- A little history on Diabetes mellitus...

- Diabetes means: “flowing through”
- Mellitus means: “sweet as honey”
- Egyptian hieroglyphic describe the disease, dating back to 1550 BC
- So researchers believe that Type 1 diabetes was what was described early on and that Type 2 is a “new disease” appearing in the last two centuries

- Type 1

- Type 2


Metformin Tablets
500mg
SANDOZ
28 tablets
Simvastatin
20mg
28

- In the not-to-distant past the diagnosis of DM was made by tasting the urine of the ill person
- Type 1 always resulted in death and usually quickly
- There was no effective treatment until the discovery of insulin
- The 1st person treated with insulin was a 14 y.o. Canadian boy in 1922
- Initially insulin was distributed as a powder or tablets

- Type 1 Diabetes, typically diagnosed in childhood or the teenaged years
- Insulin-dependent means that treatment with insulin is necessary from the time the disease is 1st diagnosed
- This is because the insulin producing cells in the pancreas are either destroyed or there are too few functional to produce adequate insulin
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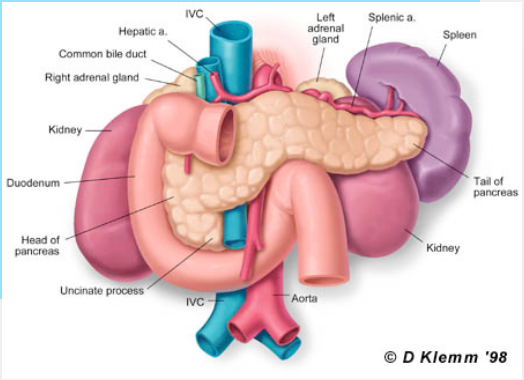

- Folks with Type 1 diabetes have a predisposition to the disease.
- However, one or more environmental “insults” are required to trigger the disease.
- Studies from the Joslin Clinic involving identical twins have born this out.
- One such trigger is thought to be Coxsackie B virus.
- What happens….

- GAD (a protein) has a small segment that is structurally similar to a segment of a Coxsackie B protein.
- GAD is found on the surface of insulin-producing beta cells.
- It is believed that the body's immune system has fought off the virus, however it continues to attack the beta-cells because of the similarity of GAD to the virus.
- So what happens....

- 5 Stages:
- 1. Genetic predisposition
- 2. Environmental trigger
- 3. Active autoimmunity
- 4. Progressive beta-cell destruction
- 5. Presentation of symptoms of Type 1 diabetes

- Children often will have antibodies in their blood that will indicate an autoimmune response or an “allergy to one’s self.”
- These antibodies will often be present months even years before the onset of diabetes.
- “Common antibodies” found include:
- islet cell antibody
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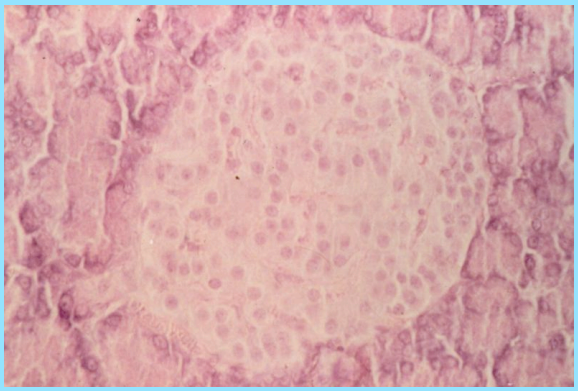
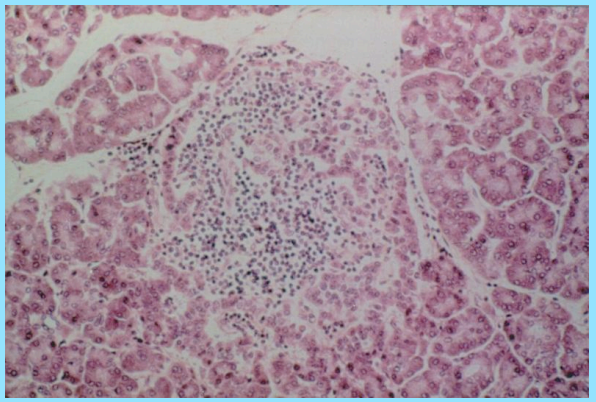
What’s this got to do with EMS?





