DIABETES MELLITUS

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DIABETES MELLITUS

- A CHRONIC MULTI-SYSTEM DISEASE RELATED TO ABNORMAL INSULIN PRODUCTION OR IMPAIRED INSULIN UTILIZATION
- CHARACTERIZED BY HYPERGLYCEMIA RESULTING FROM LACK OF INSULIN, LACK OF INSULIN EFFECT, OR BOTH

TYPES OF DM

- TYPE I DM (IMMUNE MEDIATED VS IDIOPATHIC)
- TYPE II DM
- GESTATIONAL DIABETES
- DM is not limited to just these classifications

- LEADING CAUSE OF:
  ADULT BLINDNESS
  END-STAGE KIDNEY DISEASE
  NON-TRAUMATIC AMPUTATIONS
- MAJOR CONTRIBUTING FACTORS TO:
  HEART DISEASE
  STROKE
  HYPERTENSION

ETIOLOGY AND PATHO

- COMBINATION OF CAUSATIVE FACTORS
  1. GENETIC/HEREDITARY
  2. AUTOIMMUNE
  3. ENVIRONMENTAL (INFECTION, TOXINS)
  4. LIFESTYLE
- ABSENT OR INSUFFICIENT INSULIN AND/ OR POOR UTILIZATION OF INSULIN

METABOLIC PROCESS

1) GLYCOLYSIS

2) GLYCOGENOLYSIS

3) GLUCONEOGENESIS
    1) HORMONES THAT STIMULATE: GLUCAGON, GLUCOCORTICOIDS, THYROID
    2) THIS MOSTLY OCCURS IN THE LIVER

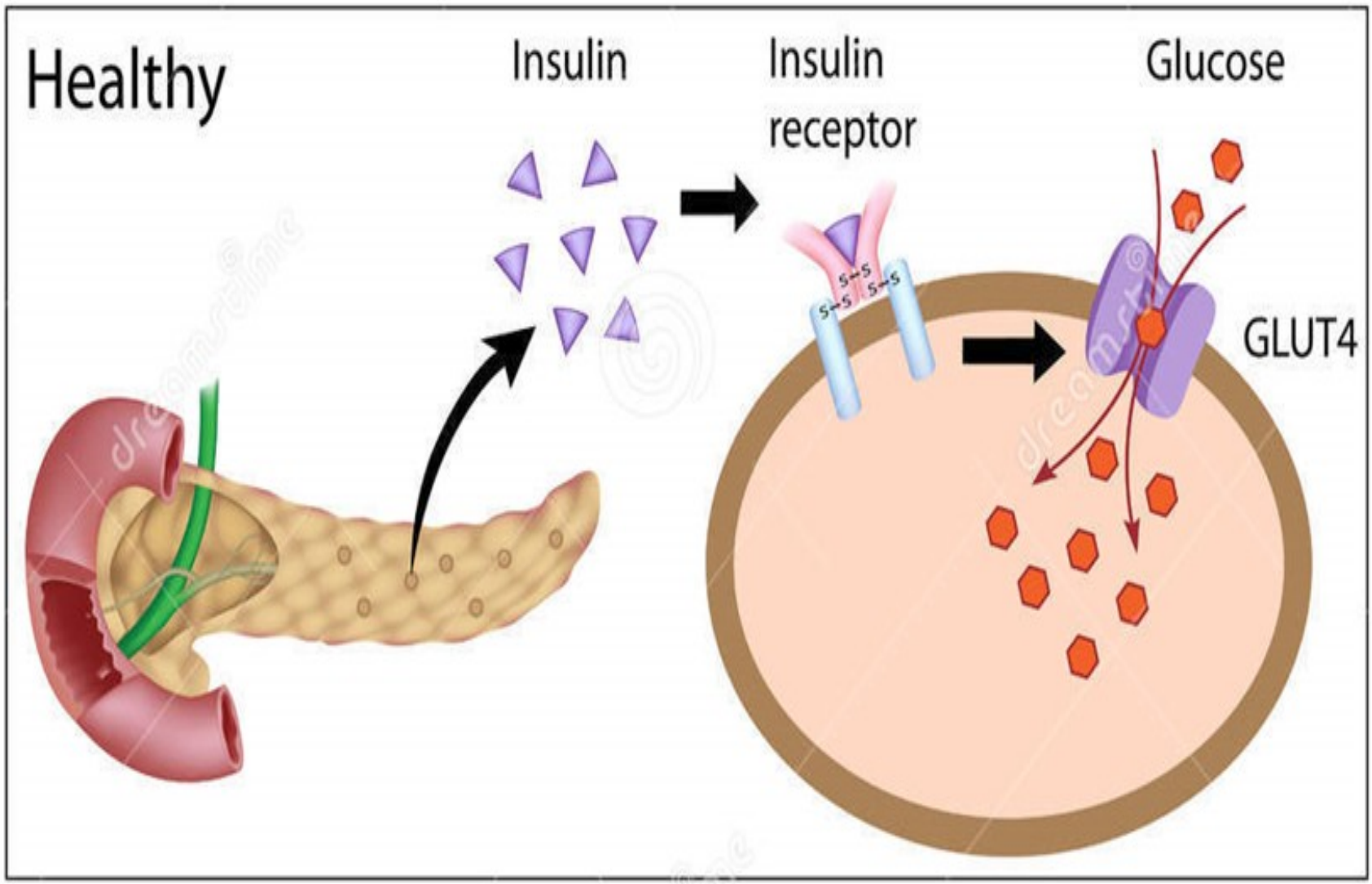
PATHOPHYSIOLOGY

- INSULIN: RELEASED FROM THE BETA CELLS OF PANCREAS TO LOWER GLUCOSE LEVELS

- GLUCAGON: RELEASED FROM THE ALPHA CELLS OF THE PANCREAS

Actions of Insulin

- Carbohydrate (CHO) metabolism
  - Facilitate glucose transport into cell to bring down blood glucose level
  - Stimulate liver - storage of glucose
- Lipid metabolism
  - Glucose entry into lipid cells
  - Inhibit breakdown of fat in adipose tissue
- Protein Utilization
  - Amino acids to form proteins
- Other
  - Increase permeability of cells to K , Mg, and phosphate ions.


Healthy
Insulin
Insulin receptor
Glucose
GLUT4

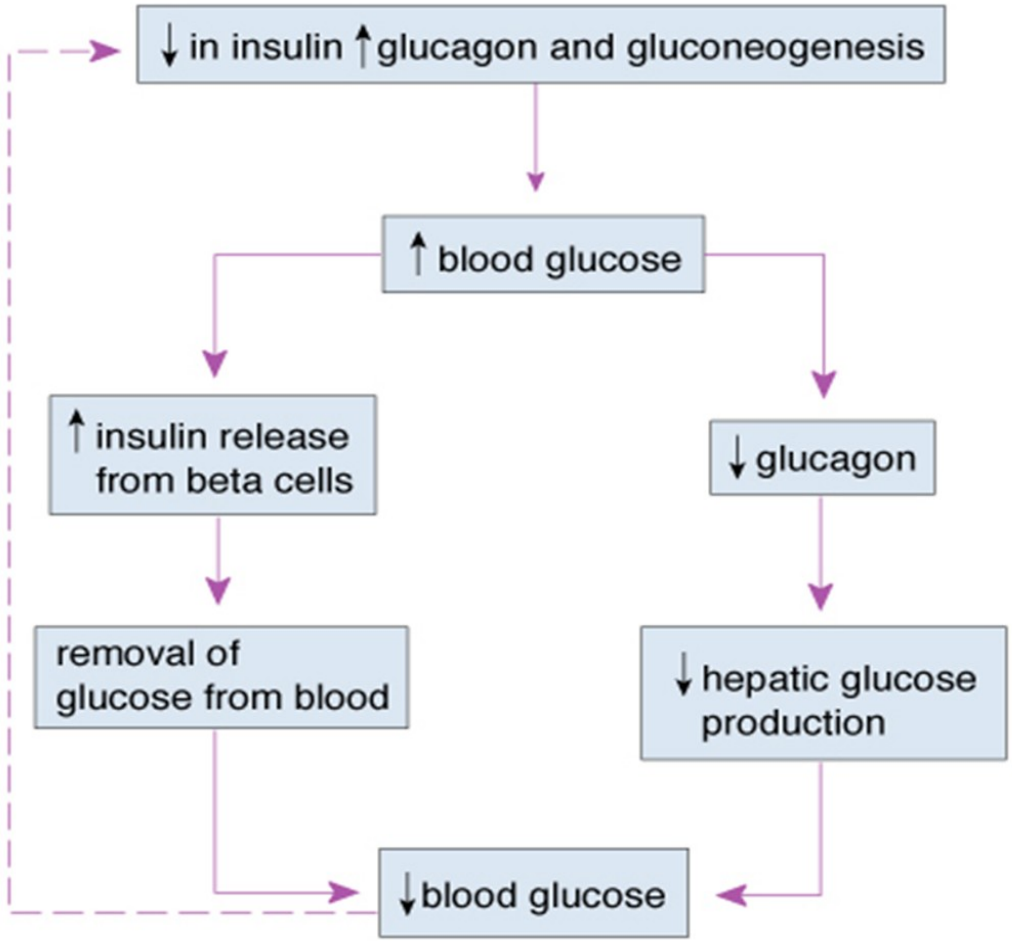
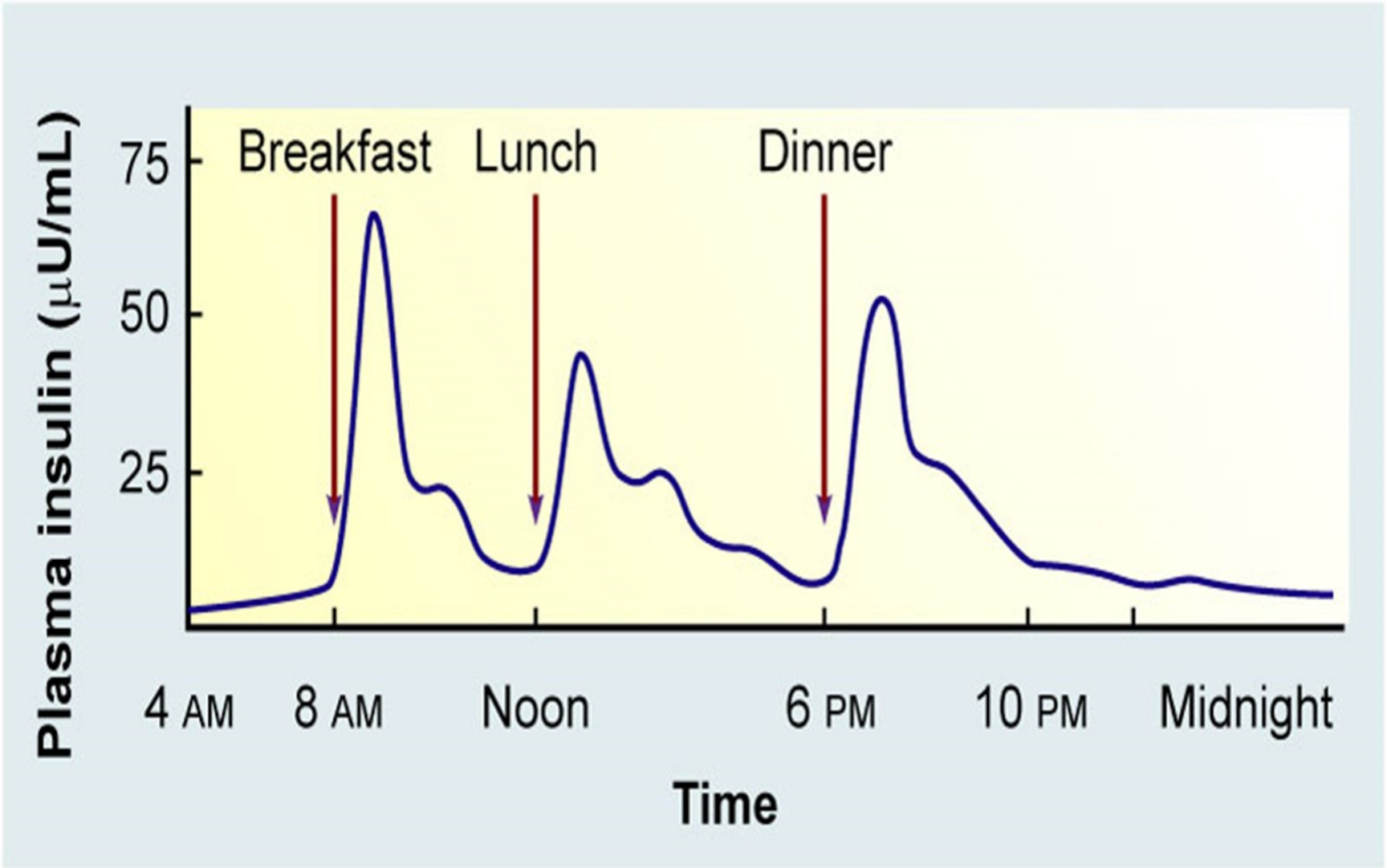


Figure 43-1 Hormonal and hepatic regulation of blood glucose.



PATHO OF INSULIN

- Counter regulatory hormones
  - Glucagon, epinephrine, growth hormone, cortisol
  - Oppose effects of insulin
  - Stimulate glucose production and release by the liver
  - Decrease movement of glucose into cell
  - Help maintain normal blood glucose levels

Gestational Diabetes

- Develops during pregnancy
- Usually glucose levels normal 6 weeks post partum
- Baby weighs > 9 lb. at birth
- 35% to 60% chance of developing T2DM within 10 years.

