and a rash that occurs all over your body. If any of these occur, notify your physician immediately. Skin changes due to repeated insulin injections, such as slight pitting or areas of thickened skin, are rare but possible. If you notice that your skin is changing in the area you inject insulin, consult your diabetes care team. A change in injection technique or needle size may solve this problem. Common causes of high blood glucose include not taking enough insulin for the amount of food eaten and physical stress such as an illness or infection. Very high blood glucose can lead to serious consequences such as diabetic ketoacidosis or hyperosmolar hyperglycemic state, both of which usually require hospitalization. Your diabetes care team can help you learn to keep your blood glucose in target range and develop a plan for responding to high blood glucose if it occurs. Insulin delivery While alternative delivery methods continue to be researched, currently the only ways to take insulin outside a medical setting in the United States are to inject or infuse it into the fatty tissue just below the skin and to inhale it. There are a few device options for doing this. The body areas used most commonly for insulin injections or to insert an insulin pump infusion set are the abdomen, buttocks, and thighs. The traditional way of taking insulin, using a syringe to draw insulin from a vial and inject it, is widely used in the United States. Technique is important when administering insulin with a syringe and is best learned with guidance from a health-care provider. Insulin syringes come in a variety of sizes to accommodate larger or smaller doses. Different lengths and gauges of needles are available, too. Your diabetes care team can help determine the right size syringe and needle for you. Insulin pens and dosing devices. Insulin pens are usually the size of a large fountain pen. Some are reusable, and some are disposable. Reusable insulin pens and devices use cartridges of insulin that are replaced as they are emptied. Disposable pens and devices are prefilled with insulin and discarded when empty. However, there is a limited time an insulin pen or device can be stored at room temperature. Check package inserts for specifics, and discard any cartridge or disposable pen or device that has been kept at room temperature longer than specified by the manufacturer.

**Chapter 3 : Insulin Pump Therapy | Diabetes Pump Therapy | Medtronic Diabetes**

*Over the past 25 years, needle size has evolved from a mm (length), gauge (thickness) needle in , to a 4-mm, gauge needle in A shorter, thinner needle reduces pain and anxiety during insulin injection.*

Immediate access to this article To see the full article, log in or purchase access. Reprints are not available from the author. No relevant financial affiliations to disclose. Physiology of glucose homeostasis and insulin secretion. University of California, San Francisco. Accessed December 10, Betacell dysfunction and glucose intolerance: Prospective Diabetes Study Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes UKPDS Hypoglycemic episodes and risk of dementia in older patients with type 2 diabetes mellitus. Hypoglycaemia and cardiac arrhythmias in patients with type 2 diabetes mellitus. Insulin glargine use and short-term incidence of malignanciesâ€”a population-based follow-up study in Sweden. Road maps to achieve glycemc control in type 2 diabetes mellitus: Effects of intensive glucose lowering in type 2 diabetes. N Engl J Med. Intensive blood glucose control and vascular outcomes in patients with type 2 diabetes. Glucose control and vascular complications in veterans with type 2 diabetes [published corrections appear in N Engl J Med. Standards of medical care in diabetesâ€” [published correction appears in Diabetes Care. Efficacy and safety of insulin analogues for the management of diabetes mellitus: A comparative study of insulin lispro and human regular insulin in patients with type 2 diabetes mellitus and secondary failure of oral hypoglycemic agents. Glucose tolerance and mortality: European Diabetes Epidemiology Group. Differences in hypoglycemia event rates and associated cost-consequence in patients initiated on long-acting and intermediate-acting insulin products. Curr Med Res Opin. Accessed January 9, Cost-effectiveness and cost-utility of insulin glargine compared with NPH insulin based on a year simulation of long-term complications with the Diabetes Mellitus Model in patients with type 2 diabetes in Switzerland. Int J Clin Pharmacol Ther. Cost-effectiveness of insulin analogues for diabetes mellitus. Dealing with ceiling baseline treatment satisfaction level in patients with diabetes under flexible, functional insulin treatment. Glimpiride combined with morning insulin glargine, bedtime neutral protamine hagedorn insulin, or bedtime insulin glargine in patients with type 2 diabetes. A randomized, controlled trial. The management of type I diabetes. Accessed December 6, Three-year efficacy of complex insulin regimens in type 2 diabetes [published correction appears in N Engl J Med. Timing of meal insulin boluses to achieve optimal postprandial glycemc control in patients with type 1 diabetes. Randomized, open-label, parallel-group evaluations of basal-bolus therapy versus insulin lispro premixed therapy in patients with type 2 diabetes mellitus failing to achieve control with starter insulin treatment and continuing oral antihyperglycemic drugs: Impact of active versus usual algorithmic titration of basal insulin and point-of-care versus laboratory measurement of HbA1c on glycemc control in patients with type 2 diabetes: Contact frequency determines outcome of basal insulin initiation trials in type 2 diabetes. Impaired absorption of insulin aspart from lipohypertrophic injection sites. Effect of pioglitazone in combination with insulin therapy on glycaemic control, insulin dose requirement and lipid profile in patients with type 2 diabetes previously poorly controlled with combination therapy. Effects of metformin in patients with poorly controlled, insulin-treated type 2 diabetes mellitus. A randomized, double-blind, placebo-controlled trial. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes UKPDS Efficacy and safety of acarbose in insulin-treated patients with type 2 diabetes. Riddle MC, Schneider J. Efficacy and safety of sitagliptin when added to insulin therapy in patients with type 2 diabetes. Safety and efficacy of exenatide in combination with insulin in patients with type 2 diabetes mellitus.