- At the point that 85 - 90% of the beta cells are destroyed, the body is no longer able to regulate blood sugar levels
- The patient will develop some or all of the classic symptoms of diabetes...

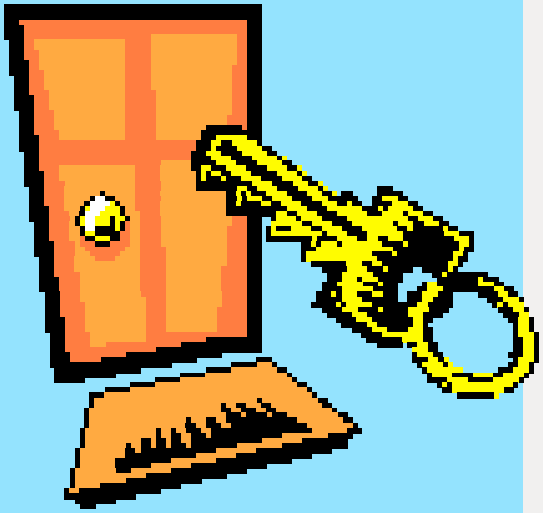
- excessive thirst
- excessive urination
- excessive hunger
- weight loss
- fatigue
- blurred vision
- high blood sugar level
- sugar and ketones in the urine

* vaginal yeast infection in girls (even infants and toddlers)
* Kussmaul breathing (deep, rapid breathing)
* Dehydration, in spite of fluid intake
* Flu-like symptoms
* Fruity odor on the breath

- While the symptoms often appear abruptly [why EMS is called] the onset of the disease is over a much longer period of time.

- Without insulin, glucose remains locked in the bloodstream, thus the blood glucose level (BG/L) increases
- The glucose in the bloodstream is then passed through the body, via the kidneys and excreted in the urine

- Insulin provides the “key” to
- allow the sugars to be broken down
- so that they can be used to fuel the
- body…



- Gary’s simple A&P lesson…

- It is important to remember that EVERYONE is insulin-dependent!
- Insulin is not a one-trick pony...there are 3 critical functions of insulin:
- 1. allows glucose to pass into cells and be used for energy.
- 2. suppress excess production of sugar in the liver and muscles.
- 3. suppress breakdown of fat for energy.

- In the absence of insulin, blood/sugar levels rise because muscle and fat cells are not able to utilize glucose for energy.
- They “signal” the body that they are “hungry.”
- The liver will then release glycogen…this will further increase the blood/sugar level.
- When the blood/sugar level reaches ~180mg/dl glucose begins to spill into the urine.
- Large amounts of water are needed to dissolve the excess sugar, resulting in excessive thirst and urination.

- Denied glucose for energy, the body will begin to metabolize protein and fat.
- Fat metabolism results in the production of Ketones in the liver.
- Ketones are excreted via the urine along with $NaHCO_3$ this results in a decrease in the pH of the blood, which means the body is moving into a state of?

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- ACIDOSIS

- In an attempt to correct this acidosis the individual will begin deep, labored breathing to “blow off” CO_2
- This is know as Kussmaul’s breathing.
- Left unchecked the individual in this circumstance will fall into coma and die.

