Welcome to the Fourth Edition of Knowledge Notes!

The Franciscan Northwest Physicians Health Network (FNPHN) is bringing Knowledge Notes to you as a quarterly educational resource. Each edition will provide a variety of short articles on a particular clinical topic. This Edition will focus on Diabetes, with emphasis on: Foot Care, A1C, Sick Care, Pharmacology of Diabetes, Insulin Pumps, and Tips for Blood Glucose Checks. The next Edition will be devoted to the continuum of care efforts that CHI- FH is doing on Heart Failure for Heart Failure accreditation.

Knowledge Notes is produced by the CHI - Franciscan Health, Education Services Department, with guidance from the CCN Clinical Education Ad Hoc Subcommittee, and is intended to support our partner organizations in the delivery of excellent patient care in the post-acute care setting.

Over time, the FNPHN website (www.fnphn.com) will become a convenient repository of information and learning that you and your fellow employees can freely access 24/7/365. We are always looking for feedback about how we are doing, so please give us feedback at zenafuhrmann@fhshealth.org

Once again, welcome to the fourth edition of Knowledge Notes.

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Knowledge Notes

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Diabetes

Introduction

The common name of diabetes is often called diabetes mellitus in the professional world (diabetes insipidus is not a related disease). It is a group of metabolic disorders in which the person has an abnormally high blood sugar. This occurs because of inadequate insulin production or because cells do not appropriately respond to the insulin. Symptoms of an elevated blood sugar (glucose) typically are polyuria (excessive/frequent urination), polydipsia (excessive thirst) and polyphagia (abnormal, sometimes unquenchable hunger). Understanding the care and concerns of the diabetic patient is important.

Demographics

Diabetes is a growing health concern for all ages. Seniors, as well as, the young have an increasing incidence of diabetes. American Heart Association published their National Statistics Report (2014) with a review of the growing numbers of the United States population with diabetes. The report indicates that in 2012 there were 29.1 million Americans with the diagnosis of diabetes; this is 9.3% of the total population. (See Table 1) These numbers are up from the 2010 information that identified 25.8 million or 8.3% of the population with diabetes. There appears to be differential rates of disease based on ethnic background, with American Indians and Alaskan Natives being twice as likely to have diabetes as non-Hispanic Whites. (see Table 2)

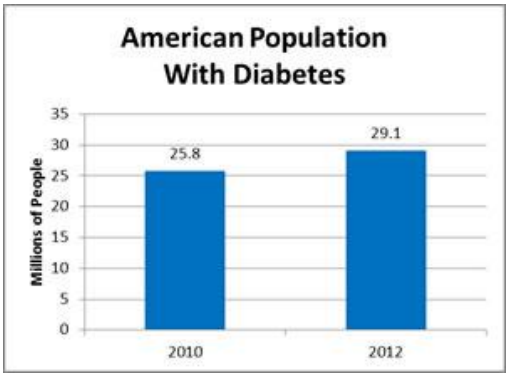


Table 1.

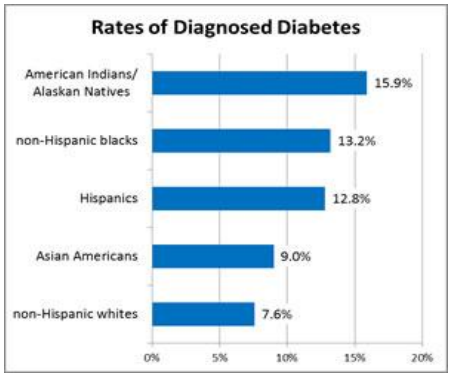


Table 2.

Source: AHA (2014)

Tips for blood glucose checks

Glucometers are unable to differentiate between the glucose found in blood versus that found from a sugary drink, food remnants, or other solutions that contain a sugary substance. Because of this inability to discriminate, the person doing the blood glucose test, whether that be the diabetic themselves or a caregiver, must have clean hands. Wash hands with soap and

water, rinse thoroughly, and dry completely. Small amounts of water on the hands may dilute the sample enough to falsely lower the blood glucose (BG). It is not recommend that alcohol be used to clean the area to be pricked. When alcohol is used the test result may not be accurate and treatment decisions may not be appropriate. If alcohol is the only available source of ensuring cleanliness, be sure that the alcohol is completely dry before puncturing the skin.