### Chapter 4 : Insulin (medication) - Wikipedia

*Long-acting insulin (such as insulin glargine and insulin detemir) starts working in about 1 hour and lasts 20 to 26 hours. Premixed insulin is a combination of 2 types of insulin (usually a rapid- or short-acting insulin and an intermediate-acting insulin).*

Brand names Why is this medication prescribed? Insulin injection is used to control blood sugar in people who have type 1 diabetes condition in which the body does not make insulin and therefore cannot control the amount of sugar in the blood or in people who have type 2 diabetes condition in which the blood sugar is too high because the body does not produce or use insulin normally that cannot be controlled with oral medications alone. Insulin injection is in a class of medications called hormones. Insulin injection is used to take the place of insulin that is normally produced by the body. It works by helping move sugar from the blood into other body tissues where it is used for energy. It also stops the liver from producing more sugar. All of the types of insulin that are available work in this way. The types of insulin differ only in how quickly they begin to work and how long they continue to control blood sugar. Over time, people who have diabetes and high blood sugar can develop serious or life-threatening complications, including heart disease, stroke, kidney problems, nerve damage, and eye problems. Using medication s , making lifestyle changes e. This therapy may also decrease your chances of having a heart attack, stroke, or other diabetes-related complications such as kidney failure, nerve damage numb, cold legs or feet; decreased sexual ability in men and women , eye problems, including changes or loss of vision, or gum disease. Your doctor and other healthcare providers will talk to you about the best way to manage your diabetes. How should this medicine be used? Insulin comes as a solution liquid and a suspension liquid with particles that will settle on standing to be injected subcutaneously under the skin. Insulin is usually injected several times a day, and more than one type of insulin may be needed. Your doctor will tell you which type s of insulin to use, how much insulin to use, and how often to inject insulin. Follow these directions carefully. Do not use more or less insulin or use it more often than prescribed by your doctor. Insulin controls high blood sugar but does not cure diabetes. Continue to use insulin even if you feel well. Do not stop using insulin without talking to your doctor. Do not switch to another brand or type of insulin or change the dose of any type of insulin you use without talking to your doctor. Insulin comes in vials, prefilled disposable dosing devices, and cartridges. The cartridges are designed to be placed in dosing pens. Be sure you know what type of container your insulin comes in and what other supplies, such as needles, syringes, or pens, you will need to inject your medication. Make sure that the name and letter on your insulin are exactly what your doctor prescribed. If your insulin comes in vials, you will need to use syringes to inject your dose. Be sure that you know whether your insulin is U or U and always use a syringe marked for that type of insulin. Always use the same brand and model of needle and syringe. Ask your doctor or pharmacist if you have questions about the type of syringe you should use. Ask your doctor or pharmacist if you have questions about how to inject your dose. If your insulin comes in cartridges, you may need to buy an insulin pen separately. Talk to your doctor or pharmacist about the type of pen you should use. Carefully read the instructions that come with your pen, and ask your doctor or pharmacist to show you how to use it. If your insulin comes in a disposable dosing device, read the instructions that come with the device carefully. Ask your doctor or pharmacist to show you how to use the device. Never reuse needles or syringes and never share needles, syringes, cartridges, or pens. If you are using an insulin pen, always remove the needle right after you inject your dose. Dispose of needles and syringes in a puncture-resistant container. Ask your doctor or pharmacist how to dispose of the puncture-resistant container. Your doctor may tell you to mix two types of insulin in the same syringe. Your doctor will tell you exactly how to draw both types of insulin into the syringe. Always draw the same type of insulin into the syringe first, and always use the same brand of needles. Never mix more than one type of insulin in a syringe unless you are told to do so by your doctor. Always look at your insulin before you inject. If you are using a regular insulin Humulin R, Novolin R , the insulin should be as clear, colorless, and fluid as water. Do not use this type of insulin if it appears cloudy, thickened, or colored, or if it has solid particles. Do not use these types of insulin if there are clumps in the