- The preceding physiological process is better known as
- DKA - Diabetic Ketoacidosis

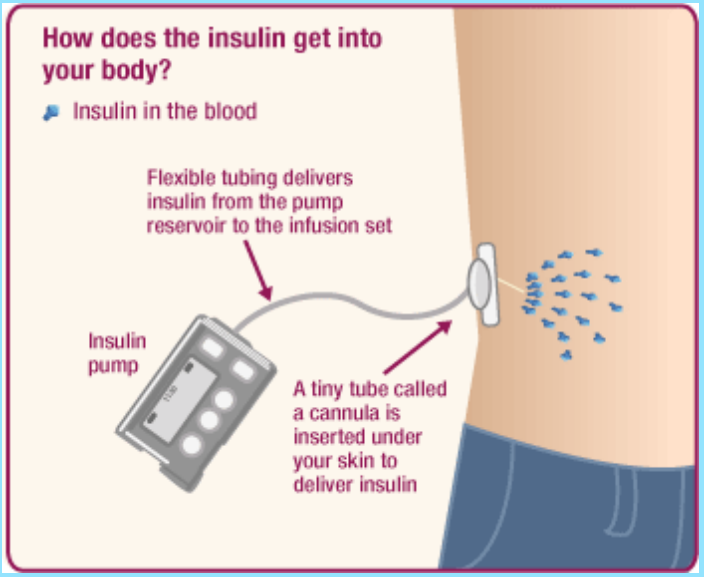
- Okay Gary we get it, cells need insulin…
- Common questions:
- Why is it injected? Insulin is a protein and if taken orally the digestive system would break it down.
- How many kinds are there? In the U.S. there are essentially four groups of insulin patients may use:
- Short acting; Intermediate acting; Long acting; "Pre-mixed" action varies.

Type of insulin	Appearance	Begins working	Peak activity	Gone from system
Short acting				
Regular Humalog NovaLog Apidra	Clear	Regular 20-30′ 10-15′	2 - 4 hours 30-60 minutes	4 - 8 hours 4 hours
Intermediate acting				
NPH	Clear	2 - 4 hours	6 - 8 hours	12 - 15 hours
Long acting				
Lantus Levemir	Clear	Lantus 4 - 6 hours Levemir 1 - 2 hours	No peak 2 - 12 hours varies	24 hours 24+ hours
Pre-mixed	action varies			
NPH/Regular NPL/Humalog NovaLog mix	Cloudy	30 minutes 10 - 15 minutes 10 - 15 minutes	Varies	18 - 24 hours 12 - 15 hours 10 - 12 hours

- Treating Type 1 Diabetes
- Injected insulin
- The GOAL is to keep the body's BG/L within a specified range for the patient; the patient and/or their caregiver know what that range is.
- Typically a "sliding scale" measuring food, type of food, activity level and arriving at a proper dose of insulin.
- Confirmation is made with a glucometer.

- With a sliding scale approach it is imperative that a schedule is maintained.
- Many times it is an issue with the patient's schedule that leads to the call for EMS.
- Took usual insulin / did not eat or ate too little
- Distractions as a cause of not eating…
- Involved with play or friends

- The insulin pump



- Insulin pump therapy is often know as “Un-Tethered” treatment
- About the size of a pager or small cell phone
- Usually worn on a belt, often times very discrete
- The pump delivers fast-acting insulin to the body via an “infusion set”
- Typically this site is in the abdomen or upper buttocks
- The site is moved usually every 2 to 3 days

- All insulin is delivered via the infusion set in very precise amounts
- The wearer must check their BG/L more often (usually) than compared with the scheduled user, however the advantage of being able to have greater control regarding when to eat, changes in the what one eats, less worry about hypoglycemia
- There are approximately 250,000 Un-Tethered Type 1 diabetics currently and the number is increasing
- Recent studies have show that the therapy outcomes are improved for teen and young adults

- Research has also show that toddlers and pre-school children have improved control and outcomes as well
- Why? The insulin used in pumps is FAST acting insulin
- With scheduled injections, the insulin is usually longer acting and there is a greater chance for unpredictability in absorption
- That is why there is often highs and lows with BG/L for those that “take shots”
- Small doses delivered via a pump attempt to mimic the action of a normal pancreas

- Emergency management of of the patient with an insulin pump and there is a perceived “pump failure.”
- Is it on? Simple enough-right!
- Battery charged and/or fresh batteries installed.
- Line clear of kinks.
- Does the site need to be changed? When was it last changed?
- How does the site look?