To further ensure that the test results are accurate, check the test strip container for the expiration date, do not use the strips if they are beyond the expiration date. Keep in mind that every time a new batch of strips is opened they must have a quality control test completed before use. If more than one type of meter is in use, confirm that the correct test solution for the meter is used; they are specific for each different brand of meter. Additionally, a quality control test should always be run if the meter is dropped. Finally, confirm that the quality control test results are within the range identified on the side of the control solution bottle. Test strips should always be kept in their original container. Only remove the cap when a strip is to be removed, then immediately recap the bottle. Strips are sensitive to light and moisture and must be protected to ensure accuracy. The blood glucose test is an easy monitoring tool to use, but to treat the blood glucose with confidence care must be taken that the above parameters are followed.

To decrease the discomfort of the lancet, use the side of the finger rather than the pad of the finger. The pad of the finger is involved with many daily functions, but the side of the finger is much less used and therefore unlikely to have significant compression and sensitivity. Another method that can be used that causes less pain is a blood glucose check using urine. The urine test is less accurate than the blood glucose, but can be used if necessary. As will be discussed, urine is routinely used to test ketones when the patient is sick and the blood glucose is high.

Keep a log of the blood glucose. This log is a good reference tool for critically looking at when the blood glucose may be high or low and whether there are patterns to these out of range results. The log should be taken to provider appointments so that the provider can review the treatment plan and adjust it to maintain within range blood glucose checks and decrease the complications of both hypoglycemia (low BG) and hyperglycemia (high BG).

Foot care

Persons with diabetes must be extra vigilant about the care of their feet. As diabetes progresses there is too frequently a loss of feeling in the feet which allows for increased opportunity for damage to the feet. This nerve damage is called neuropathy. In addition to loss of feeling the feet may have the sensation of burning, tingling, pin pricks, or stinging. Changes in the ability to feel heat and cold also occur with neuropathies. It is high concentrations of glucose in the blood that causes the blood vessels to narrow and harden or become sclerotic, which allows

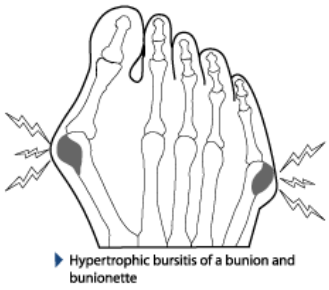
decreased amounts of blood with oxygen and nutrients to be delivered to the tissues of the feet and sets up the stage for damage to skin and underlying tissue.

Patients with diabetes should have a foot assessment done by the provider once a year. As caregivers for these patients we should be aware that patients do best when they have their feet washed daily with warm water and dried completely, especially between their toes. Lotions such as plain petroleum jelly, unscented hand cream or lotions can be used to keep the feet soft, but it should not be applied between the toes as this gives a warm, moist environment for bacterial growth and the development of an infection. Soaking the feet can lead to dangerous drying of the skin and should be avoided. Inspect feet daily for any openings in the skin such as:

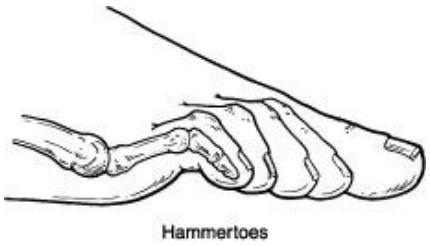
- Cuts
- Sores
- Blisters
- Redness
- Calluses
- Or other skin issues

Neuropathies leading to major foot deformities

- **Bunions** - a bony bump that forms on the medial aspect of the great toe. The big toe moves in toward the toe next to it and the joint is pushed outwards, causing an area that rubs against shoes and can become red and extremely tender. This is caused by wearing shoes that are too tight, the diabetic must be on guard for this.



Source: The Foot Specialist



Source: Health Facts

- **Hammer toes** – a contraction of at least one of the joints of the toes other than the great toe. This causes an abnormal bending of the toe and the opportunity for areas of pressure to develop when wearing shoes. Caused by structural problems within the muscles or tendons of the toe. Treatment should be decided on by the provider.

- **Charcot Feet** – people with substantial neuropathy in their feet may develop Charcot feet. This is a weakening of the bones in the feet that occurs over time and allows for deformity of the feet such that they may appear to have a rocker bottom appearance. Early symptoms of this problem may be a foot that is warm to the touch when compared to the other foot, redness in the foot, swelling and pain. Early recognition and provider notification is important to develop a treatment plan.