liquid or if there are solid white particles sticking to the bottom or walls of the bottle. Do not use any type of insulin after the expiration date printed on the bottle has passed. Some types of insulin must be shaken or rotated to mix before use. Ask your doctor or pharmacist if the type of insulin you are using should be mixed and how you should mix it if necessary. Talk to your doctor or pharmacist about where on your body you should inject insulin. You can inject your insulin in the stomach, upper arm, upper leg, or buttocks. Do not inject insulin into muscles, scars, or moles. Use all available sites in the same general area before switching to a different area for example, the upper arm. Other uses for this medicine This medication may be prescribed for other uses. Ask your doctor or pharmacist for more information. What special precautions should I follow? Before using insulin, tell your doctor and pharmacist if you are allergic to any type of insulin or any other medications. Be sure to mention any of the following: Your doctor may need to change the doses of your medications or monitor you carefully for side effects. If you become pregnant while using insulin, call your doctor. Alcohol may cause a decrease in blood sugar. Ask your doctor about the safe use of alcoholic beverages while you are using insulin. These changes can affect your blood sugar and the amount of insulin you may need. Be aware that hypoglycemia may affect your ability to perform tasks such as driving and ask your doctor if you need to check your blood sugar before driving or operating machinery. What special dietary instructions should I follow? Be sure to follow all exercise and dietary recommendations made by your doctor or dietitian. It is important to eat a healthy diet and to eat about the same amounts of the same kinds of foods at about the same times every day. Skipping or delaying meals or changing the amount or kind of food you eat can cause problems with your blood sugar control. What should I do if I forget a dose? When you first start using insulin, ask your doctor what to do if you forget to inject a dose at the correct time. Write down these directions so that you can refer to them later. What side effects can this medication cause? This medication causes changes in your blood sugar. You should know the symptoms of low and high blood sugar and what to do if you have these symptoms. Insulin may cause side effects. Tell your doctor if any of these symptoms are severe or do not go away: If you experience any of the following symptoms, call your doctor immediately:

**Chapter 5 : Recognition of and steps to mitigate anxiety and fear of pain in injectable diabetes treatment**

*Bye bye, syringe: Insulin pumps eliminate the need for insulin injections using a syringe. Instead of giving yourself multiple injections with a syringe every day, you reinsert the needle for the insulin pump only once every two to three days.*

Impaired awareness of hypoglycaemia. Possible organic causes, including gastroparesis. Lack of appropriate knowledge and skills for self-management. If the person is experiencing symptoms of nocturnal hypoglycaemia fatigue, headache, or a hangover sensation or if this is detected on monitoring: Review their knowledge and self-management skills. Review their current insulin regimen, evening eating habits, and previous physical activity. Occasionally check their blood glucose between 2 am and 3 am, when hypoglycaemia is most likely to happen. Managing episodes of hypoglycaemia People with hypoglycaemia who are able to swallow should: It may be necessary to give the carbohydrate in small amounts as hypoglycaemia may cause vomiting. As a guide for children and young people, approximately 0. Chocolates and biscuits should be avoided if possible because they have a lower sugar content and their high fat content may delay stomach emptying. Improvements in signs and symptoms may lag behind improvement in blood glucose level. When symptoms improve or normoglycaemia is restored: If the next meal is due, the carbohydrate intake of that meal should be increased for example with bread, potatoes, or pasta. If the next meal is not due soon, the person should immediately eat some long-acting starchy carbohydrate such as a sandwich or some biscuits to maintain blood glucose. This is not necessary for people on a continuous subcutaneous insulin infusion insulin pump therapy. Intramuscular IM glucagon should be administered immediately. Emergency transfer to hospital should be arranged by calling if: IM glucagon is not available. Alcohol is the cause of, or has contributed to, the development of hypoglycaemia intravenous [IV] glucose is required. Vomiting is common in the recovery phase, and recurrent hypoglycaemia may recur. Consequently, the person should be closely monitored with regular checking of blood glucose. If hypoglycaemia recurs, the person may require additional oral carbohydrate or urgent hospital admission for treatment with IV glucose if symptoms are severe. To manage impaired awareness of hypoglycaemia: Offer additional education focusing on avoiding and treating hypoglycaemia if the person continues to have impaired awareness of hypoglycaemia. Review insulin regimens and doses and prioritize strategies to avoid hypoglycaemia. If impaired awareness of hypoglycaemia is associated with recurrent severe hypoglycaemia despite these interventions, refer the person to the diabetes specialist team. Recommended insulin regime There are different types of insulin regimen: Premixed analogue insulins consist of a mix of a rapid-acting insulin analogue mixed with an intermediate-acting insulin analogue. This regimen offers greater flexibility for blood glucose control. Continuous subcutaneous insulin infusion insulin pump “this is a programmable pump and insulin storage reservoir that gives a regular or continuous amount of insulin usually in the form of a rapid-acting insulin analogue or short-acting insulin by a subcutaneous needle or cannula. Insulin therapy for people with type 1 diabetes should only be initiated and managed by healthcare professionals with the relevant expertise and training. For basal insulin replacement: Twice-daily insulin detemir should be offered, unless: A rapid-acting insulin analogue injected before meals is recommended, rather than rapid-acting soluble human or animal insulins. The routine use of rapid-acting insulin analogues after meals should be discouraged. If a multiple daily injection basal-bolus insulin regimen is not possible and a twice-daily mixed insulin regimen is preferred: A trial of a twice-daily analogue mixed insulin regimen should be considered if the person has hypoglycaemia that affects their quality of life. Back to top Children and young people Insulin therapy for people with type 1 diabetes should only be initiated and managed by healthcare professionals with the relevant expertise and training. Encouraged to adjust the insulin dose if appropriate after each blood glucose measurement. Unlike the other insulin regimens, insulin pump therapy dispenses with the need for an intermediate-acting or long-acting insulin to provide basal cover. The pump can be programmed to deliver different basal rates of insulin at different times of the day and night, with higher infusion rates triggered by the push of a button at meal times. Should only be initiated by a trained specialist team, which should