- If the youngster is hyperglycemic and you've been called to the scene and there are other care givers that know the child you should inquire about an insulin-pen
- Similar to an epi-pen the insulin-pen delivers a dose of (usually) short acting insulin which in this case may prove to be just what the child needs
- However, local medical direction does provide our oversight....!

- Diabetic Ketoacidosis (DKA)
- In the pediatric population this may indeed be the dramatic event that leads to the diagnosis of diabetes
- EMS is called for a “diff breather” or decreased L.O.C. -typically
- The parents or caregiver will indicate that something like this “has never happened before”
- History taking is key and knowing the right questions to ask will be of marked value to the EMS Careprovider
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- Why be concerned with DKA in the pediatric population?
- DKA - tends to occur in individuals younger than 19 years of age

- 40% underlying concomitant infection
- 25% missed insulin Rx
- 15-25% new on-set
- 10-20% are related to “other causes”

- DKA -
- Because the body is not able to utilize available glucose for energy, the term “famine in the midst of plenty” is a common saying in regard to diabetes
- Eat all you want it is not getting to the cells and they are starving

- DKA can be diagnosed if the BG/L is greater than 200 and metabolic acidosis is present w/ a venous pH of less than 7.30 along with...
- "Spilling" ketones in the urine
- The presence of dehydration, electrolyte imbalance, and hyperosmolarity
- Clinically DKA presents related to the degree of hyperosmolarity, dehydration, and acidosis
-

- What the heck are these ketones?
- When the body does not have enough glucose for energy, the body will attempt to breakdown fat for energy. The “breakdown” products are known as Ketones.
- Ketones can be used as fuel for the brain, heart, kidneys, and muscles.
- In he diabetic ketones are produced in excess when there is a lack of insulin and the BG/L are unusually high.

- Ketones are measured in both blood and urine. Blood testing at home is relatively new for ketone detection.
- (+) ketones in the urine can be found in anyone who is fasting regardless of diabetic HX. Up to 30% of pregnant women a first in the AM urine sample will be (+) for ketones as well.
- An important question to ask regarding the pediatric patient (diabetic) feeling ill is if someone has checked their ketones? This is especially key if they are nauseated or vomiting.

- Therefore make the connection that vomiting in the pediatric diabetic should be considered an insulin deficiency until proven otherwise!
- Point to remember that if ketones are present, then the body's cells are starving. Not enough food or insulin to make the conversion.
- It is the high ketone level that will make the child feel ill and NOT the elevated BG/L.

- Mortality/Morbidity related to DKA
- It is the most common cause of of diabetic related deaths in childhood.
- Under 19 years correct? Yes
- Infants and children under 5 years are at the greatest risk of presenting w/DKA because the DX of diabetes in younger children is more difficult and may not be made.
- Remember Hx taking is key as this more often than not has been progressing over a few days and is not just a “right now” presentation.