Source: Health facts

Toenail care is another area that diabetic patients must be more concerned with than the average person. (Refer to your facility policy for toenail care for diabetic patients.) A Podiatrist may be needed for nails that have not been well cared for up to the current time. Diabetic patients who have been instructed on toenail care likely have been taught to cut toenails after bathing when the nail is softer, to cut straight across and not cut into the corners of the nail, and to avoid cutting cuticles.

These are some basic foot care guidelines that help protect the diabetic foot from harm:

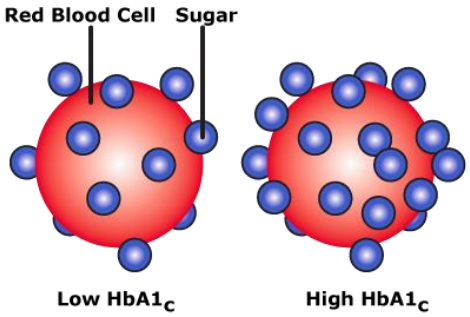
- Wear clean, soft socks that fit well
  - Change socks daily
  - Wear natural fibers (cotton, cotton-wool blends, or wool)
  - Do not wear socks or knee-high stockings that are too tight below the knee
- Never go barefoot
  - Break in new shoes slowly over time (do not wear for over one hour at a time)
  - Avoid high heels and pointed toes
  - Wear shoes with enclosed toes and heels
- Prior to putting shoes on check for sharp edges, cracks, pebbles, or other items that could cause injury to the foot

A1C

Previously known as Hemoglobin A1C or more technically as glycosylated hemoglobin, the A1C provides an average of the person's blood glucose level over the previous 2-3 months, and is reported as a percentage. As an example, an A1C of 7% would reflect an average blood glucose

of 154 mg/dl. Knowing the A1C predicts the risk of complications from diabetes, which includes: blindness, kidney disease, heart attack, stroke, or potentially an amputation from vascular disease.

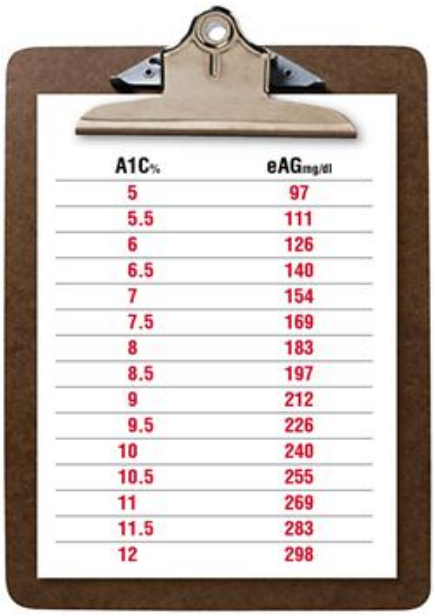
Glucose attaches to the hemoglobin cells, which have a life span of approximately three months and therefore reflects what the blood glucose has averaged over the preceding two to three months. (Some references call this value the eAG or estimated average glucose, it is measured in mg/dl.) This also explains why if a person has had a blood transfusion in the past three months the A1C would not be a reliable reflection of the patient's average blood glucose.



Picture courtesy of MedExpress Rx

Glucose attached to a hemoglobin cell

The American Diabetic Association recommends an A1C of less than 7% and suggests that lowering the A1C decreases the risk of complications. How much a change actually decreases risk is variable based on the A1C level where one starts. For example, a change from 12% to 11% offers greater improvement than a change from 7% to 6%. However, a decrease in the A1C level of any sort should be encouraged as being a beneficial change.



A1C%	eAG mg/dl
5	97
5.5	111
6	126
6.5	140
7	154
7.5	169
8	183
8.5	197
9	212
9.5	226
10	240
10.5	255
11	269
11.5	283
12	298

Graphic courtesy of Joslin Diabetes Center

Comparison of A1C% and estimated average glucose (eAG)

Consider that the American Diabetic Association has recommended relaxing A1C goals for older individuals with other co-morbidities, "Less stringent A1C goals (such as less than 8%) may be appropriate for patients with a history of severe hypoglycemia, limited life expectancy, advanced microvascular or macrovascular complications, and extensive comorbid conditions and in those with long-standing diabetes in whom the general goal is difficult to attain despite diabetes self-management education, appropriate glucose monitoring, and effective doses of multiple glucose-lowering agents including insulin." Care of the diabetic patient, however, must be individualized to that particular person.