normally comprise of a physician with a specialist interest in insulin pump therapy, a diabetes specialist nurse, and a dietician. Adults and children 12 years of age or older if: Children younger than 12 years of age, provided that multiple daily injection therapy is considered to be impractical or inappropriate. The child would be expected to undergo a trial of multiple daily injection therapy between 12 and 18 years of age. Self-monitoring skills should be taught at the time of diagnosis and at the time of initiation of insulin therapy. For adults with type 1 diabetes aged 18 years and older, advise routine self-monitoring of blood glucose levels at least 4 times a day including before meals and before bed. More frequent testing up to 10 times a day or more may be required if any of the following apply: During periods of illness. When planning a pregnancy, during pregnancy, and while breastfeeding – see the National Institute for Health and Care Excellence NICE guideline on Diabetes in pregnancy for more information. If there is a need to know blood glucose levels more than 4 times a day for other reasons, for example in people with impaired awareness of hypoglycaemia. A bedtime target plasma glucose level should be agreed with the person. This should take into account the timing of the last meal and its related insulin dose, and be consistent with the recommended fasting level on waking. Advise that they should routinely perform at least 5 blood glucose tests per day. More frequent testing is often needed for example with physical activity and during intercurrent illness. The optimal targets for glucose self-monitoring in children and young people with type 1 diabetes are: Explain that achieving and maintaining blood glucose levels towards the lower end of the target optimal ranges will help them to achieve the lowest attainable HbA1c. Self-monitoring skills should be reviewed at least annually. This should include checking that the person knows: How to use their blood glucose monitoring meter – this can be done by asking them to demonstrate their technique. When to test – for example before breakfast and 2 hours after meals, during periods of illness, before driving, and if they feel hypoglycaemic. How to assess and respond to test results, including how to: Interpret trends in blood glucose levels as well as individual readings – this is important for adjusting insulin doses. Identify the causes of high and low blood glucose values. It may be considered in secondary care for: Adults with one or more of the following: Children with one or more of the following: Back to top Available insulin products Three types of insulin are available in the UK: Although widely used in the past, animal insulins are no longer initiated in people with diabetes. However, they are still used in some people who cannot, or do not wish to, change to human insulins. These insulins are not covered in this CKS topic. Insulins are broadly categorized according to their time-action profiles as: Short-acting insulins – these aim to work like the insulin normally produced by the body to cope with glucose absorbed from a meal or drink. They have a rapid onset of action and a short duration of action. Two types are available: Intermediate-acting isophane or NPH [Neutral Protamine Hagedorn] insulins – these are used to mimic the effect of the basal insulin that is secreted continuously throughout the day. They have an onset of action of approximately 1–2 hours, maximal effects between 4–12 hours, and a duration of action of 16–35 hours. They are normally used once or twice a day and achieve a steady-state level after 2–4 days to produce a constant level of insulin. Once in use, it can be stored at room temperature for 28 days or longer depending on the product. Non-adherence to insulin treatment – this is a common cause of poor glucose control. Children and young people should be encouraged to attend diabetes clinic regularly four times per year as this is associated with good glucose control. Referral to an appropriate mental health professional should be arranged if necessary. Gastroparesis should be suspected if the person also has unexplained bloating or vomiting. If insulin adjustment is required, it should only be done by healthcare professionals with the relevant expertise and training. Offer a review of injection sites: For children and young people, at each clinical visit. Manage injection site problems as follows: Consider changing the size of the needles – a shorter needle may be less painful. Ensure that the person uses a new needle for every injection. Ensure that insulin is not used straight from the refrigerator – cold insulin can make injection painful. Reassure the person that bleeding may occasionally occur when the needle is withdrawn. Advise them to gently apply pressure to the site for a couple of minutes to minimize bruising. Review the injection technique – bruising and bleeding can occur if the insulin is accidentally injected intramuscularly instead of subcutaneously. Consider changing the size of the needle – a shorter needle may reduce the problem of injecting insulin intramuscularly. Redness, swelling, and itching at the site of injection: Reassure the person that local reactions usually resolve after a few

days sometimes several weeks. Exclude other causes for the symptoms, such as a reaction to soap or cosmetics, poor injection technique, or reaction to the preservatives in the insulin preparations in which case a change of insulin preparation may be needed. Explain that lipohypertrophy is caused by repeatedly injecting the same small area, resulting in a build up of lumps under the skin.