- In the very young child (wearing diapers) it is easy to miss the aspects of polyuria, the increasing fluid intake my not be so noticeable. It can once again be overlooked, UTI and not diabetes.
- With your usual assessment would you attempt and EKG? Yes / No / may be?
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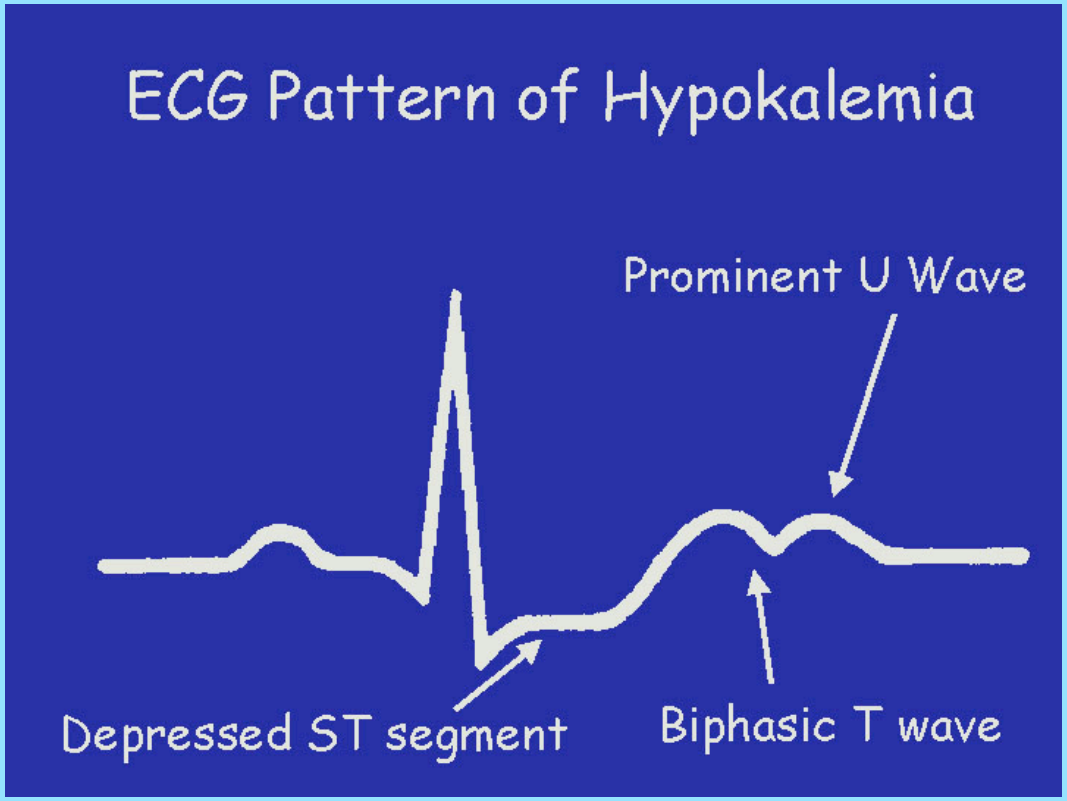
- As a reminder:



- Complications associated treatment of DKA are hypokalemia (low K+); hyponatremia (low Na+); hypoglycemia, fluid overload, and cerebral edema.

- Prehospital R/O:
- Should be made/considered by clinical history, physical signs, and elevated BG/L.
- Again - being able to paint a good picture based upon recent H&P and questioning of caregivers should be of maximum benefit to EMS on the scene.

- Treatment
- As with any emergency patient the ABCs apply here as well.
- Oxygen should be administered, this will not affect the acidosis nor will it change the respiratory drive.
- Fluid replacement once ABCs and O_2 are managed is the next priority. Fluid of choice is normal saline or 1/2 strength normal saline.

- Fluid replacement is very critical with the pedi DKA patient initial replacement in the prehospital setting should be at a rate of 10-20 mL/kg in the initial 30 minutes.
- Long term (for us) over the next 24-48 hours the fluid replacement will be monitored very closely and the introduction of insulin to aid in correcting of BG/L will begin at very judicious amounts. Fluid replacement will also include the addition of Na+ and K+. Dextrose may be added until the child is able to eat and drink.

- It is hoped that the introduction of small doses of insulin will aid in the correction of electrolytes.
- Recent studies have shown the it is beneficial to hold on insulin administration for the first few hours and allow fluid replacement and correction first. There is no indication for prehospital providers to administer insulin in cases of DKA. Like many things in medicine insulin administration remains a debated topic.

- One last word about cerebral edema associated with DKA resuscitation…it is the most critical complication and carries an overall risk of 1-2%

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