TYPE 1 DIABETES MELLITUS

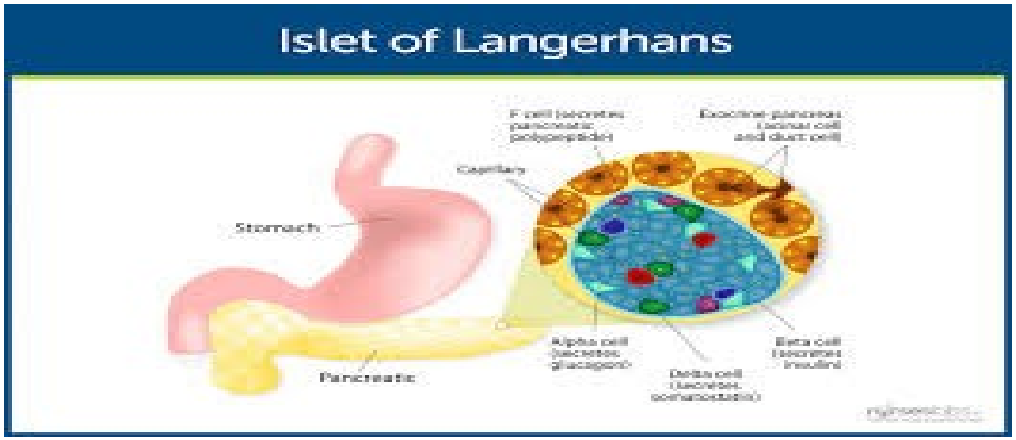
(T1DM)

TYPE 1 DIABETES MELLITUS (T1DM)

- FORMERLY KNOWN AS JUVENILE-ONSET DIABETES OR INSULIN DEPENDENT DIABETES
- ACCOUNTS FOR 5-10% OF POPULATION
- 40% DEVELOP IT BEFORE THE AGE OF 20
- GENERALLY AFFECTS PEOPLE YOUNGER THAN 40
- INCIDENCE HAS INCREASED 3-5% OVER RECENT DECADES

PATHO OF T1DM

- COMPLETE DESTRUCTION OF THE PANCREATIC CELLS
- PROGRESSES TO LACK OF INSULIN PRODUCTION



RISK FACTORS

- AUTOIMMUNE
- VIRAL
- ENVIRONMENTAL
- MEDICALLY INDUCED: EX: REMOVAL OF PANCREAS

DIABETES MELLITUS - TYPE 1
SIGNS & SYMPTOMS:

Polyuria
↑Urination

Polydipsia
↑Thirst

Polyphagia
↑Hunger

- Weight Loss
- Fatigue
- ↑ Frequency of Infections
- Rapid Onset
- Insulin Dependent
- Familial Tendency
- Peak Incidence From 10 to 15 Years

DIAGNOSIS

- HEMOGLOBIN A1C (HGB A1C)
- FASTING BLOOD GLUCOSE
- 2 HR POSTPRANDIAL OR ORAL GLUCOSE TOLERANCE TEST (OGTT)
- RANDOM BLOOD GLUCOSE

HGB-A1C

- MEASURES THE AVERAGE BG LEVELS OVER THE PRIOR 2-3 MONTHS
- DOES NOT GIVE CHANGES IN ACUTE OR HOUR-TO-HOUR CHANGES
- REPORTED AS THE PERCENTAGE OF TOTAL BLOOD
- RESULTS AFFECTED BY PREGNANCY, CKD, THALASSEMIA, Fe DEF ANEMIA, PERNICIOUS ANEMIA, RECENT ACUTE BLOOD LOSS OR TRANSFUSION

Correlation of A1C with Average Glucose

% A1C	Level of Control	Average Blood Glucose Levels mg/dL
12.0	IMMEDIATE ACTION SUGGESTED	345
11.5		
11.0		310
10.5		
10.0	ACTION SUGGESTED	275
9.5		
9.0		240
8.5		
8.0	MONITOR CLOSELY	205
7.5		
7.0	ADA GOAL*	170
6.5		
6.0	NORMAL	135

FASTING BLOOD GLUCOSE

- NO CALORIC INTAKE FOR AT LEAST 8 HOURS
- 70-110 mg/dL normal range
- GREATER THAN OR EQUAL TO 126 mg/dL is considered a positive DM

2-HR POSTPRANDIAL ORAL GLUCOSE TOLERANCE TEST (OGTT)

- PATIENT CONSUMES BEVERAGE WITH GLUCOSE LOAD (75g CHO) AFTER FASTING 8-12 HOURS
- BLOOD SAMPLE TAKEN PRIOR TO CONSUMPTION THEN AGAIN 1 hr AND 2 hrs AFTER CONSUMPTION
- VALUE BASED ON LEVEL AT THE 2 hr MARK
- IF >200 OR = TO 200 mg/dL is postive for DM

RANDOM BLOOD GLUCOSE

- A RANDOM BG LEVEL OF >/= 200 mg/dL
- MUST HAVE SYMPTOMS OF HYPERGLYCEMIA OR HYPERGLYCEMIC CRISIS TO BE CLASSIFIED AS DM

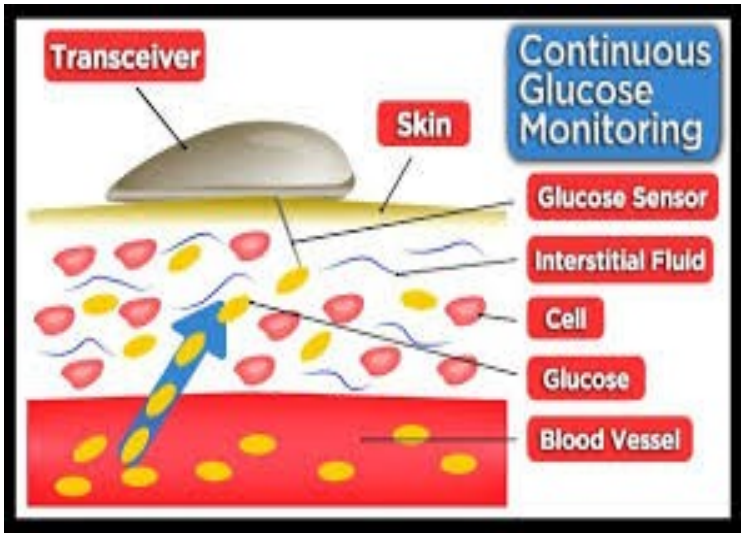
MONITORING GLYCEMIC CONTROL

SELF-BLOOD GLUCOSE MONITORING

- VIA FINGER STICK MOST COMMON
- PROVIDES TIMELY FEEDBACK TO THE PATIENT
- MOST COMMON ERROR IS BLOOD SAMPLE SIZE
- ADVISED BEFORE EACH MEAL AND AT BEDTIME

CONTINUOUS GLUCOSE MONITORING (CGS)

- TINY SENSOR UNDER THE SKIN
- SENDS INFO VIA RADIO WAVES TO MONITOR
- PROVIDES REAL-TIME MEASUREMENTS OF BG LEVELS
- GOOD FOR THOSE PATIENTS WITH ERRATIC AND UNPREDICTABLE DROPS
- WARNS OF DANGEROUS LEVELS

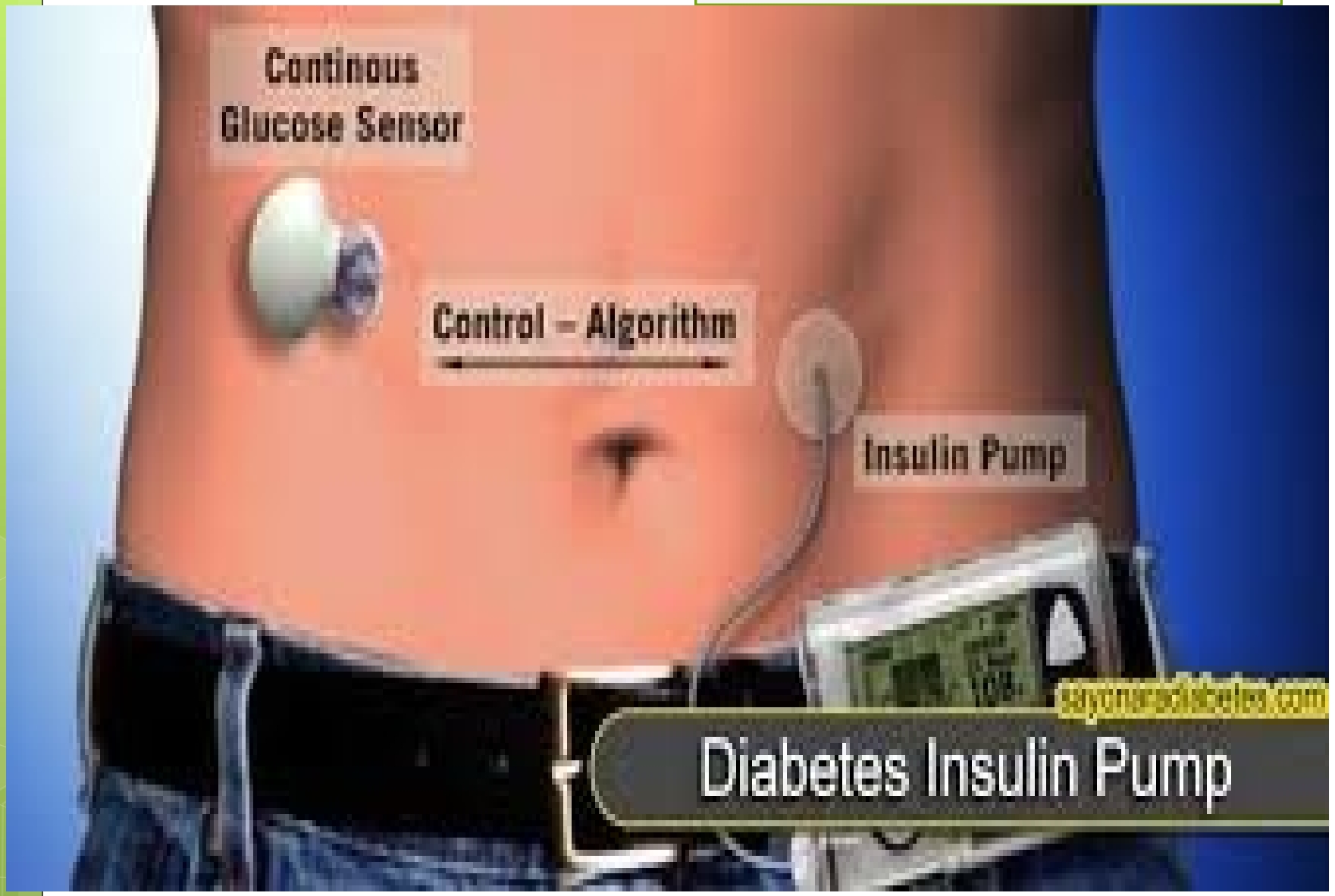


DexcomG6
CGS

PINNACLE
Medical Solutions

Insulin Pump Therapy

- Continuous subcutaneous insulin infusion (CSII) via external device worn somewhere on the body
- Provides a continuous infusion of “basal” insulin
- Patient “boluses” for meal at time of meal
- Bolus determined by pre-meal BS and CHO content of meal
- Never uses long or intermediate acting insulin


Continous
Glucose Sensor
Control – Algorithm
Insulin Pump
Diabetes Insulin Pump

Pump Therapy Is NOT

- Pump does not regulate blood glucose automatically
- Does not decrease need to check BS
- Does not replace the regulatory system of the normal functioning pancreas
- Not easy or inexpensive
- Not complication free

Pump Therapy Indicators

- HbA1C > 6.5%
- Frequent hypoglycemia
- Shift work
- Type 2 w/ gastroparesis
- Dawn phenomenon
- Pediatrics
- Exercise
- Hectic lifestyle

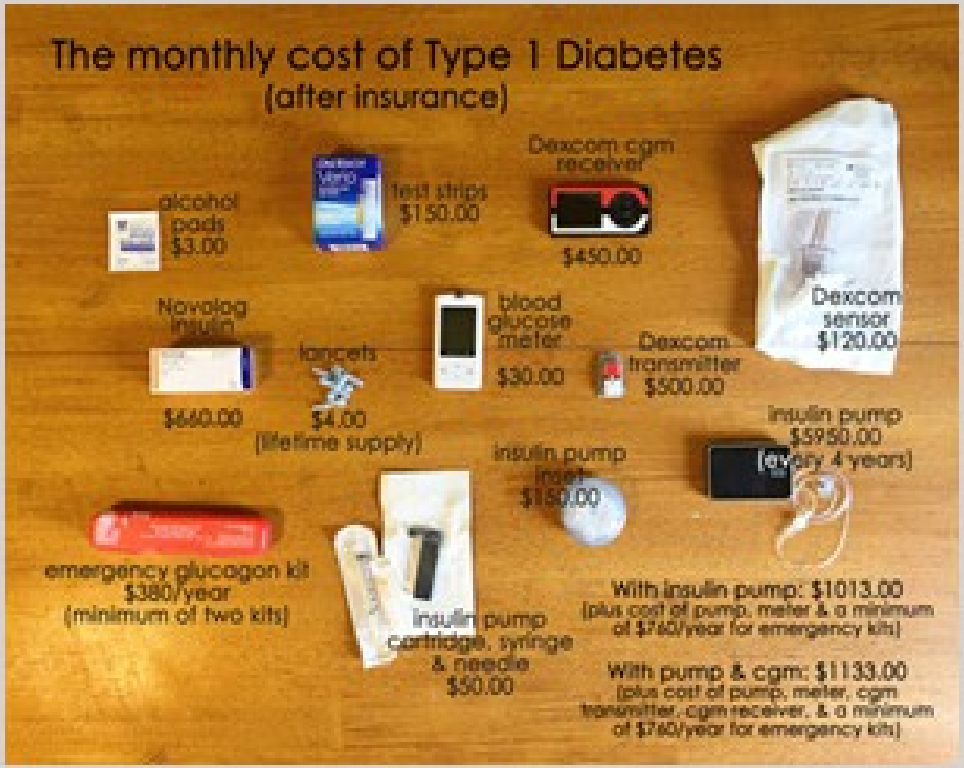
Pump Candidates

- **Motivated to**
  - Be active participant in management
  - Quantify food intake
  - Monitor BG
- **Adequate vision & fine motor skills**
- **Strong support system**
- **Insurance coverage**

Insulin Pump Therapy

Benefits	Risks
❖Improved glycemic control	❖ Hypoglycemia
❖Better pharmacokinetic delivery of insulin	❖ Hyperglycemia
❖Increased flexibility	❖Infusion site problems
❖Variable & individualized basal rates	❖ Takes time & commitment
❖Does NOT eliminate SMBG	❖Proper planning
	❖Cost

Cost of insulin pump for 1 month



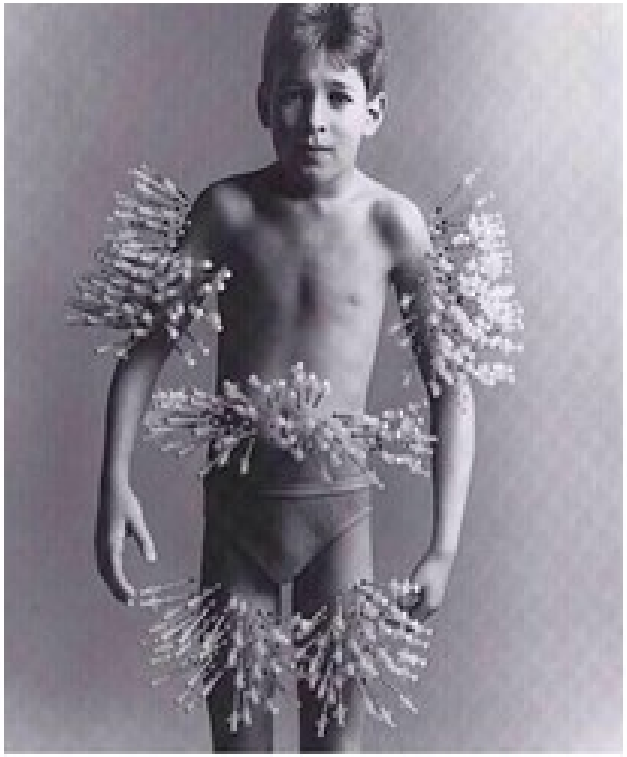
Nursing Consideration – Insulin Pumps

- **Pumps cannot be worn to MRI or CT**
- **Ensure all members of health care team aware patient is wearing pump**
- **If problems occur**
  - Contact HCP who manages pump
  - 24 hr 800 number on back of pumps for tech support