**Chapter 6 : Insulin: Compare common options for insulin therapy - Mayo Clinic**

*Insulin Leakage. Despite concern that shorter needles are more apt to cause insulin leakage, especially with larger doses of insulin or with obese patients, the evidence seems to demonstrate the contrary (2,4,5,9,10).*

**Overview** Insulin is a hormone that helps cells use glucose sugar for energy. Diabetes is normally managed with diet and exercise, with medications, including insulin, added as needed. If you have type 1 diabetes, injecting insulin is required for life. This may seem difficult at first, but you can learn to successfully administer insulin with the support of your healthcare team, determination, and a little practice.

**Insulin injection methods** There are different ways to take insulin, including syringes, insulin pens, insulin pumps, and jet injectors. Your doctor will help you decide which technique is best for you. Syringes remain a common method of insulin delivery.

**Syringes** Syringes vary by the amount of insulin they hold and the size of the needle. Traditionally, needles used in insulin therapy were 8 mm, 6 mm, and 4 mm. Recent research shows that smaller 8 mm, 6 mm, and 4 mm needles are just as effective, regardless of body mass. This means insulin injection is less painful than it was in the past.

**Where to inject insulin** Insulin is injected subcutaneously, which means into the fat layer under the skin. In this type of injection, a short needle is used to inject insulin into the fatty layer between the skin and the muscle. Insulin should be injected into the fatty tissue just below your skin. If you inject the insulin deeper into your muscle, your body will absorb it too quickly, it might not last as long, and the injection is usually more painful. This can lead to low blood glucose levels. People who take insulin daily should rotate their injection sites. This is important because using the same spot over time can cause lipodystrophy. In this condition, fat either breaks down or builds up under the skin, causing lumps or indentations that interfere with insulin absorption. You can rotate to different areas of your abdomen, keeping injection sites about an inch apart. Or you can inject insulin into other parts of your body, including your thigh, arm, and buttocks.

**Abdomen** The preferred site for insulin injection is your abdomen. Insulin is absorbed more quickly and predictably there, and this part of your body is also easy to reach. Select a site between the bottom of your ribs and your pubic area, steering clear of the 2-inch area surrounding your navel. These can interfere with the way your body absorbs insulin. Stay clear of broken blood vessels and varicose veins as well.

**Thigh** You can inject into the top and outer areas of your thigh, about 4 inches down from the top of your leg and 4 inches up from your knee.

**Arm** How to inject insulin Before injecting insulin, be sure to check its quality. If it was refrigerated, allow your insulin to come to room temperature. If the insulin is cloudy, mix the contents by rolling the vial between your hands for a few seconds. Be careful not to shake the vial. Follow these steps for safe and proper injection:

*Introduction Insulin therapy is a cornerstone of treatment in type 1 diabetes and, in many cases, also critical to the management of type 2 diabetes.*

Relief May Be on the Way Written by Susan Ito on August 26, One of the most onerous components of life with diabetes is dealing with all of the needles. Needles for regular blood glucose testing as well as needles for insulin injection. For those who have anxiety over being regularly pricked, it can mean avoidance or noncompliance, which can have dire results. But a new study indicates that relief for the needle-averse may be on the horizon. An oral form of insulin is in development. Researchers presented their studies on this topic at the American Chemical Society national meeting this week. A few prior approaches, including an inhalable form of insulin, had temporary successes, but nothing has proved to be as effective as injections. One was that harsh stomach acids easily destroy orally ingested insulin before it could be absorbed into the body. The second has been that it has been difficult for insulin to cross the intestinal membrane in order to reach the bloodstream. Now, a team of researchers led by Dr. Mary McCourt and Dr. Lawrence Mielnicki of Niagara University, have discovered a new vehicle for orally ingested insulin. These lipid vesicles can be made in any size and are made of materials that are naturally occurring in the body. So we are happy to see success in the initial animal studies. The insulin is packaged in a nanoscale vesicle that is in essence a cocoon of lipids that surrounds and protects the insulin, and yet allows it to easily release into the bloodstream. Drugs can be loaded inside, and the tiny packages can pass through the stomach without being destroyed. When Cholestosomes reach the intestines, the body recognizes them as something to be absorbed. The vesicles pass through the intestines, into the bloodstream, and then cells take them in and break them apart, releasing the insulin. Since they are packaged as neutral, they have no reaction to the environment, and the acid on the stomach has no effect on them. Additionally, the vesicles are structurally stable and amenable to storage without leaking or breaking down before ingestion. When asked about the effectiveness of this delivery method versus that of an insulin injection, McCourt responded that it was found to be similar in the control studies, and that it had the potential to be even longer lasting than injected insulin. However, the team indicated that all of the materials used are widely available, so it is not anticipated to be excessively expensive. Based on the animal studies, the researchers stated that this method could be universally applicable for any patients who are insulin dependent. Looking beyond diabetes treatment, they have also successfully encapsulated molecules of varying sizes. This bodes well for other pharmaceutical treatments. Written by Susan Ito on August 26, related stories.