Definition of Diabetes Type I & Type II

Type I Diabetes is commonly called "insulin dependent diabetes". We are all insulin dependent in that we need insulin to help regulate our metabolism of carbohydrates and fats. Insulin helps the cells of the musculoskeletal and fat tissue absorb the glucose from the circulating blood. Additionally, the glucose can be stored as fat rather than be used for energy and then called into action when carbohydrates are not readily available. (This storage as fat is one of the side effects of using exogenous insulin.) However, in Type I diabetes, the diabetic does not have the supply of insulin that is normally produced by the Beta-cells in the pancreas, in fact they have an *complete* lack of insulin.

Type II Diabetes is a disorder of insulin utilization. The person is resistant to the circulating insulin that is produced in normal amounts by their pancreas. This resistance is frequently a result of obesity, age, or physical inactivity. Almost half of the Type II diabetics require the addition of insulin as part of their medical therapy.

Picture courtesy of Trusted Health Products

Sick Care

Being sick when one has diabetes takes extra thought and careful consideration. Should insulin still be given? How often is the blood glucose measured? When should the provider be looped into the care of the sick diabetic patient?

It is important to closely monitor the blood glucose during the illness because it is common for the blood glucose to elevate. When the body is stressed, hormones are released to combat the sickness. These hormones raise the blood glucose and decrease the effectiveness of the hormone that usually lowers the blood glucose – insulin. The outcome of this change in hormone activity can cause Type I diabetes to go into ketoacidosis and possibly coma. Both Type I and Type II diabetics, can be at risk for developing hyperosmolar hyperglycemic nonketotic syndrome (HHNS). However, older Type II diabetics more commonly develop HHNS.

How does one differentiate between diabetic ketoacidosis (DKA) and HHNS? The following table may help to more clearly define the two conditions.

	Diabetic Ketoacidosis	**Hyperosmolar Hyperglycemic Nonketotic Syndrome**
Early symptoms:	Thirst or very dry mouth	Dry parched mouth & Extreme thirst
	Frequent urination	Frequent urination
	High blood glucose	Blood glucose over 600mg/dl
	High levels of ketones	Check for ketones if BG >300
DKA progresses:	Constant tired feeling	Sleepiness or confusion
	Dry or flushed skin	High fever (over 101° F.)
	Nausea, vomiting, abdominal pain	
	Difficulty breathing	
	Fruity odor on breath	
	Difficult to concentrate or focus	Sleepiness or confusion
		Hallucinations
		Loss of vision
Untreated	Diabetic coma →Life threatening	Seizures, coma, & death

Medication plan

Diabetic medications should be continued, even if nausea and vomiting are present. In fact, if the patient uses insulin they may need an increased dosage of insulin due to the increased release of glucose caused by the stress of the illness. Oral diabetic medication should also be continued, if possible. Call the provider if vomiting occurs after taking the pill.

Before any over-the-counter medications are given/taken, the provider should be consulted. These medications include commonly used drugs such as: aspirin, cough syrup, or decongestants. Aspirin is known to cause blood glucose levels to lower, cough syrup may contain high levels of sugar, decongestants and other products for treating the common cold actually raise the blood glucose level. FYI - antibiotics lower blood glucose levels in patients that have Type II diabetes and take oral diabetic medications.

Glucose Monitoring

Monitor the blood glucose level at least every 2-4 hours. Call the provider if the blood glucose increases to greater than 240 mg/dl. Type I diabetics should have ketones monitored every 4 hours. When the blood glucose is high, but unable to be used as the source of energy because of a lack of insulin, the body may start breaking down fat as a source of energy, the end-product of this breakdown is ketones. Ketones lower the bodies' pH and the kidneys attempt to remove the glucose and ketones, it can therefore be measured in the urine and is a good indicator of how seriously ill the person is becoming. When there is a moderate to large amount of ketones detected in the urine for more than 6 hours the provider should be consulted.