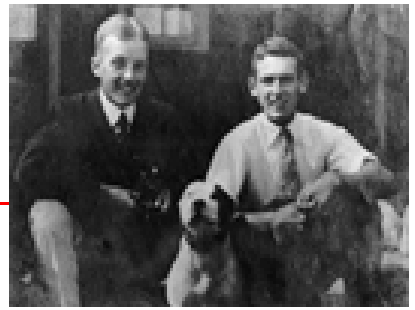
INSULIN

- EXOGENOUS INSULIN
  - INSULIN FROM OUTSIDE SOURCE
  - REQUIRED FOR TIDM
  - PRESCRIBED FOR PATIENTS WITH T2DM WHO CANNOT MANAGE BLOOD GLUCOSE LEVELS BY OTHER MEANS

1 month of insulin injections



Exogenous Insulin Actions

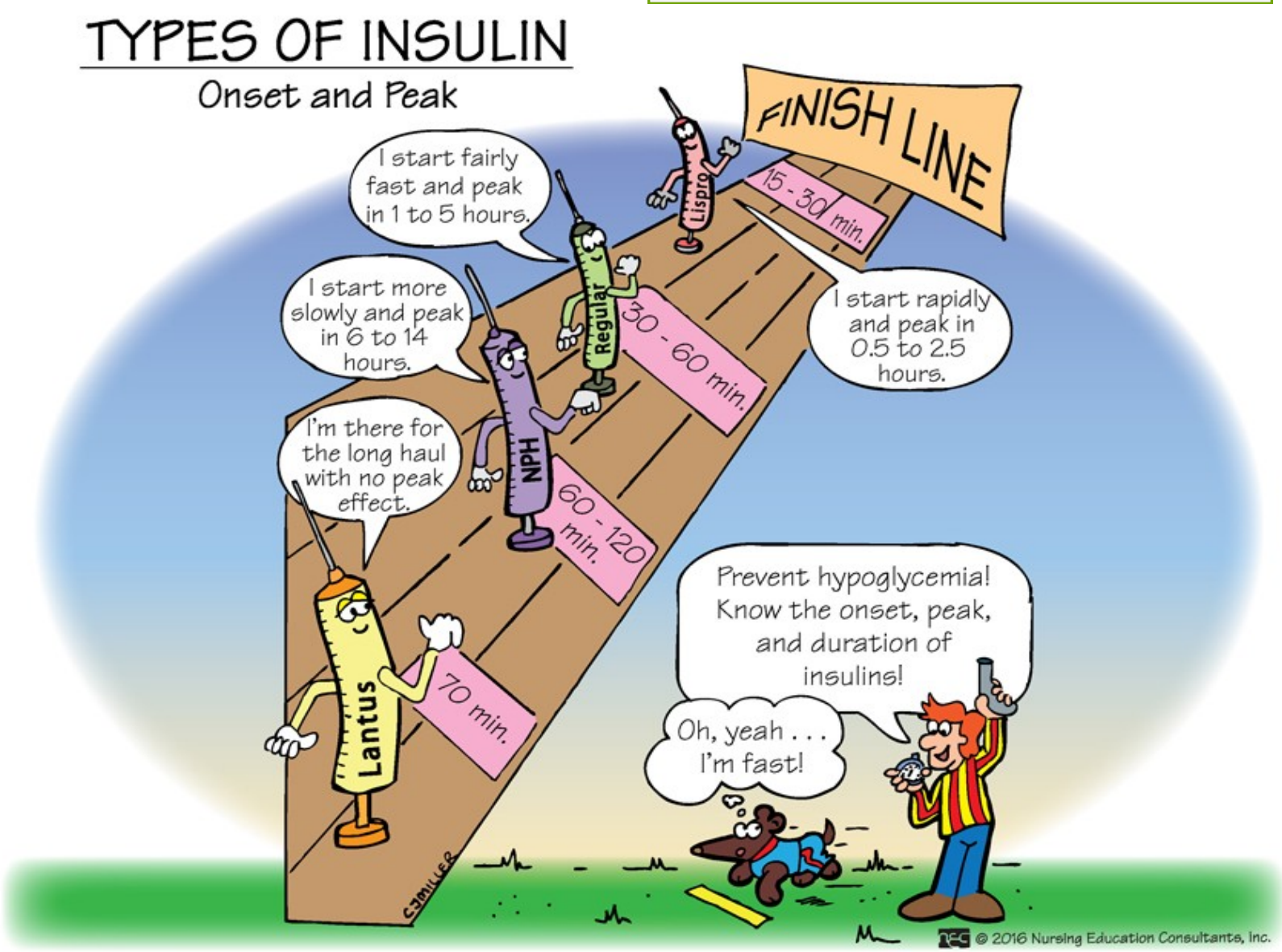


- Restores ability of cells to use glucose as an energy source
- Corrects hyperglycemia
- Corrects many associated metabolic imbalances
- Treats both type 1 & type 2 diabetes
- Lowers plasma potassium levels

NOTE: Insulin preparations are HIGH ALERT agents

TREATMENT--INSULIN

- HUMAN INSULIN—IDENTICAL TO INSULIN PRODUCED BY THE PANCREAS
- HUMAN INSULIN ANALOGS– MODIFIED FORMS OF HUMAN INSULIN


TYPES OF INSULIN
Onset and Peak
FINISH LINE
I start fairly fast and peak in 1 to 5 hours.
Lispro
15 - 30 min.
I start more slowly and peak in 6 to 14 hours.
Regular
30 - 60 min.
I start rapidly and peak in 0.5 to 2.5 hours.
I'm there for the long haul with no peak effect.
NPH
60 - 120 min.
Lantus
70 min.
Prevent hypoglycemia! Know the onset, peak, and duration of insulins!
Oh, yeah . . . I'm fast!
C.J.MILLER
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Types of Insulin

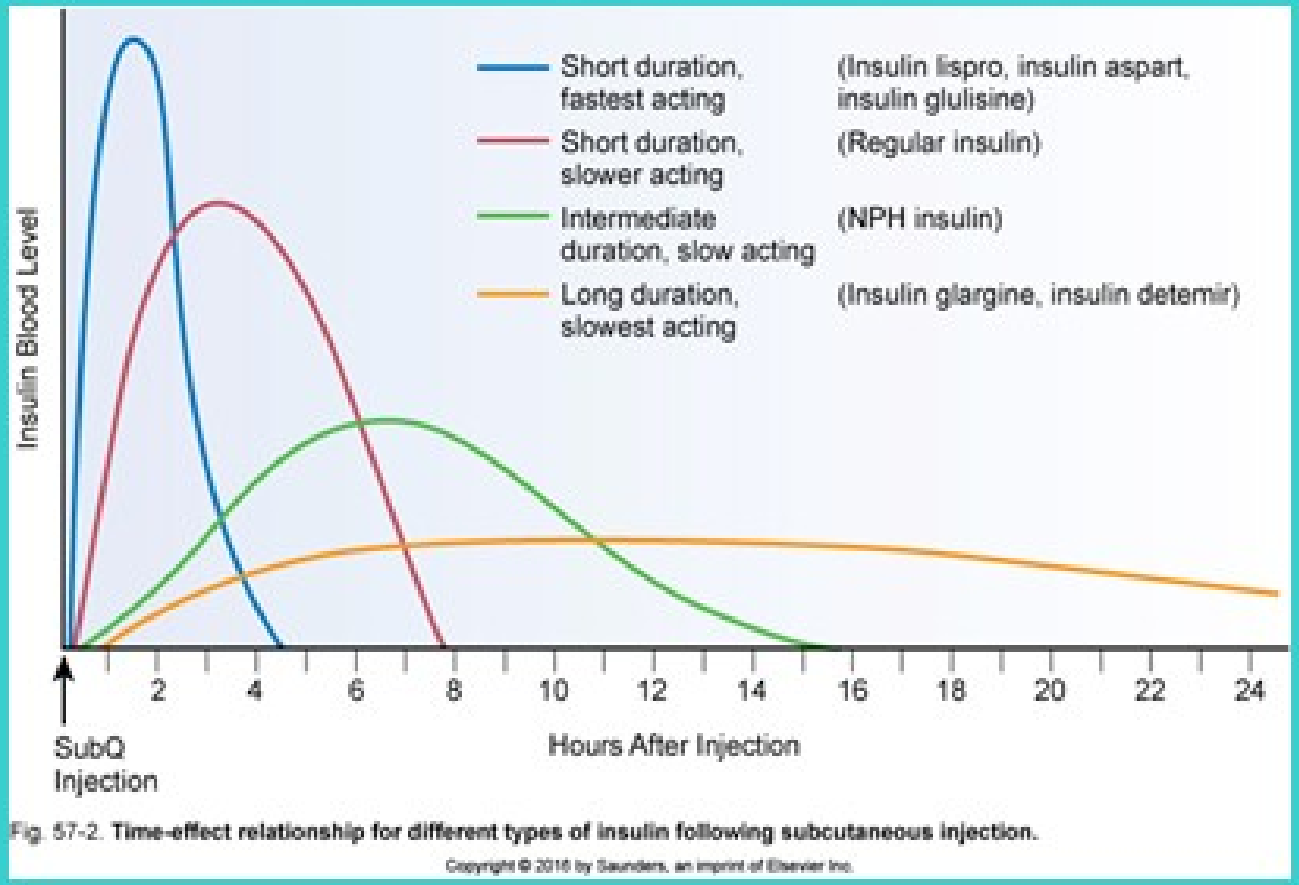


Fig. 57-2. **Time-effect relationship for different types of insulin following subcutaneous injection.**

RAPID ACTING INSULIN

- ADMINSTERED WITH MEALS (eat within 15 min)
- Onset 15-30min, Peaks 30min-90 min, Duration 3-5 hrs
- **INSULIN LISPRO (HUMALOG)**
- **INSULIN ASPART (NOVOLOG)**
- **INSULIN GLULISINE (APIDRA)**
- **INHALED HUMAN INSULIN (AFREZZA)** CAN BE USED IN T1DM AND T2DM

SLOWER ACTING INSULIN

- CAN BE GIVEN SQ, IM, OR IV
- FOR ROUTINE TREATMENT TO CONTROL POSTPRANDIAL HYPERGLYCEMIA AND BASAL GLYCEMIC CONTROL
- **REGULAR INSULIN (HUMULIN R, NOVOLIN R)**
- USED IN SLIDING SCALE COVERAGE
- ONSET 30-60 MIN; PEAK 2-3 HR; DURATION 5-7 HR

RAPID ACTING INSULIN

INTERMEDIATE

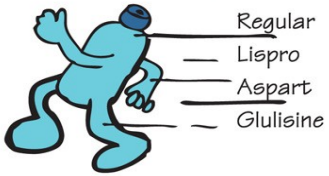
- **NPH INSULIN (HUMULIN, NOVOLIN N)**

- ONSET 1-2 hrs; PEAK 4-6 HOURS; D ION 14-24 HOURS

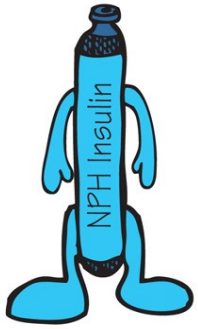
MIXING INSULIN:

Draw Up The Clear...

(Clear and Short-Acting)



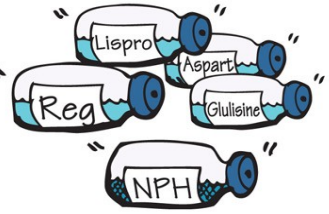
Before The Cloudy...



(NPH Cloudy and Intermediate-Acting)

Only *Longer Acting You Can Mix!*

Only the short-acting preparations—regular, lispro, aspart, and glulisine insulin—can be mixed with other insulins (usually NPH insulin).

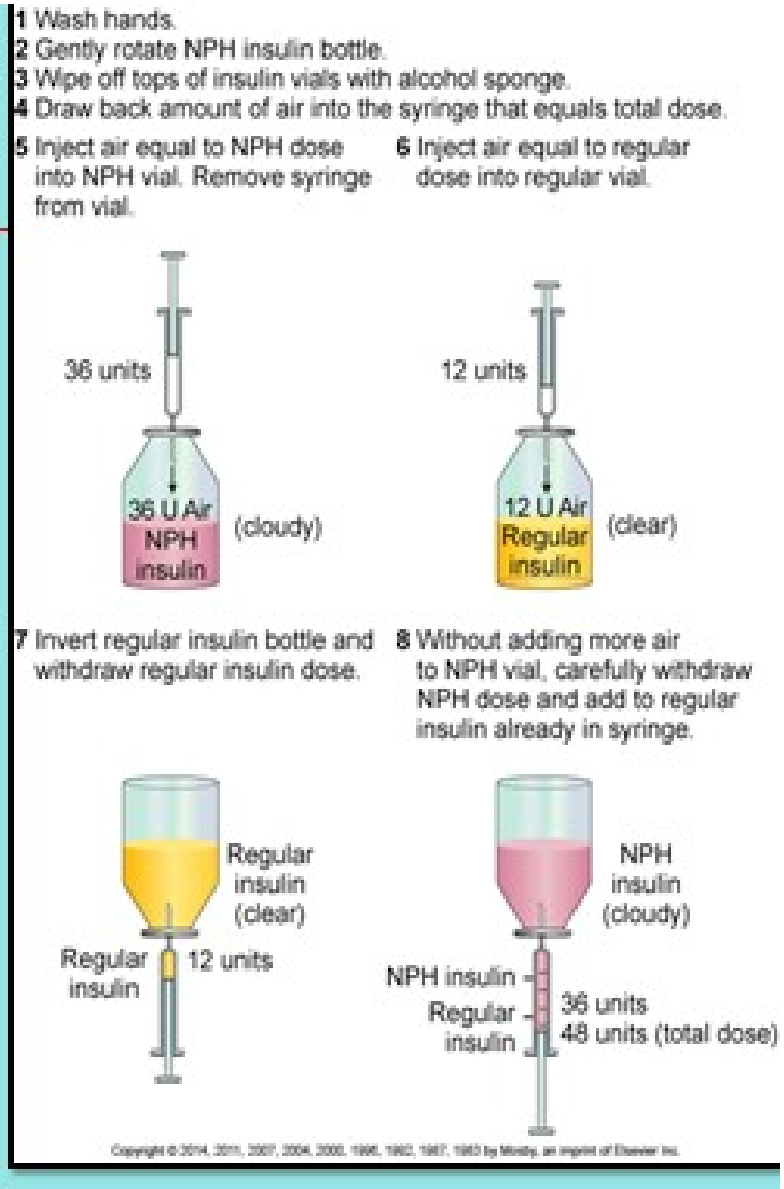


Note: All insulins available today are clear, except NPH.