**Chapter 8 : Diabetes Care - BD**

*Traditionally, needles used in insulin therapy were millimeters (mm) in length. Recent research shows that smaller 8 mm, 6 mm, and 4 mm needles are just as effective, regardless of body mass.*

Too much glucose in the blood can lead to serious health problems. Why do I need to take insulin? All people who have type 1 diabetes and some people who have type 2 diabetes need to take insulin to help control their blood sugar levels. The goal of taking insulin is to keep your blood sugar level in a normal range as much as possible. Keeping blood sugar in check helps you stay healthy. It is usually taken by injection a shot. It can also be taken by using an insulin pen or an insulin pump. Path to improved health How often will I need to take insulin? You and your doctor will develop a schedule that is right for you. Most people who have diabetes and take insulin need at least 2 insulin shots a day for good blood sugar control. Some people need 3 or 4 shots a day. Do I need to monitor my blood sugar level? Monitoring and controlling your blood sugar is key to preventing the complications of diabetes. Checking your blood sugar involves pricking your finger to get a small drop of blood that you put on a test strip. You can read the results yourself or insert the strip into a machine called an electronic glucose meter. The results will tell you whether your blood sugar is in a healthy range. Your doctor will give you additional information about monitoring your blood sugar. When should I take insulin? You and your doctor should discuss when and how you will take your insulin. Some people who use regular insulin take it 30 to 60 minutes before a meal. Some people who use rapid-acting insulin take it just before they eat. They last for 3 to 5 hours. What is rapid-acting insulin? How can it help control my blood sugar level? Rapid-acting insulin starts working more quickly than other types of insulin. It begins working within 15 minutes and leaves your body after 3 to 5 hours. To keep your blood sugar level steady throughout the day, your doctor may also prescribe a longer-acting insulin. Or he or she may prescribe another drug for you to take each day in addition to rapid-acting insulin. When do I take rapid-acting insulin? You should inject rapid-acting insulin no more than 15 minutes before you eat. Your doctor will tell you how much insulin to inject. Remember, you should not wait more than 15 minutes to eat after you take this insulin shot. Rapid-acting insulin can be more convenient to take than regular insulin. With regular insulin, you inject the insulin and then wait 30 to 60 minutes before eating. Many people find it hard to time their meals around regular insulin injections. Sometimes they end up eating too soon or too late. Since rapid-acting insulin is taken so close to mealtime, it may help you control your blood sugar more effectively. Can I mix rapid-acting insulin with other types of insulin? Rapid-acting insulin should always be drawn into the syringe first. This will keep the intermediate-acting insulin from getting into the rapid-acting insulin bottle. After mixing rapid-acting insulin in the same syringe with an intermediate-acting insulin, you must inject the mixture under your skin within 15 minutes. Remember to eat within 15 minutes after the injection. How do I prepare the correct dose of insulin? You may take insulin using a syringe that you fill from a vial or using a dosing pen that contains the insulin. If your rapid-acting insulin comes in a pen, your doctor or his or her office staff can show you how to use it correctly. Follow the directions carefully. Take the plastic cover off the new insulin bottle. Wipe the top of the bottle with a cotton swab that you have dipped in alcohol. Pull back the plunger of the syringe. This draws air into the syringe equal to the dose of insulin that you are taking. Then put the syringe needle through the rubber top of the insulin bottle. Inject air into the bottle by pushing the syringe plunger forward. Then turn the bottle upside down. Make sure that the tip of the needle is in the insulin. Pull back on the syringe plunger to draw the correct dose of insulin into the syringe. The dose of insulin is measured in units. Make sure there are no air bubbles in the syringe before you take the needle out of the insulin bottle. Air bubbles can cut down the amount of insulin that you get in your injection. If air bubbles are present, hold the syringe and the bottle straight up in one hand, tap the syringe with your other hand and let the air bubbles float to the top. Push on the plunger of the syringe to move the air bubbles back into the insulin bottle. Then withdraw the correct insulin dose by pulling back on the plunger. Clean your skin with cotton dipped in alcohol. Grab a fold of skin and inject the insulin at a degree angle. Where do I inject the insulin? Insulin is injected just under the skin. Your doctor or his or her office staff will show you how and where to

give an insulin injection. The usual places to inject insulin are the upper arm, the front and side parts of the thighs, and the abdomen. To keep your skin from thickening, try not to inject the insulin in the same place over and over. Things to consider What is an insulin reaction? Rapid-acting insulin begins to work very quickly. So while you and your doctor are working to find the right dosage of this insulin, you may have some insulin reactions. Most people who take insulin have insulin reactions at some time. Signs of an insulin reaction and hypoglycemia include the following:

**Chapter 9 : Insulin Management of Type 2 Diabetes Mellitus - - American Family Physician**

*Insulin therapy is recommended for patients with type 2 diabetes mellitus and an initial A1C level greater than 9 percent, or if diabetes is uncontrolled despite optimal oral glycemic therapy.*

Its mechanisms of action are highly similar across species. Many patients require insulin therapy to manage their blood sugar levels and keep them within a target range. Animal glands were obtainable as a waste product of the meatpacking industry. The making of eight ounces of purified insulin could require as much as two tons of pig parts. Minor allergic reactions still occur occasionally, even to synthetic "human" insulin varieties. Genentech developed the technique used to produce the first such insulin, Humulin, but did not commercially market the product themselves. Eli Lilly marketed Humulin in The host cells are then allowed to grow and reproduce normally, and due to the inserted human DNA, they produce a synthetic version of human insulin. Manufacturers claim this reduces the presence of many impurities. However, the clinical preparations prepared from such insulins differ from endogenous human insulin in several important respects; an example is the absence of C-peptide which has in recent years been shown to have systemic effects itself. Novo Nordisk has also developed a genetically engineered insulin independently using a yeast process. Adverse reactions have been reported; these include loss of warning signs that sufferers may slip into a coma through hypoglycemia , convulsions, memory lapse and loss of concentration. A special FDA importation process is required to obtain bovine or porcine derived insulin for use in the U. The amount of carbohydrates one unit of insulin handles varies widely between persons and over the day but values between 7 and 20 grams per 1 IE is typical. Adjusting dosage and timing to fit food intake timing, amounts, and types. Adjusting dosage and timing to fit exercise undertaken. Adjusting dosage, type, and timing to fit other conditions, for instance the increased stress of illness. Variability in absorption into the bloodstream via subcutaneous delivery The dosage is non-physiological in that a subcutaneous bolus dose of insulin alone is administered instead of combination of insulin and C-peptide being released gradually and directly into the portal vein. It is simply a nuisance for patients to inject whenever they eat carbohydrate or have a high blood glucose reading. Clinical insulins are specially prepared mixtures of insulin plus other substances including preservatives. These delay absorption of the insulin, adjust the pH of the solution to reduce reactions at the injection site, and so on. They have absorption and activity characteristics not currently possible with subcutaneously injected insulin proper. Insulin analog Includes the insulin analogues aspart , lispro , and glulisine. These begin to work within 5 to 15 minutes and are active for 3 to 4 hours. Most insulins form hexamers , which delay entry into the blood in active form; these analog insulins do not but have normal insulin activity. Newer varieties are now pending regulatory approval in the U. Intermediate-acting[ edit ] Includes NPH insulin , which begins working in 1 to 3 hours and is active for 16 to 24 hours. Long-acting[ edit ] Includes the analogues glargine and detemir , each of which begins working within 1 to 2 hours and continues to be active, without major peaks or dips, for about 24 hours, although this varies in many individuals. Ultra-long acting[ edit ] Currently only includes the analogue degludec , which begins working within 30 to 90 minutes and continues to be active for greater than 24 hours. The combination products begin to work with the shorter acting insulin 5â€”15 minutes for fast-acting, and 30 minutes for short acting , and remain active for 16 to 24 hours. There are several variations with different proportions of the mixed insulins e. Methods of administration[ edit ] Insulin delivery devices Unlike many medicines, insulin cannot be taken orally at the present time. Like nearly all other proteins introduced into the gastrointestinal tract , it is reduced to fragments single amino acid components , whereupon all activity is lost. There has been some research into ways to protect insulin from the digestive tract, so that it can be administered in a pill. So far this is entirely experimental. Subcutaneous[ edit ] Insulin is usually taken as subcutaneous injections by single-use syringes with needles , an insulin pump , or by repeated-use insulin pens with needles. Patients who wish to reduce repeated skin puncture of insulin injections often use an injection port in conjunction with syringes. Administration schedules often attempt to mimic the physiologic secretion of insulin by the pancreas. Hence, both a long-acting insulin and a short-acting insulin are typically used. Insulin pump Insulin pumps are a reasonable solution for some. The