Indications to seek medical assistance

The CHI – FH diabetic nurse educator has compiled a list of signs or symptoms for when the provider should be consulted:

- Blood glucose is less than 70 mg/dl
- Blood glucose is greater than 240mg/dl for more than 6 hours
- Unable to eat or drink for 4 hours
- Fever at or greater than 101.5°
- Illness lasting longer than 24 hours
- Complaints of severe abdominal pain, chest pain, or difficulty breathing
- Vomiting or diarrhea for greater that 6 hours
- Moderate to large amount of ketones for greater than 6 hours

Food and Drink

Even if vomiting or having diarrhea, one should try to take in carbohydrates (CHO). The recommendation is to eat or drink 50 grams of CHO every 3 – 4 hours. The following foods have 15 grams of CHO: ½ cup of fruit juice (orange, apple, or grape), ½ cup of regular soda pop (not sugar-free), ½ cup regular jello, 1 double Popsicle, 1 cup of soup, 1 cup of sports drink, 1 slice of toast, or 6 soda crackers.

To maintain fluid intake, consume at least 8 ounces or 1 cup of caffeine-free liquids every hour. When vomiting is present sucking on a Popsicle may be easier. Another method of attempting to maintain fluid intake when vomiting is to take 1-2 tablespoons of fluid every 20 minutes. Again, use fluids that offer some nutritive value such as fruit juice, clear soups, or sports drinks if the blood sugar is low. Sugar-free liquids can be substituted if the blood sugar is high.

Pharmacology of Diabetes Treatment

Oral agents

There are four major classes of drugs used to treat Type II diabetes: Sulfonylureas, alpha-glucosidase inhibitors, biguanides, and thiazolinediones. A brief overview of these medications follows.

Sulfonylureas (Glyburide/Diabeta, Micronase; Glipizide/Glucotrol; Glimiperide/Amaryl)

These drugs stimulate the pancreas to release insulin from the Beta cells and increase the sensitivity to insulin at receptor sites. They may also decrease hepatic production of glucose. Side effects include hypoglycemia and dermatologic photosensitivity. Insulin may be required during times of stress, fever, trauma, infection, or surgery.

Biguanides (Metformin/Glucophage, Fortamet)

The actions for this group of drugs are that they: decrease hepatic glucose production, decrease intestinal glucose absorption, and increase sensitivity to insulin. Adverse reactions and side effects include abdominal bloating, diarrhea, nausea, vomiting. Life threatening side effects include lactic acidosis. Interestingly, digoxin, morphine, calcium channel blockers, and vancomycin may compete for elimination pathways with the biguanides. Furosemide has been shown to increase the effects of the biguanides. This drug is contraindicated when there is renal dysfunction (serum Cr greater than 1.5 mg/dl in men and greater than 1.4 mg/dl in women). The drug is cleared through the kidney, therefore if there is a possibility of decreased blood flow to the kidney such as dehydration, radiographic studies requiring IV iodinated contrast media, or NPO status the drug should be held to prevent an unhealthy accumulation of the drug.

Thiazolidinediones (Rosiglitazone/Avandia; Actos/Pioglitazone)

The primary action of the Thiazolidinediones is to improve sensitivity to insulin by acting as an agonist at receptor sites involved in insulin responsiveness and subsequent glucose production and utilization. In order to be useful, insulin must be available. The therapeutic effect is to decrease insulin resistance, resulting in glycemic control without hypoglycemia. Several life threatening reactions are possible, such as Heart Failure, Liver Failure, bladder cancer, and rhabdomyolysis. These drugs may take several weeks to work to their full potential. (Rosiglitazone/Avandia in particular has the risk of myocardial infarction and stroke that has severely limited its use.)

Drug	Onset	Peak	Duration
Sulfonylureas	45-60 minutes	1.5-3 hours	24 hours
Biguanides	Unknown	Unknown	12 hour
XR Biguanides	Unknown	4-8 hours	24 hours
Actos/Pioglitazone	30 minutes	204 hours	24 hours
Rosiglitazone	Unknown	Unknown	12-24 hours
Alpha-glucosidase	Unknown/rapid	1 hour`	Unknown

Alpha- glucosidase inhibitors (Precose/Acarbose; Miglitol/ Glyset)

The action of these drugs is to lower BG by inhibiting the enzyme alpha-glucosidase in the GI tract. There is a delay and reduction of glucose absorption from complex carbohydrates, which results in lowering of the BG, especially postprandial hyperglycemia. Complex carbohydrates include foods such as: bread, cereal, grains, pasta, rice, and beans. This effect is not observed with simple sugars like those found in soda, candy, desserts, fruit or honey. The medication should be taken with the first bite of food. Used as the sole source of glucose control they will not cause hypoglycemia. Adverse reactions include abdominal pain, diarrhea and flatulence.