Mixing Insulins

Fastest acting **F**irst

Longer acting **L**ast



LONG DURATION

- **INSULIN GLARGINE (U-100) (*LANTUS*)**
- **INSULIN DETEMIR (*LEVEMIR*)**
- DOSING CAN BE DONE ANY TIME OF THE DAY BUT SAME TIME EVERYDAY
- **Onset: 1 hour, No Peak, Duration 24+ hours**

LONGER DURATION

- **INSULIN GLARGINE U-300 (TOUJEO**
- **INSULIN DEGLUDEC (TRESIBA)**
- Once Daily
- Dosed in prefilled pens
- Duration: >24 hours

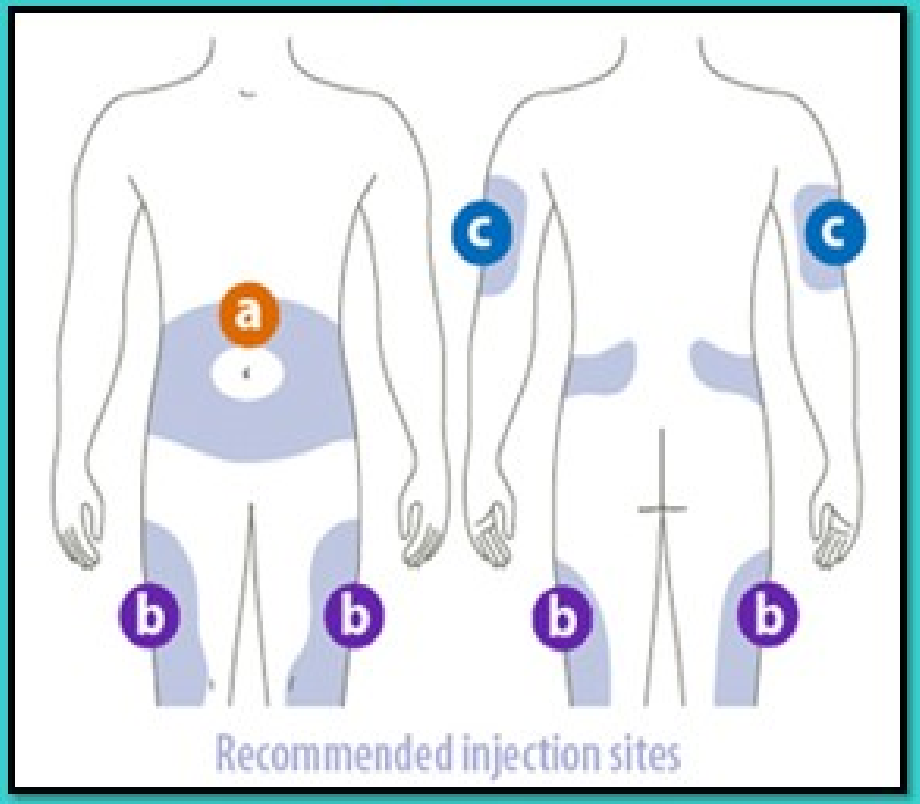
Insulin Appearance

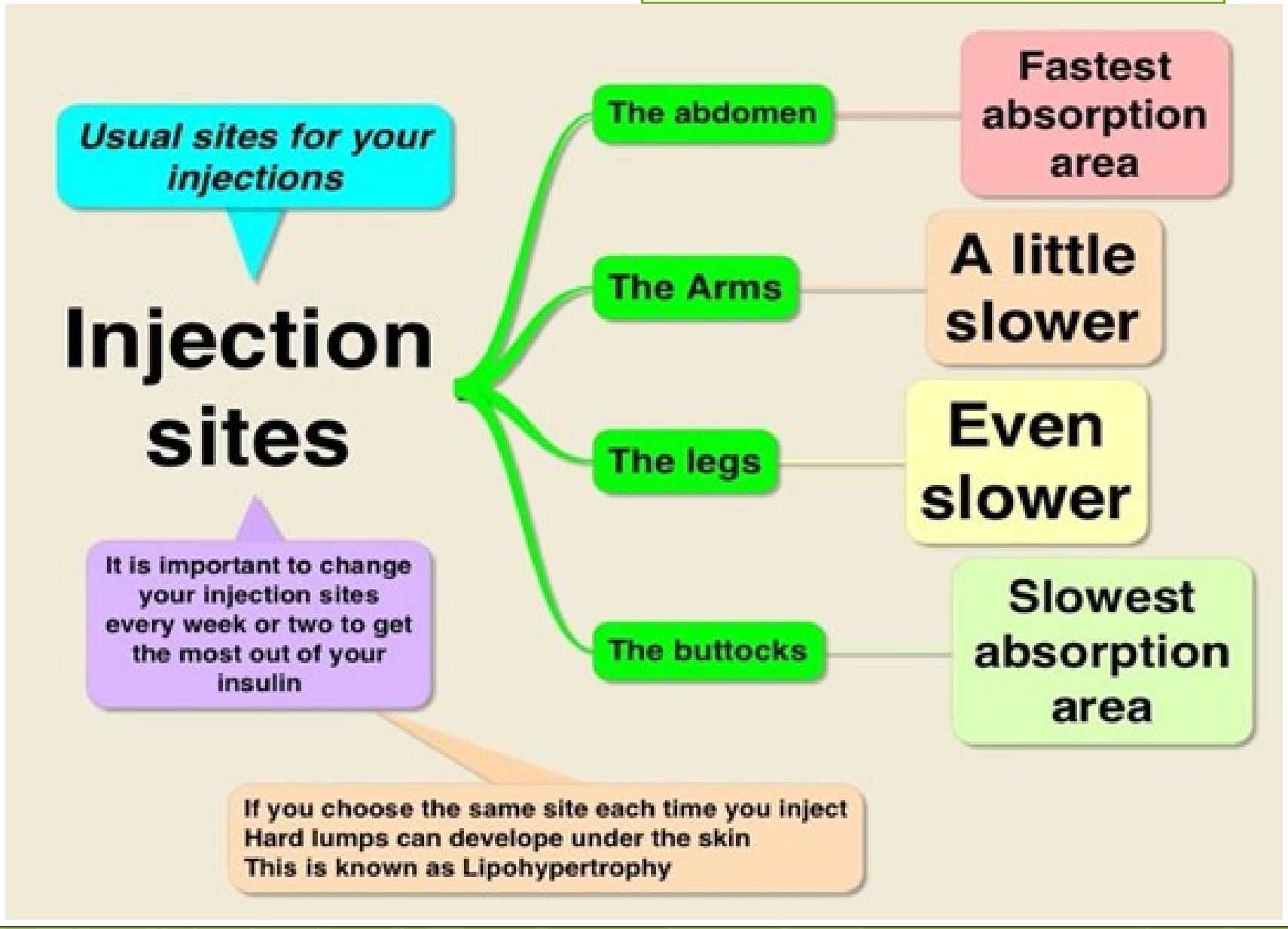
- **Insulins made in the U.S. are *clear, colorless solutions,* *except* for NPH insulins**
- **NPH insulin is a *cloudy* suspension**
- **Inspect insulin before using & should discard if the insulin looks abnormal**
- **Concentration**
  - 100 units/mL (U-100)
  - 500 units/mL (U-500)

Insulin Administration

- Given only by injection - subQ, IM
- IV use – Regular only in ICU
- Gently mix suspension prior to drawing up
- Store unopened vials in the refrigerator
- Opened vials can remain at room temperature for one month
- Label vials with date & time opened

Insulin Injection Sites



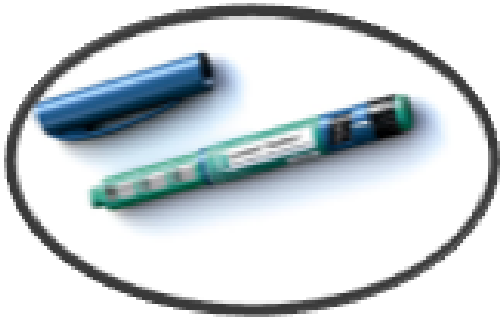

Usual sites for your injections
Injection sites
The abdomen
Fastest absorption area
The Arms
A little slower
The legs
Even slower
The buttocks
Slowest absorption area
It is important to change your injection sites every week or two to get the most out of your insulin
If you choose the same site each time you inject
Hard lumps can develope under the skin
This is known as Lipohypertrophy

Premixed Insulin

- NPH + Rapid acting analog OR Regular insulin
- A variety of mixtures 70:30 (70% NPH & 30% regular or analog)
- Cloudy appearance
- Pro: easier for patient
- Con: NPH unpredictable, risk for high/low BG

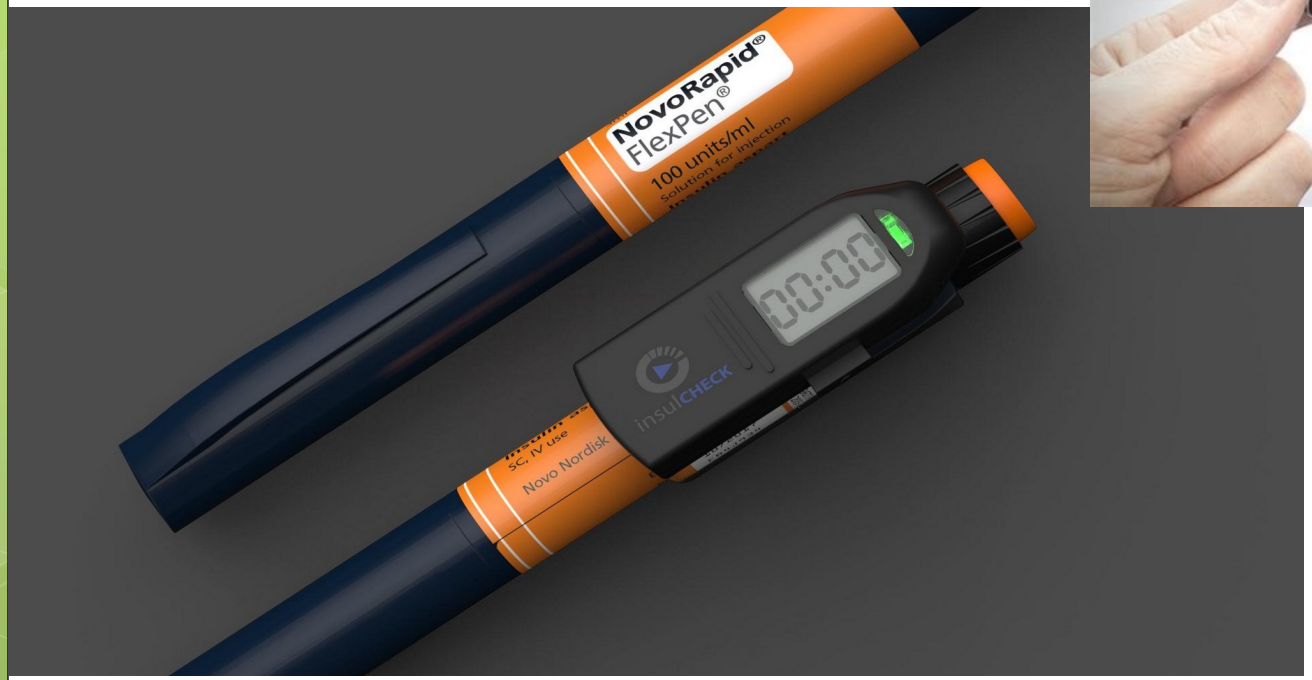
Insulin Pens

- **Pre-filled pens**
  - Hold 300 U of insulin
  - Disposable needle is attached to pen
  - Dial dose of insulin in increments of 1 or 2 units
  - Convenient when traveling
  - Good for only 28 days
  - Useful – impaired manual dexterity, vision or cognitive function.




Humalog®
KwikPen™
Lantus® SoloStar®
100 units/mL (U-100) Rx ONLY
Humalog® Pen

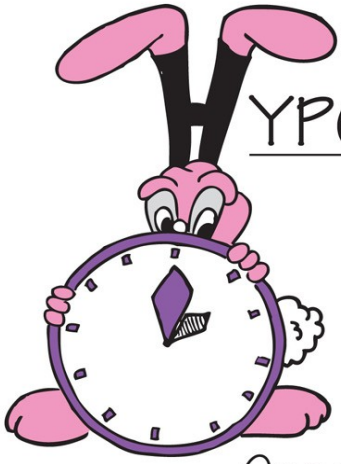

NovoMix® 30
FlexPen®


NovoRapid®
FlexPen®
100 units/ml
Solution for injection
00:00
insulCHECK
SC, IV use
Novo Nordisk

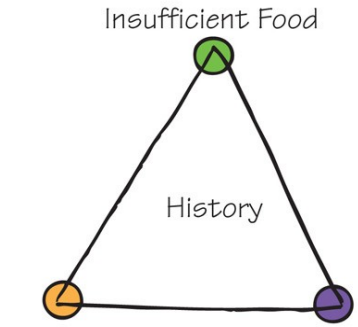
Cost of T1DM

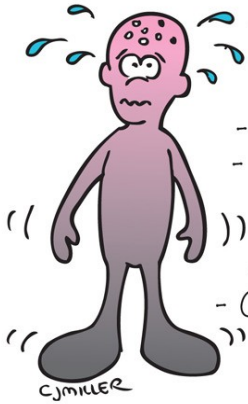

The cost of Type 1 Diabetes
$10.99
$18.99
$524.97
$29.99
$14.99
$372.99
expires annually
$111.99
for 200 needles
$65.00
$671.99
$433

HYPOGLYCEMIA



Onset
Rapid...
1 - 3 Hours





- Anxious
- Sweaty
- Hungry
- Confused
- Blurred or Double Vision
- Shaky
- Irritable
- Cool, Clammy Skin

Needs...