limitations are cost, the potential for hypoglycemic and hyperglycemic episodes, catheter problems, and no "closed loop" means of controlling insulin delivery based on current blood glucose levels. Some who cannot achieve adequate glucose control by conventional or jet injection are able to do so with the appropriate pump. Indwelling catheters pose the risk of infection and ulceration, and some patients may also develop lipodystrophy due to the infusion sets. These risks can often be minimized by keeping infusion sites clean. Insulin pumps require care and effort to use correctly. Dosage and timing[ edit ] Dosage units[ edit ] One international unit of insulin 1 IU is defined as the "biological equivalent" of The first definition of a unit of insulin was the amount required to induce hypoglycemia in a rabbit. This was set by James Collip at the University of Toronto in Of course, this was dependent on the size and diet of the rabbits. The unit of insulin was set by the insulin committee at the University of Toronto. Once the chemical structure and mass of insulin was known, the unit of insulin was defined by the mass of pure crystalline insulin required to obtain the USP unit. Potential complications[ edit ] Diagram explaining the basal-bolus insulin schedule. The long acting insulin is given once usually glargine , Lantus or twice usually detemir , Levemir daily to provide a base, or basal insulin level. Rapid acting RA insulin is given before meals and snacks. A similar profile can be provided using an insulin pump where rapid acting insulin is given as the basal and premeal bolus insulin. The central problem for those requiring external insulin is picking the right dose of insulin and the right timing. Physiological regulation of blood glucose, as in the non-diabetic, would be best. Increased blood glucose levels after a meal is a stimulus for prompt release of insulin from the pancreas. The increased insulin level causes glucose absorption and storage in cells, reduces glycogen to glucose conversion, reducing blood glucose levels, and so reducing insulin release. Even the best diabetic treatment with synthetic human insulin or even insulin analogs, however administered, falls far short of normal glucose control in the non-diabetic. Complicating matters is that the composition of the food eaten see glycemic index affects intestinal absorption rates. Glucose from some foods is absorbed more or less rapidly than the same amount of glucose in other foods. In addition, fats and proteins cause delays in absorption of glucose from carbohydrates eaten at the same time. As well, exercise reduces the need for insulin even when all other factors remain the same, since working muscle has some ability to take up glucose without the help of insulin. All such decisions by a diabetic must be based on experience and training i. But it is not straightforward and should never be done by habit or routine. With some care however, it can be done reasonably well in clinical practice. For example, some people with diabetes require more insulin after drinking skim milk than they do after taking an equivalent amount of fat, protein, carbohydrate, and fluid in some other form. Their particular reaction to skimmed milk is different from other people with diabetes, but the same amount of whole milk is likely to cause a still different reaction even in that person. Whole milk contains considerable fat while skimmed milk has much less. It is a continual balancing act for all people with diabetes, especially for those taking insulin. People with insulin-dependent diabetes typically require some base level of insulin basal insulin , as well as short-acting insulin to cover meals bolus also known as mealtime or prandial insulin. Maintaining the basal rate and the bolus rate is a continuous balancing act that people with insulin-dependent diabetes must manage each day. This is normally achieved through regular blood tests, although continuous blood sugar testing equipment Continuous Glucose Monitors or CGMs are now becoming available which could help to refine this balancing act once widespread usage becomes common. Strategies[ edit ] A long-acting insulin is used to approximate the basal secretion of insulin by the pancreas, which varies in the course of the day. The advantage of NPH is its low cost, the fact that you can mix it with short-acting forms of insulin, thereby minimizing the number of injections that must be administered, and that the activity of NPH will peak 4–6 hours after administration, allowing a bedtime dose to balance the tendency of glucose to rise with the dawn , along with a smaller morning dose to balance the lower afternoon basal need and possibly an afternoon dose to cover evening need. A disadvantage of bedtime NPH is that if not taken late enough near midnight to place its peak shortly before dawn, it has the potential of causing hypoglycemia. One theoretical advantage of glargine and detemir is that they only need to be administered once a day, although in practice many patients find that neither lasts a full 24 hours. They can be administered at any time during the day as well, provided that they are given at the same time every day. Another advantage of long-acting insulins is that the basal component of

an insulin regimen providing a minimum level of insulin throughout the day can be decoupled from the prandial or bolus component providing mealtime coverage via ultra-short-acting insulins , while regimens using NPH and regular insulin have the disadvantage that any dose adjustment affects both basal and prandial coverage. Glargine and detemir are significantly more expensive than NPH, lente and ultralente, and they cannot be mixed with other forms of insulin. Regular insulin, lispro, aspart and glulisine can be used for this purpose. Regular insulin should be given with about a minute lead-time prior to the meal to be maximally effective and to minimize the possibility of hypoglycemia. Lispro, aspart and glulisine are approved for dosage with the first bite of the meal, and may even be effective if given after completing the meal. The short-acting insulin is also used to correct hyperglycemia.