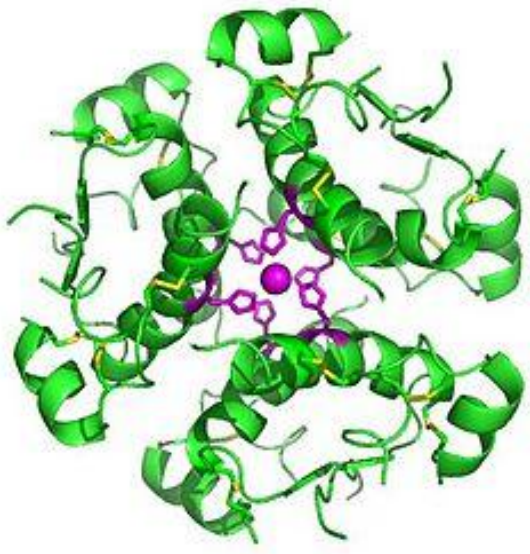
Interestingly, thiazide and loop diuretics and calcium channel blockers may increase glucose levels and lead to a decrease in the control of blood glucose. There may also be a decrease in the absorption of digoxin and this may necessitate a dosage adjustment.

Insulin

In a non-diabetic person the Beta-cells in the pancreas produce insulin. Patients with Type I diabetes have Beta-cells that no longer produce insulin due to an autoimmune-mediated destruction of the Beta cells. This destruction results in a complete lack of insulin. In Type II diabetes rather than not having any insulin, the body has developed an insulin resistance and therefore suffers from a *relative* lack of insulin, rather than the *absolute* lack of insulin that occurs in Type I Diabetes. Approximately 40% of Type II diabetes will require the addition of insulin injections at some point.

Human insulin hexamer

Courtesy of Wikipedia



Insulin Chart

Insulin/brand name	Onset	Peak	Duration	Role in blood sugar management
Rapid-acting				
Humalog/lispro	15-30m	30-90m	3-5 hours	Covers insulin needs for meals eaten at the same time as the injection. Often used with long-acting insulin.
Novolog/Aspart	10-20m	40-50m	3-5 hours	
Short-acting				
Regular (R)/novolin	30-60m	2-5 hours	5-8 hours	Covers insulin needs for meals eaten within 30-60 minutes. Typically used for tube feeding/TPN.
Intermediate-acting				
NPH (N)	1-2 hours	4-12 hours	18-24 hrs	Covers insulin needs for about half the day or overnight. Often combined with rapid or short-acting insulin.
Long-acting				
Lantus (insulin glargine)	1-1 ½ hrs	No peak	20-24 hrs	Covers insulin needs for about one full day. This type of insulin is often combined with rapid or short-acting insulin.
Levemir (insulin detemir	1-2 hours	6-8 hours	Up to 24 hours	
Pre-mixed				
Humulin 70/30	30 min	2-4 hours	14-24 hrs	Premixed insulins are a combination of specific proportions of intermediate-acting and short-acting insulin in one bottle or insulin pen (the numbers following the brand name indicate the percentage of each type of insulin. Typically given two or three times a day before mealtime.
Novolin 70/30	30 min	2-12 hours	Up to 24 hrs	
Novolog 70/30	10-20m	1-4 hours	Up to 24	
Humulin50/50	30 min	2-5 hours	18-24 hrs	
Humalog mix 75/25	15 min	30m – 2 ½ hours	16-20 hrs	