BLOOD SUGAR ↑

Increased > 70mg/dL

HYPOGLYCEMIA UNAWARENESS

- WHEN HYPOGLYCEMIA OCCURS FREQUENTLY
- THE BODY CAN LOSE THE EARLY WARNING SIGNALS OF THE SYMPATHETIC NERVOUS SYSTEM
- PATIENTS SKIP THE FIRST WARNING SIGNS
- RISK FOR NEUROLOGICAL SYMPTOMS SUCH AS CONFUSION OR LOC

TREATMENT

- ADMINISTER GLUCOSE

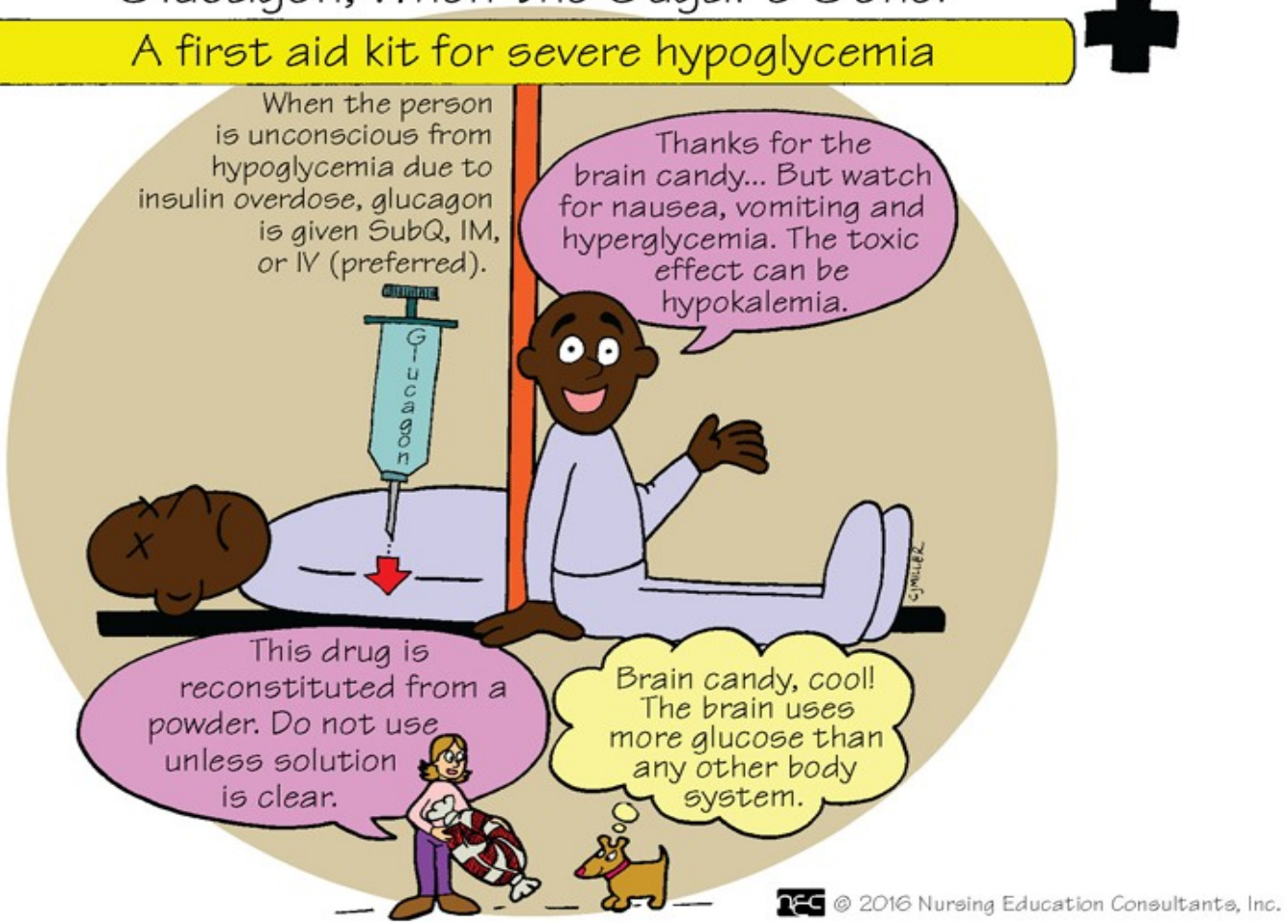
  JUICE, SODA, BREAD OR CRACKERS
- CHECK FINGERSTICK 15 MIN AFTER ADMIN OF GLUCOSE
- IF LEVEL STILL LOW, REPEAT GLUCOSE
- AFTER REACH NORMAL-EAT MEAL OR SNACK

- IN HOSPITAL SETTING OR PATIENT UNABLE TO SWALLOW:
  - IV DEXTROSE 25-50ML OF D50
  - NO IV ACCESS: 1MG IM GLUCAGON INJECTION TO RELEASE GLUCOSE STORED IN THE LIVER

GLUCAGON

"Glucagon, When the Sugar's Gone!"

A first aid kit for severe hypoglycemia



TYPE 2 DIABETES MELLITUS

TYPE 2 DIABETES MELLITUS (T2DM)

- MORE COMMON IN ADULTS
- ACCOUNTS FOR 90-95% OF ALL DM CASES
- PRESENT IN ALL ETHNIC GROUPS BUT MORE PREVALENT IN NON-WHITES
- SLOWER ONSET THAN T1DM
- INSULIN IS PRESENT BUT CELLS RESIST
- OVER TIME PANCREAS CANNOT KEEP UP WITH THE DEMAND

Leading to T2DM

- INSULIN RESISTANCE
- PRE-DIABETES
- METABOLIC SYNDROME

MODIFIABLE RISK FACTORS

- BMI >/= 26 AND RISK INCREASES >30
- PHYSICAL INACTIVITY
- HDL </= 35 MG/dL &/or TG >/= 250mg/Dl
- METABOLIC SYNDROME

NON-MODIFIABLE RISK FACTORS

- FIRST-DEGREE RELATIVE WITH DM
- MEMBERS OF HIGH RISK ETHNIC POPULATION
- WOMEN WHO DELIVERED BABY 9LBS OR GREATER OR WHO HAD GDM
- HTN
- WOMEN WITH POS
- HgbA1C OF 5.7% OR GREATER
- HISTORY OF CVD

TYPE 2 DIABETES

Genetic Mutations = Insulin Resistance
& Familial Tendency

- Polyuria, Nocturia
- Polydipsia
- Polyphagia
- Recurrent Infections
- Prolonged Wound Healing
- Visual Changes
- Fatigue, ↓Energy
- HbA1c ↑6.5%, FPG - ↑126mg/dL
- Prediabetes FPG 100-125mg/dL
- Metabolic Syndrome

Metabolic Syndrome -
↑Risk for Diabetes

- ↑Triglycerides
- ↓HDL's
- ↑B/P
- Central Obesity
- Sedentary Lifestyle
- FPG > 126 mg/dL
- Most Common ↑35yrs

Nursing Implementation

- **Health promotion**
  - Identify, monitor, & teach patients at risk
  - Obesity: primary risk factor T2DM
  - Routine screening for all overweight adults & those > 45 yr. old
  - Diabetes risk test
    - http://www.diabetes.org/diabetes-basics/prevention/diabetes-risk-test/

CLINICAL MANIFESTATIONS

3 P'S—POLYURIA, POLYDIPSIA, POLYPHAGIA

- FATIGUE
- POOR WOUND HEALING
- CARDIOVASCULAR DISEASE (CVD)
- RENAL INSUFFICIENCY
- RECURRING INFECTIONS—BACTERIAL AND YEAST

MEDICAL MANAGEMENT

- EDUCATION
- MONITORING GLYCEMIC CONTROL
- DIET
- EXERCISE
- MONITORING FOR COMPLICATIONS
- ORAL GLUCOSE CONTROL AGENTS
- INSULIN IF NEEDED

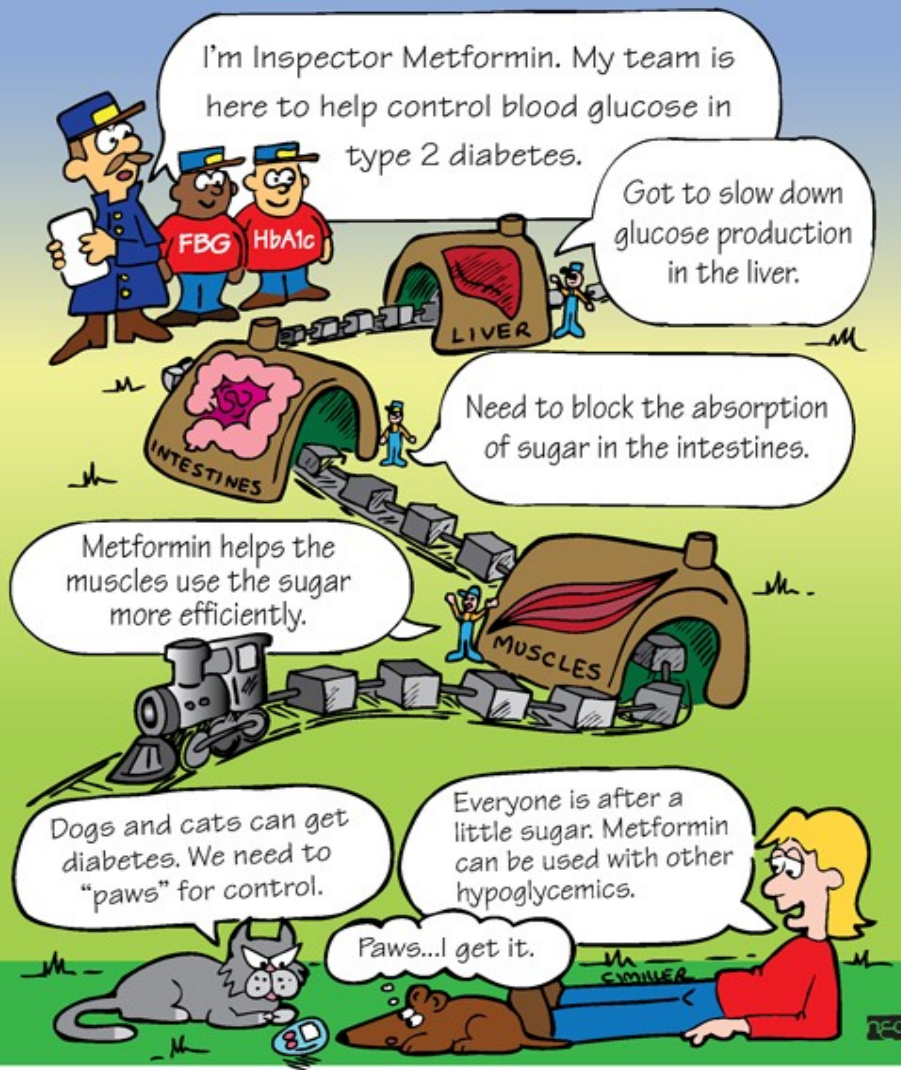
ORAL AGENTS/MEDICATIONS

- WORK IN A VARIETY OF WAYS:
  - STIMULATE INSULIN RELEASE FROM BETA CELLS
  - MODULATE THE RISE IN GLUCOSE AFTER A MEAL
  - DELAY CHO DIGESTION/ABSORPTION

METFORMIN (GLUCOPHAGE)

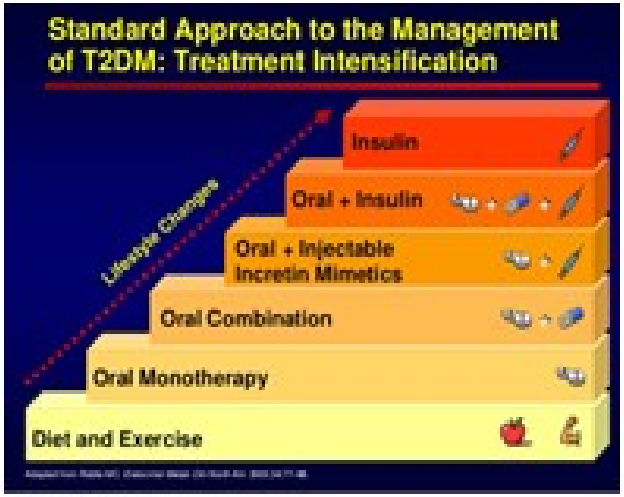
- MOST COMMONLY USED
- STARTED IMMEDIATELY AFTER THE DIAGNOSIS
- SIDE EFFECTS: GI UPSET, AND RARELY LACTIC ACIDOSIS
- LOWERS BG AND IMPROVES GLUCOSE TOLERANCE

METFORMIN
(GLUCOPHAGE)



T2DM: Step Approach to Treatment

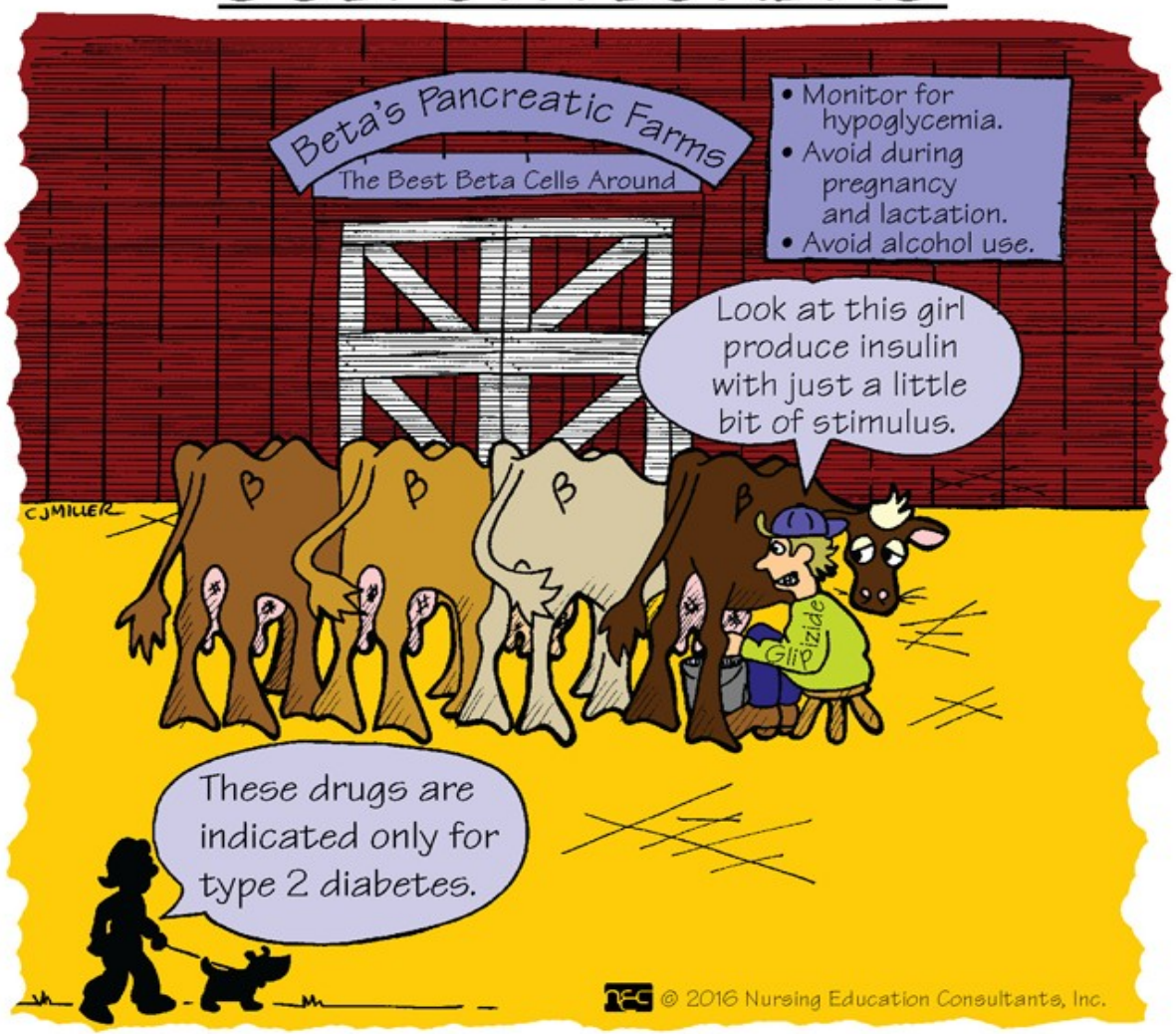
- **Step 1:** Diet and exercise
- **Step 2:** Lifestyle changes ***plus*** metformin
- **Step 3:** Lifestyle changes plus metformin & ***add*** a second drug
- **Step 4:** **L**ifestyle changes **plus** metformin & insulin therapy



SULFONYLUREAS

- PROMOTE INSULIN RELEASE
- SIDE EFFECTS: HYPOGLYCEMIA AND WEIGHT GAIN
- SECOND-GENERATION DRUGS MORE COMMONLY USED: **GLIPIZIDE, GLYBURIDE, AND GLIMEPRIDE**
- ALCOHOL USE CAN POTENTIATE HYPOGLYCEMIA EFFECTS(FLUSHING, PALPITATIONS, AND NAUSEA)

SULFONYLUREAS



MEGLITINIDES (GLINIDES)

- STIMULATE INSULIN RELEASE
- SHORT-ACTING AND TAKEN WITH EACH MEAL
- HALF-LIFE IS ONLY 1 HOUR, COMPLETELY ABSORBED/METABOLIZED IN 4 HRS
- MAIN SIDE EFFECT IS HYPOGLYCEMIA
- MUST EAT WITHIN 30 MIN OF TAKING THIS DRUG

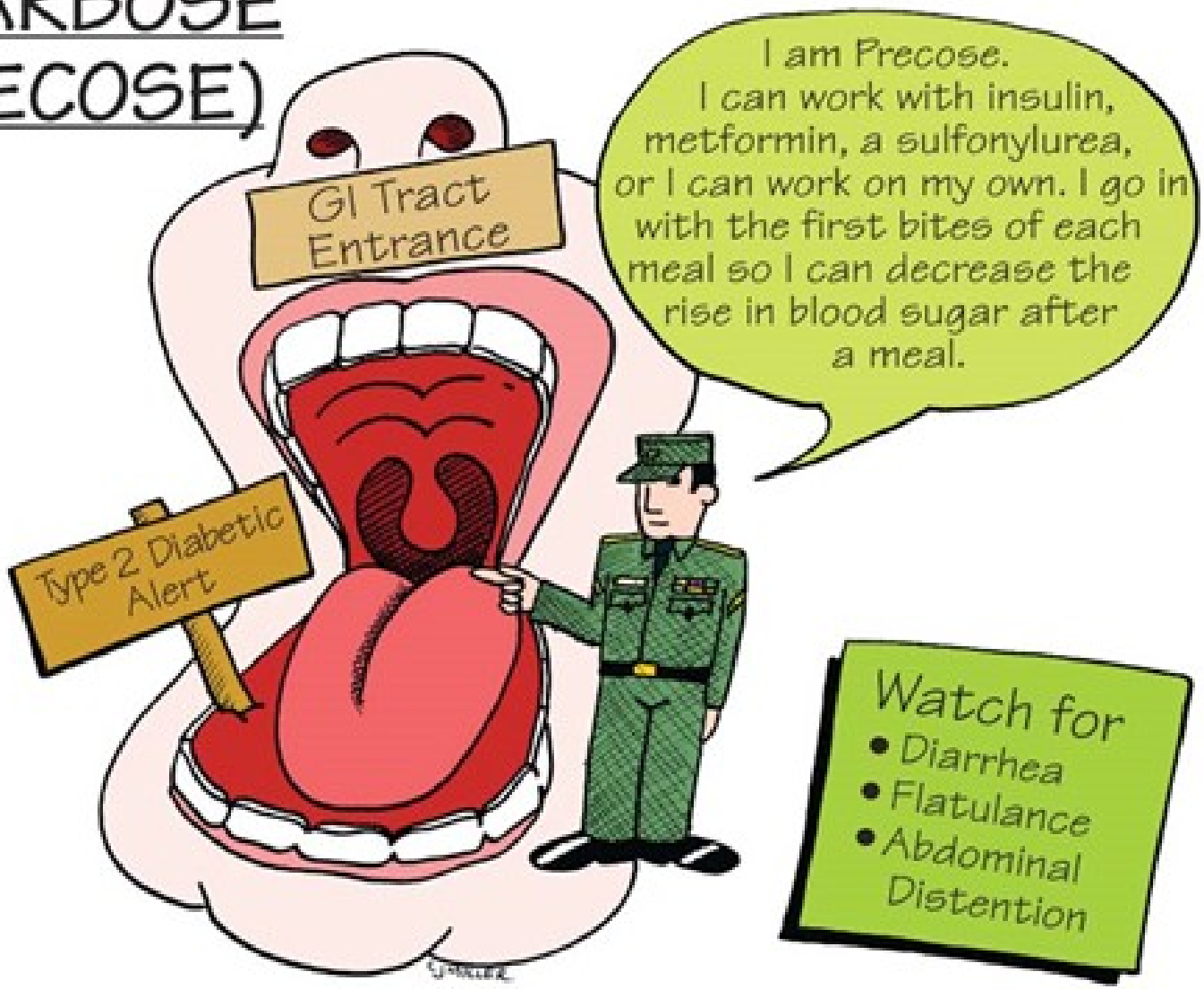
THIAZOLIDINEDIONES (GLITAZONES) OR TZD

- PROTOTYPE: pioglitazone (Actos)
- DECREASES INSUSLIN RESISTANCE & MAY ALSO DECREASE GLUCOSE PRODUCTION
- ADVERSE EFFECTS: URI, HA, SINUSITIS, & MYALGIA
- CAUTION: WITH MILD HF; AVOID IN SEVERE HF
- PEAKS IN 2 HOURS

ALPHA-GLUCOSIDASE INHIBITORS

- DELAYS CHO DIGESTION & ABOSRPTION TO ↓ POSTPRANDIAL ↑ IN BG
- ADVERSE EFFECTS: FLATULENCE, CRAMPS, ABD DISTENTION, RUMBLING, DIARRHEA
- TAKE WITH FIRST BITE OF MEAL
- KNOWN AS STARCH BLOCKERS
- **ACARBOSE (PRECOSE)**

ACARBOSE (PRECOSE)



DPP-4 (GLIPTINS)

- **SITAGLIPTIN (JANUVIA), SAXAGLIPTIN (ONGLYZA), LINAGLIPTIN (TRADJENTA), ALOGLIPTIN (NESINA)**
- STIMULATE GLUCOSE DEPENDENT RELEASE OF INSULIN AND SUPPRESS POSTPRANDIAL RELEASE OF GLUCAGON
- ADVERSE EFFECTS: SORE THROAT, RHINITIS, URI, HA, HYPOGLYCEMIA, AND RARELY PANCREATITIS

Combination Products

- **Combination oral therapy**
  - Two different classes of medications
  - Risk & benefits of both drugs
    - Glucovance: glyburide & metformin
    - Metaglip: glipizide & metformin
- **Other drugs may affect blood glucose levels**
  - Drug interactions can potentiate hypoglycemia & hyperglycemia

NON-INSULIN INJECTABLES

- GLP-1 RECEPTOR AGONISTS: SLOW GASTRIC EMPTYING, STIMULATE GLUCOSE-DEPENDENT RELEASE OF INSULIN, INHIBIT POSTPRANDIAL RELEASE OF GLUCAGON, AND SUPPRESS APPETITE
- **EXENATIDE (BYETTA)**
- USED IN T2DM
- NAUSEA IS COMMON

AMYLIN MIMETIC

- USED TO COMPLEMENT EFFECTS OF MEALTIME INSULIN IN T1DM AND T2DM PATIENTS
- DELAYS GASTRIC EMPTYING AND SUPPRESSES GLUCAGON SECRETION
- ACT IN THE BRAIN TO INCREASE THE SENSE OF SATIETY, HELPING TO LOWER CALORIC INTAKE
- **PRAMLINTIDE (SYMLIN)**

HYPOGLYCEMIA

T Tachycardia

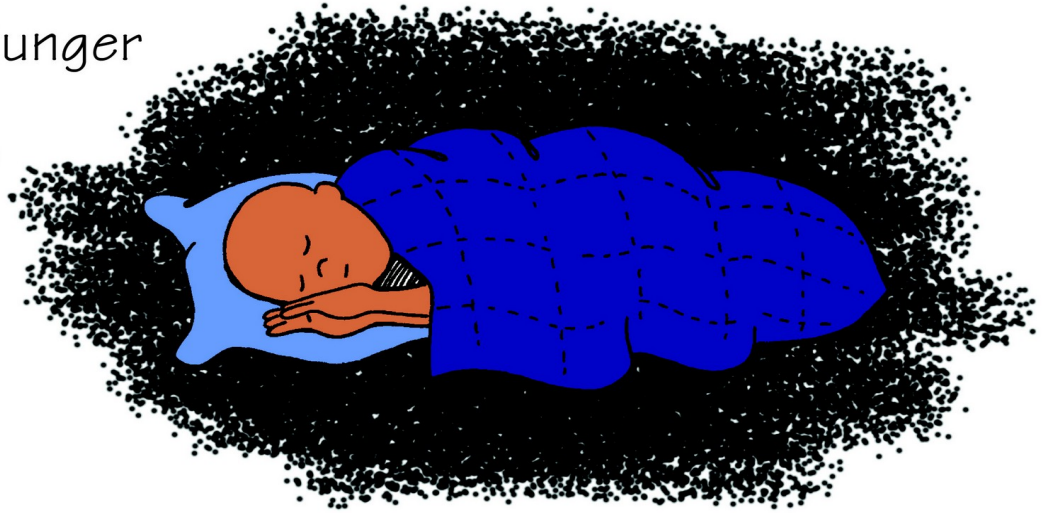
I Irritable

R Restless

E Excessive Hunger

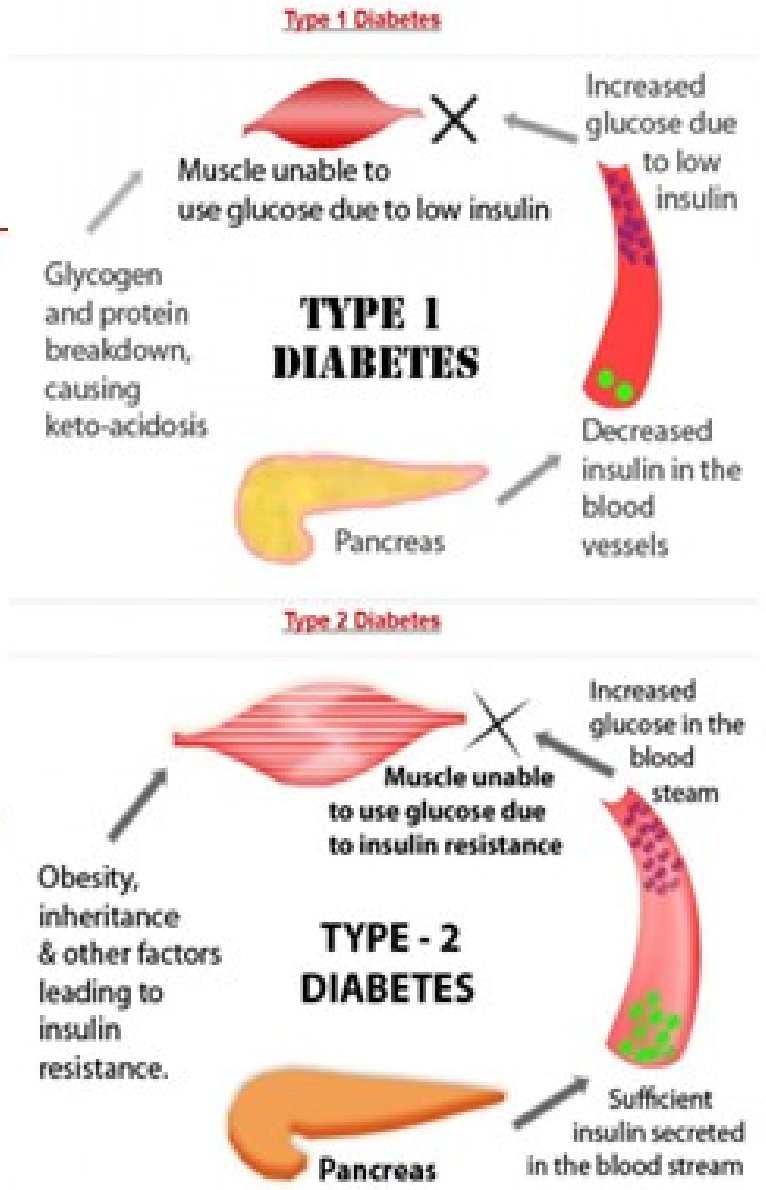
D Diaphoresis

Depression



Collaborative Care

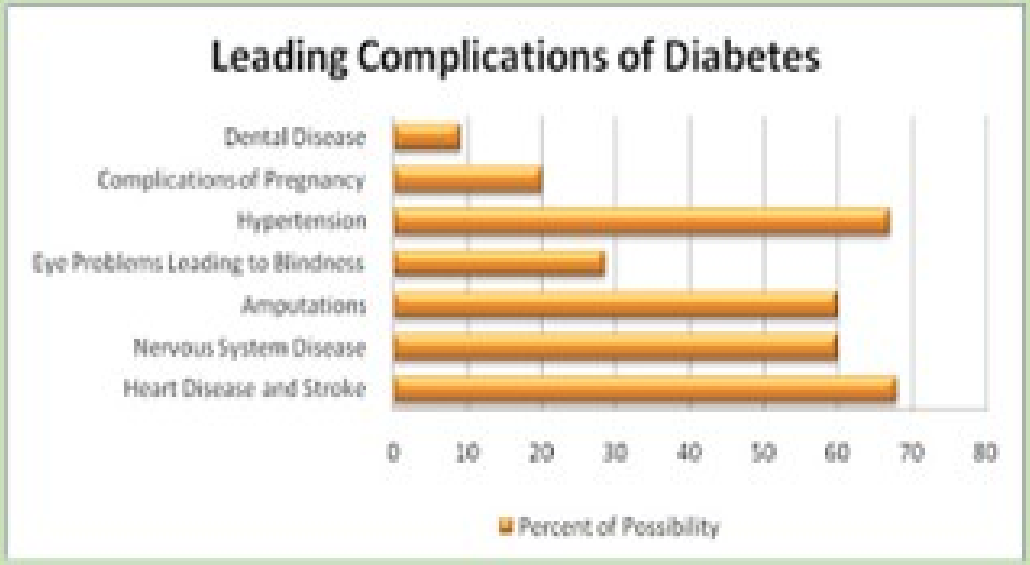
- **Patient teaching**
  - Drug therapy
  - Nutritional therapy
  - Exercise
  - Self-monitoring of BG
- **Diet, exercise, & weight loss may be sufficient for T2DM**
- **ALL patients with T1DM *require* insulin**



LONG-TERM EFFECTS OF HYPERGLYCEMIA

- MAJOR CVD: ISCHEMIC HEART DISEASE, STROKE
- LOWER-EXTREMITY AMPUTATION
- DKA, HHS
- SKIN AND SOFT TISSUE INFECTIONS
- PNEUMONIA
- INFLUENZA
- BACTEREMIA/SEPSIS
- TB

Chronic Complications



VASCULAR EFFECTS

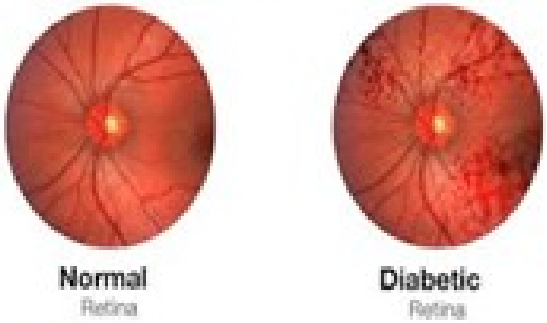
- MACRO EFFECTS:
  - CVD/PVD
  - MI
  - STROKE
- MICRO EFFECTS:
  - RETINOPATHY
  - PERIODONTAL DZ
  - RENAL INSUFFICIENCY/ FAILURE