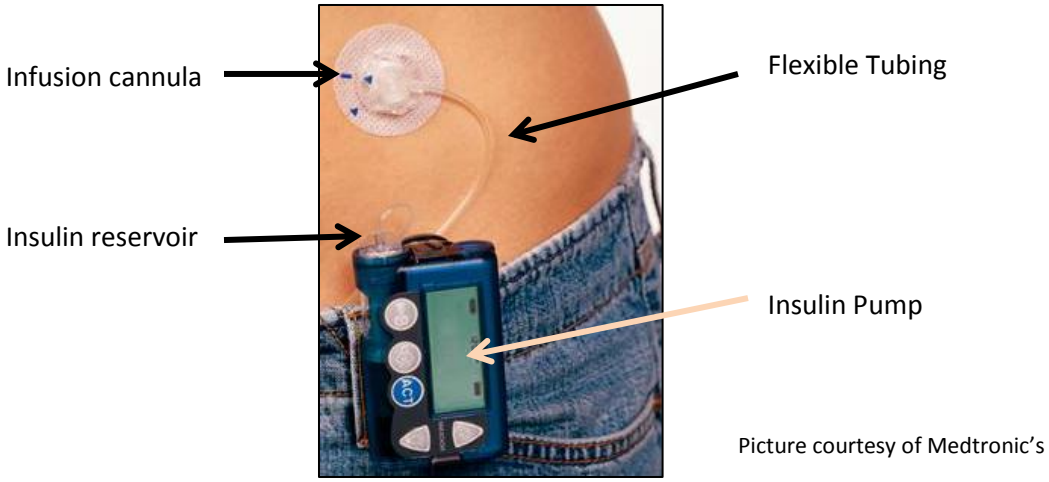
Insulin Pumps

Insulin pumps may be used primarily for outpatients to help in the management of insulin dependent diabetes. Generally, Type I diabetics are the most common group to use insulin pumps, however, if a Type II diabetic requires insulin, they too may use an insulin pump. The use of the pump can aid in treatment of diabetes by providing easy access to administering a basal dose, a correction dose, or a nutritional dose of insulin.

Either rapid acting or short acting insulin is used in the pump. Basal insulin is given 24 hours per day and may be programmed to delivery different doses through the day or night depending on individual need. Corrective insulin is given based on the person's blood glucose at their normal monitoring times, usually before meals and at bedtime, dosing is guided by their target blood glucose level. Nutritional insulin is given based upon the grams of carbohydrates that are eaten at mealtime or snack time.

Components of the pump

The insulin pump consists of the pump itself, flexible tubing that delivers the insulin from the pump reservoir to the infusion set, a tiny tube called a cannula inserted under the skin to deliver insulin, and the insulin.



Picture courtesy of Medtronic's

The pump can be attached to the waist band, as above, or placed in a pocket, attached to a bra, underwear, or a pump case. During the patient's sleep time it can be placed beside the patient on the bed, attached to pajamas, or secured with an arm band or leg band. It should be disconnected before swimming or bathing.

The following are tips for when the pump must be disconnected:

- If a bolus is interrupted when disconnecting, it will not be resumed when reconnected
- Bolus to cover the basal rate that will not be delivered during the disconnected time
- Do not leave the pump off for greater than 1-2 hours
- Monitor blood glucose every 3-4 hours looking for unexpected changes in blood glucose

Typically when patients are admitted to a facility they may keep their insulin pump in place, as long as they are cognitively able to manage the pump. Provider orders should include the type of insulin, basal rates, bolus doses for meals and correction of hyperglycemia, frequency of blood glucose testing (AC & HS), and documentation of total insulin delivery every 24 hours. A signed "Patient Agreement" form for use of the insulin pump during the facility stay may be required depending on facility policy. Discontinuation of the pump may be required if the patient's medical condition worsens, the patient has an altered state of consciousness, are at risk for suicide, the insulin pump malfunctions, or there is a lack of appropriate supplies.

As with most technology there are advantages and disadvantages to its use. For some, not having to inject insulin up to four items a day is a big advantage, it allows for variation in the timing of meal intake, and may contribute to a lowering of the A1C. Disadvantages however, may out way the benefit for some. The pump may cause a weight gain, can cause DKA if the catheter comes out, can be expensive, and it may be considered inconvenient by some to be connected to the pump continuously. The choice to treat ones diabetes using an insulin pump must be a personal decision if the provider offers it as an option.

Conclusion

Diabetes is a long-term medical management opportunity for patients and caregivers, but armed with the necessary information and desire to maintain blood glucose within it goal range and participate in healthy choices the complications of this medical condition can be managed effectively. Much information is available to the proactive diabetic patient, their loved ones, and the caregivers assisting them. The references provided are merely a springboard to increasing knowledge and competence. Enjoy the learning.

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