Chronic Complications
Macrovascular Angiopathy

- **Decrease risk factors (yearly screening)**
  - Obesity
  - Smoking
  - Hypertension
  - High fat intake
  - Sedentary lifestyle
- **Screen for & treat hyperlipidemia**

Chronic Complications
Diabetic Retinopathy

- **Microvascular damage to retina**
- **Nonproliferative –**
  - Partial occlusion of small blood vessels in retina causes microaneurysms
- **Proliferative**
  - Involves retina & vitreous humor
  - New blood vessels formed (neovascularization)
  - Can cause retinal detachment



Chronic Complications
Diabetic Retinopathy

- Initially no changes in vision
- Annual eye examinations with dilation to monitor
- Maintain glycemic control & manage hypertension
- Exercise precautions

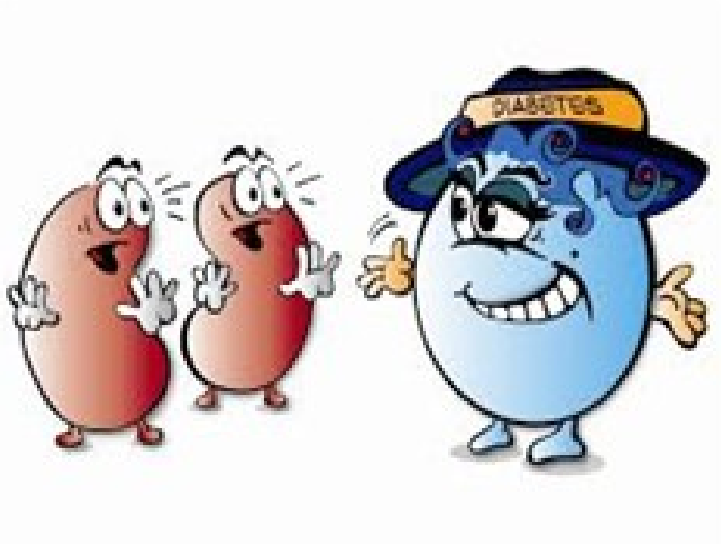
Chronic Complications
Retinopathy & other eye diseases

- **Retinopathy Treatment**
  - Laser photocoagulation: Laser destroys ischemic areas of retina
  - Vitrectomy: Aspiration of blood, membrane, & fibers inside the eye
  - Drugs to block action of vascular endothelial growth factor (VEFG)

- **Increased risk for other eye diseases**
  - Glaucoma
  - Cataracts

Chronic Complications
Diabetic Nephropathy

- **Damage to small blood vessels that supply the glomeruli**
- **Risk factors**
  - Hypertension
  - Genetics
  - Smoking
  - Chronic hyperglycemia



Chronic Complications
Diabetic Nephropathy

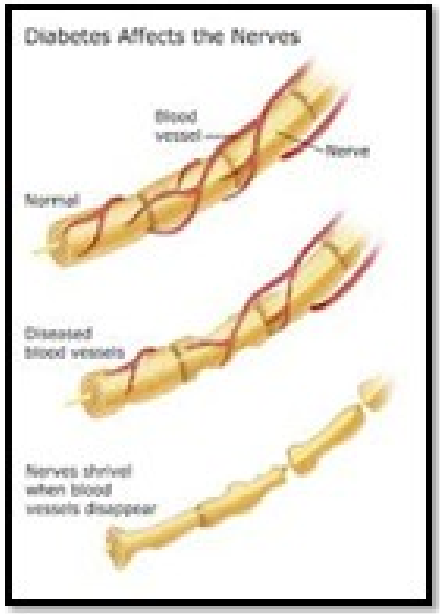
- **Annual screening**
- **If albuminuria present, drugs to delay progression:**
  - ACE inhibitors
  - Angiotensin II receptor antagonists
- **Control of hypertension & tight BG control**

NEUROLOGICAL EFFECTS

- MECHANISMS NOT COMPLETELY UNDERSTOOD
- DAMAGE TO THE NERVE CELLS
  - DIABETIC PERIPHERAL NEUROPATHY
  - AUTONOMIC NEUROPATHY

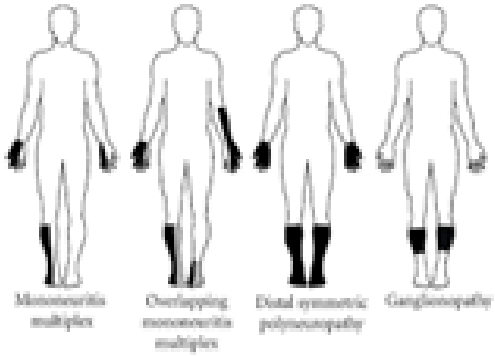
Chronic Complications
Diabetic Neuropathy

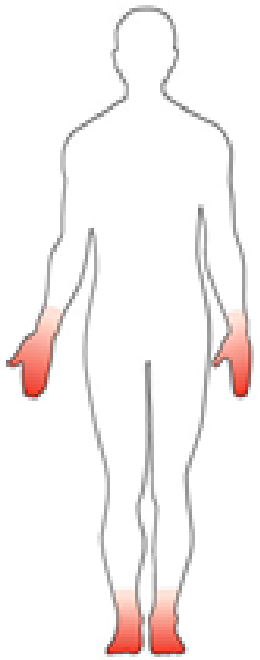
- Nerve damage due to metabolic derangements of diabetes
- Reduced nerve conduction & demyelinization
- Sensory or Autonomic



Chronic Complications
Diabetic Neuropathy

- **Sensory neuropathy**
  - Loss of protective sensation
- **Distal symmetric polyneuropathy**
  - Loss of sensation, abnormal sensations, pain, & paresthesias





Distal symmetric polyneuropathy

Neuropathy: Neurotrophic Ulceration

Chronic Complications
Diabetic Neuropathy

- **Treatment for *SENSORY* neuropathy**
  - Tight BG control
  - Drug therapy
    - Topical creams
    - Tricyclic antidepressants
    - Selective serotonin & norepinephrine reuptake inhibitors
    - Antiseizure medications

Chronic Complications
Diabetic Neuropathy

- ***AUTONOMIC*** **neuropathy**
  - **Gastroparesis**
    - Delayed gastric emptying
  - **Cardiovascular abnormalities**
    - Postural hypotension, resting tachycardia, painless myocardial infarction
  - **Hypoglycemic unawareness**

Chronic Complications
Diabetic Neuropathy

- **Autonomic neuropathy**
  - **Sexual function**
    - Erectile dysfunction
    - Decreased libido
  - **Neurogenic bladder** → urinary retention
    - Empty frequently, use Credé's maneuver
    - Medications
    - Self-catheterization

Chronic Complications
Foot Complications

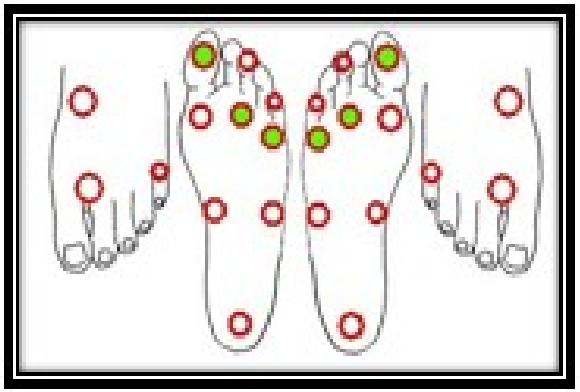
- Microvascular & macrovascular diseases increases risk for injury & infection
- Sensory neuropathy & PAD - risk factors for amputation
- Clotting abnormalities, impaired immune function, autonomic neuropathy
- Smoking increases risk

Chronic Complications
Foot Complications

- **Sensory neuropathy → loss of protective sensation → unawareness of injury**
  - Monofilament screening
- **Peripheral artery disease**
  - ↓ Blood flow, ↓ wound healing, ↑ risk for infection

Recommendations: Foot Care

- **Annual comprehensive foot examination by HCP to identify risk factors predictive of ulcers & amputations.**
  - Inspection
  - Test for loss of sensation: 10g monofilament plus
    - Vibration using 128 HZ tuning fork
    - Pinprick sensation
    - Ankle reflexes
    - Vibration perception threshold



Green dots are preferred testing areas.

Complications of Feet

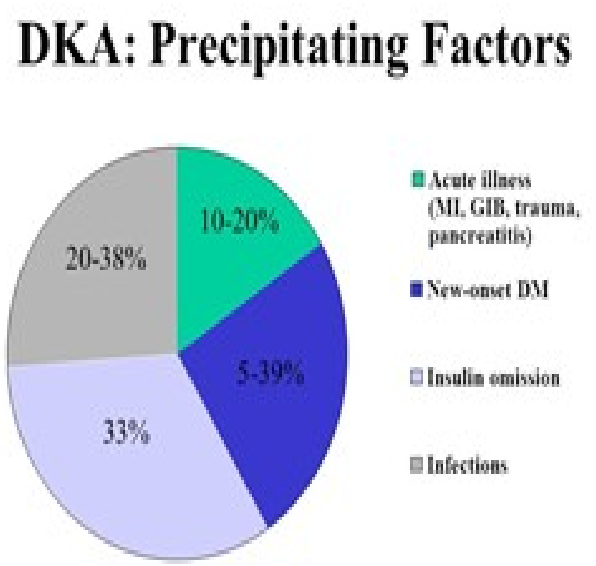
- **Neuropathic arthropathy (Charcot's foot)**
- **Diabetic foot ulcers**
  - Begins with soft tissue injury of foot.
  - Formation of fissure between toes or in area of dry skin.
  - Formation of callus.
  - Ingrown toenails
  - Venous insufficiency is a contributing cause of foot ulcers

Treatment of Foot Ulcers

- Bed rest
- Antibiotics
- Debridement
- Good control of BG
- If patient has PVD, ulcers may not heal
- Amputation may be necessary

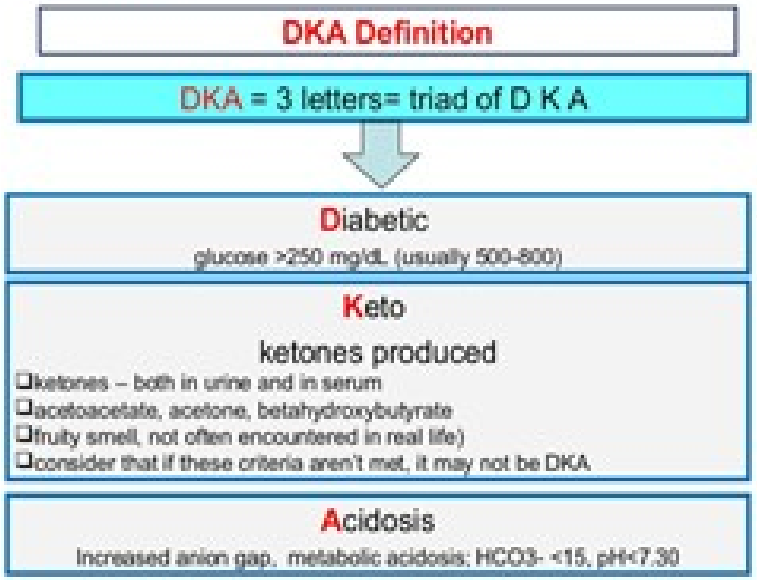
Diabetic Ketoacidosis (DKA)

- **Precipitating factors**
  - Infection
  - Inadequate insulin dose
  - Illness
  - Undiagnosed T1DM



Diabetic Ketoacidosis - Patho

- **Caused by profound deficiency of insulin**
- **Characterized by**
  - Hyperglycemia
  - Ketosis
  - Acidosis
  - Dehydration
- **Most likely to occur in T1DM**

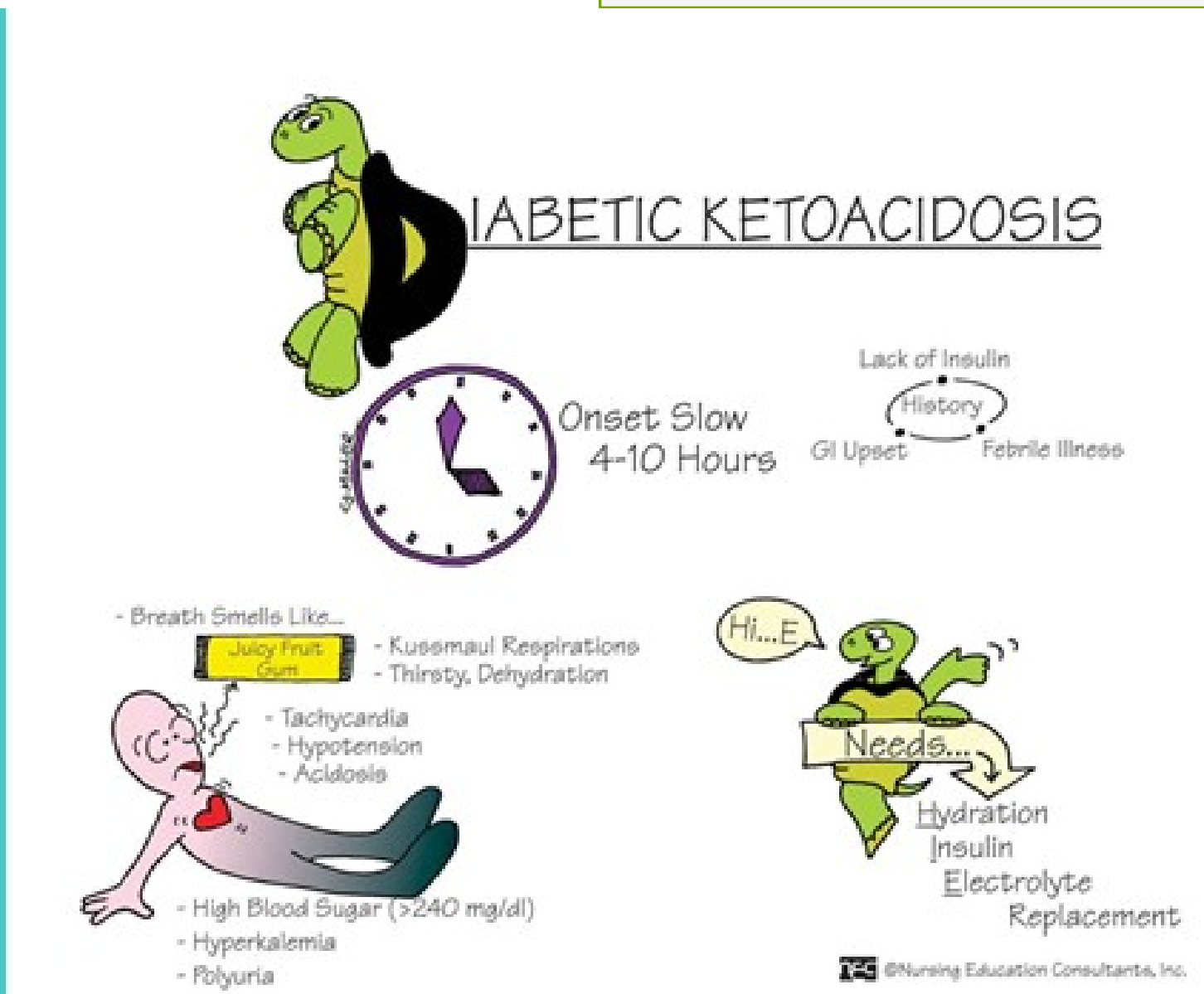


Dka Symptoms & Testing

- **Clinical manifestations**
  - Abd pain, anorexia, N/V
  - Kussmaul respirations
  - Sweet, fruity breath odor
- **Lab work**
  - BG level of 250 mg/dL or higher
  - Blood pH < than 7.30
  - Serum bicarbonate level < 16 mEq/L
  - Moderate to high ketone levels in urine or serum

https://www.youtube.com/watch?v=raEKXVfuWTo

Copy and paste this into the YouTube search bar or just search Kussmaul breathing


IABETIC KETOACIDOSIS
Onset Slow
4-10 Hours
Lack of Insulin
History
GI Upset
Febrile Illness
- Breath Smells Like...
Juicy Fruit Gum
- Kussmaul Respirations
- Thirsty, Dehydration
- Tachycardia
- Hypotension
- Acidosis
- High Blood Sugar (>240 mg/dl)
- Hyperkalemia
- Polyuria
Hi...E
Needs...
Hydration
Insulin
Electrolyte
Replacement
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DKA vs. HHS

DKA

- Most often seen in T1DM
- Rapid onset
- BG > 250 mg/dL
- pH <7.3
- Bicarb <15 or 16
- Ketones-urine/ serum +
- Anion Gap +

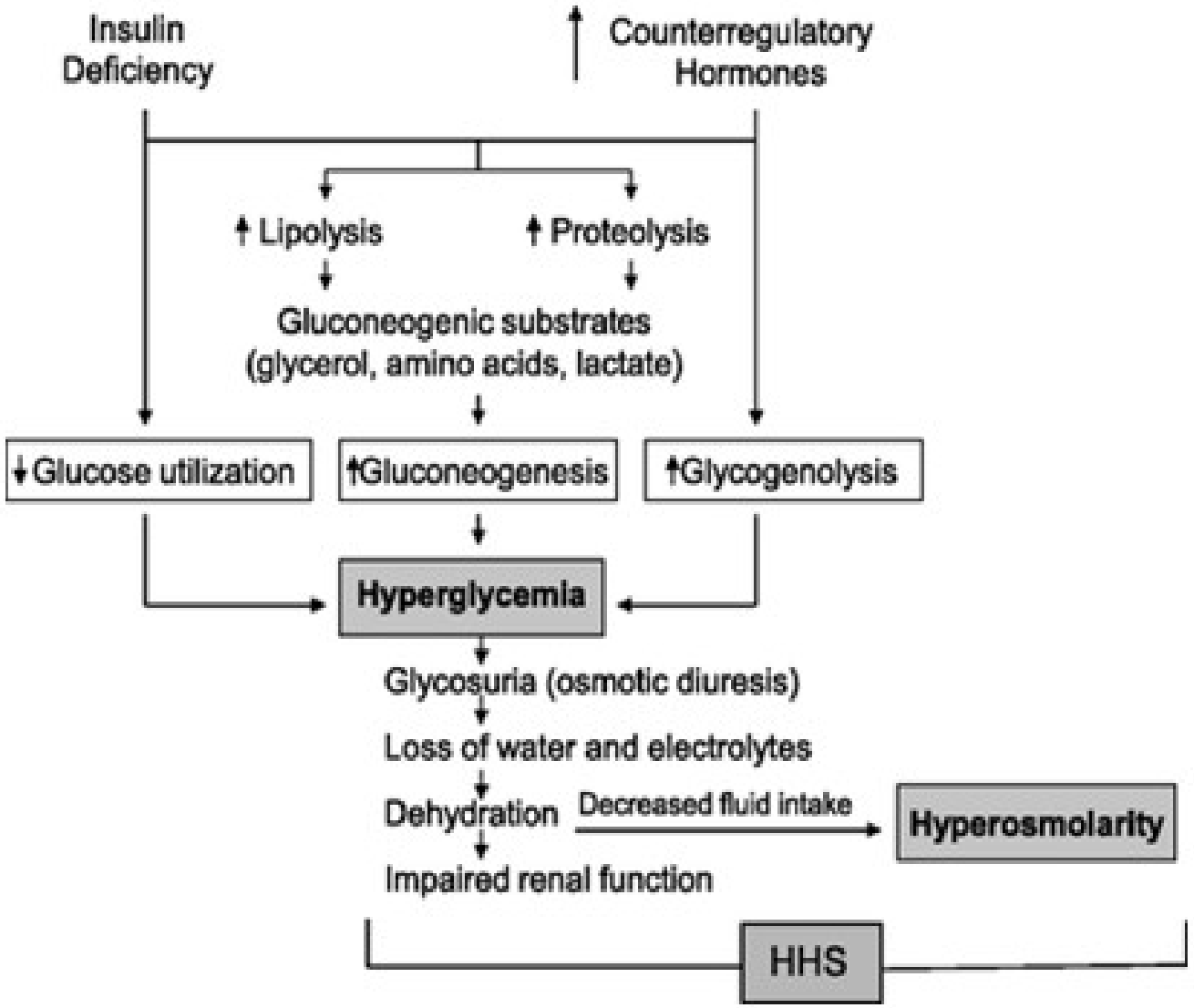
HHS

- Occurs more common in elderly
- Gradual onset
- BG >600 mg/dL
- pH >7.3
- Bicarb >30
- Ketones urine/serum –
- Anion Gap -

Hyperosmolar Hyperglycemic Syndrome (HHS)

- **Life-threatening syndrome**
- **Occurs with T2DM**
- **Precipitating factors**
  - UTIs, pneumonia, sepsis
  - Acute illness
  - Newly diagnosed T2DM
  - Impaired thirst sensation and/or inability to replace fluids

HHS Patho Map



HHS Pathology

- **Enough circulating insulin to prevent ketoacidosis**
- **Fewer symptoms lead to higher glucose levels**
- **More severe neurologic manifestations – 2nd to ↑ serum osmolality**
- **Lab**
  - BG > 600mg/dL is possible
  - Ketones absent or minimal in blood & urine

DKA & HHS: Nursing Management

- **Monitor**
  - Electrolytes
  - IV fluids
  - Insulin therapy
- **Assess**
  - Renal status
  - Cardiopulmonary status
  - Level of consciousness

Complications of Insulin Treatment

- Hypoglycemic reaction
- Somogyi phenomenon
- Dawn phenomenon
- Coma from too much/not enough dosing
- Hypokalemia
- Lipohypertrophy

Hypoglycemia Signs & Symptoms

- **Common manifestations**
  - Shakiness
  - Palpitations
  - Nervousness
  - Diaphoresis
  - Anxiety
  - Hunger
  - Pallor

Hypoglycemia Treatment

- **Check BG level**
  - If less than 70 mg/dL, begin treatment
  - If more than 70 mg/dL, investigate further for cause of signs/symptoms
  - If monitoring equipment not available, treatment should be initiated

Hypoglycemia Treatment

- **Rule of 15 in 15**
  - Consume 15 g of a simple carbohydrate
    - Fruit juice or regular soft drink, 4 to 6 oz.
  - Recheck glucose level in 15 minutes
    - Repeat if still less than 70 gm/dL
  - Avoid foods with fat
    - Decrease absorption of sugar
  - Avoid overtreatment
  - Give complex CHO after recovery

Examples of 15 grams of carbohydrates:

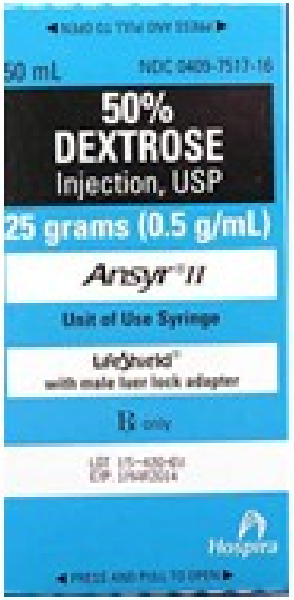
3-4 Glucose Tabs
OR
1 tube Glucose Gel

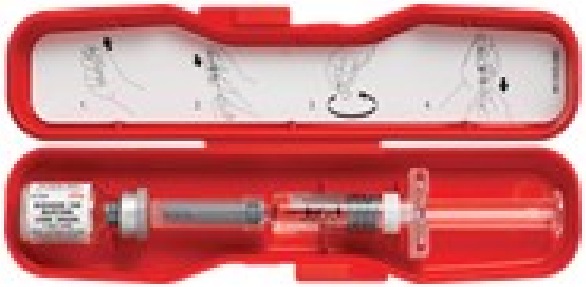
3-5 Pieces of Hard Candy (NOT chocolate)

½ cup (4 oz) Juice or Regular Soda (NOT diet soda)

Hypoglycemia Hospitalized Patient

- **Treatment**
  - See orders or hospital protocol
  - 15 in 15 rule generally followed
  - If patient not alert enough to swallow
    - Fifty percent dextrose, 20 to 50 mL, IV push
    - Glucagon, 1 mg, IM or subcutaneously
- **Explore reason why occurred**





Glucagon

- **MOA:** stimulate conversion of glycogen to glucose
- **Peak:** 15-30 min. Lasts 90 min. (IV, SQ or IM)
- **Adverse effects:** N/V, allergic reaction
- **Reconstitute –**Sterile Water
- **Caution:** Risk for aspiration; follow with complex CHO; recheck BG

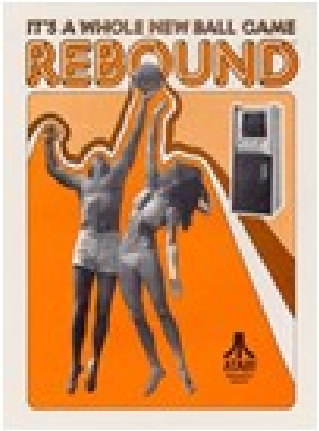
BLOOD SUGAR MNEMONIC

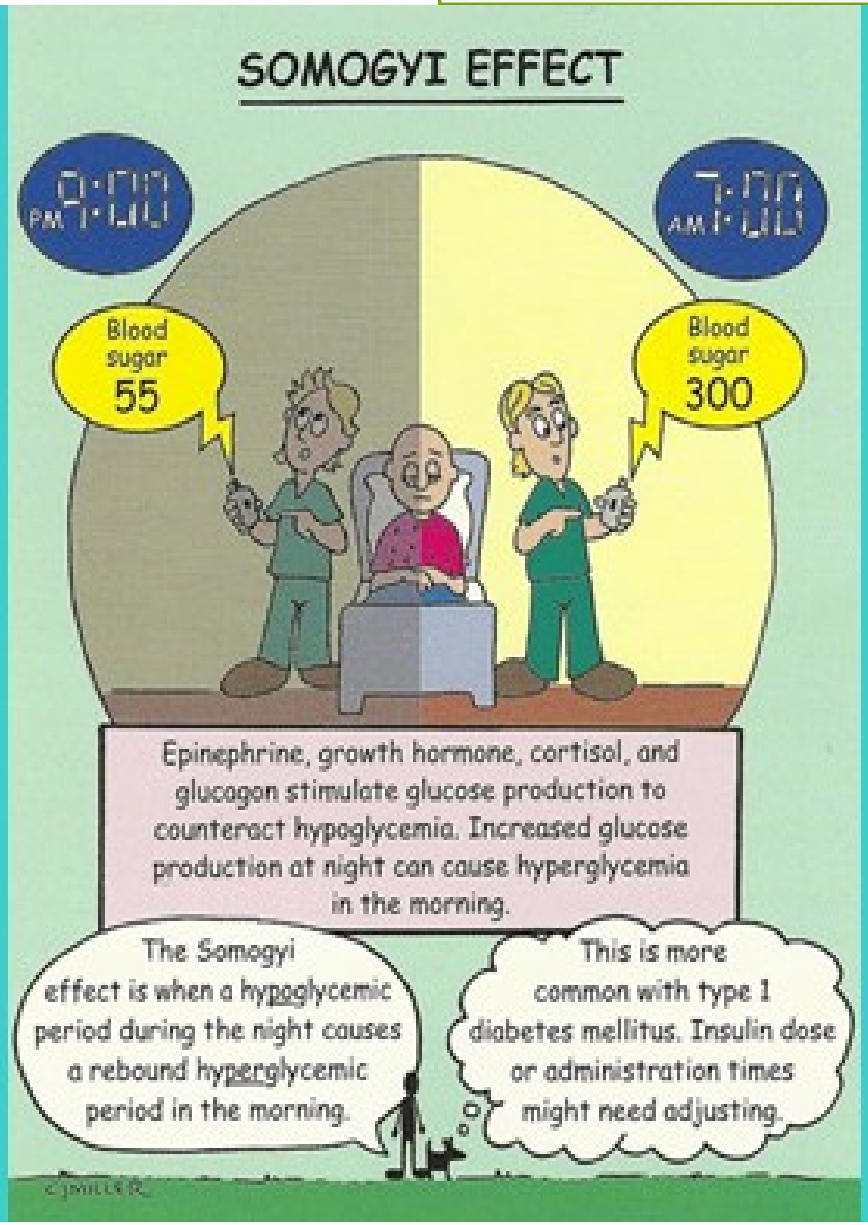
HOT & DRY = SUGAR HIGH

COLD & CLAMMY =
NEED SOME CANDY

Somogyi Effect

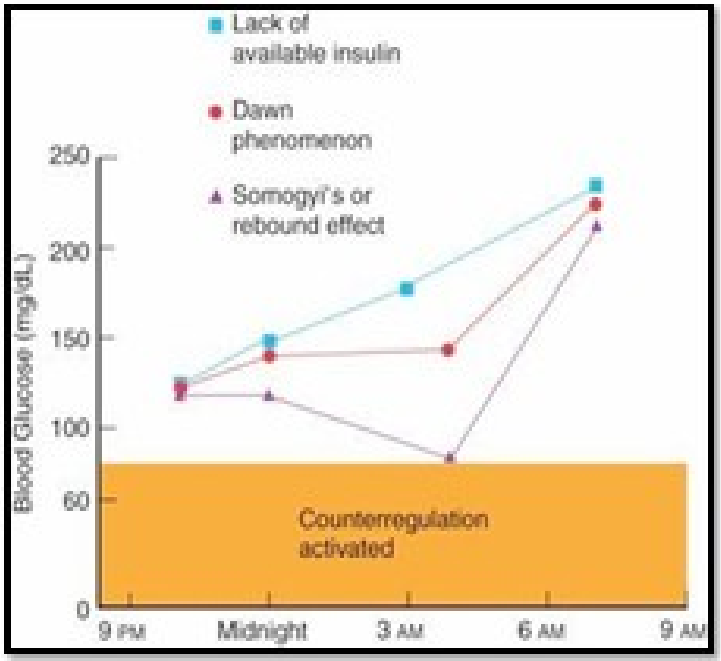
- **Somogyi effect**
  - *Rebound effect* in which an overdose of insulin causes hypoglycemia
  - Release of counterregulatory hormones causes *rebound* hyperglycemia

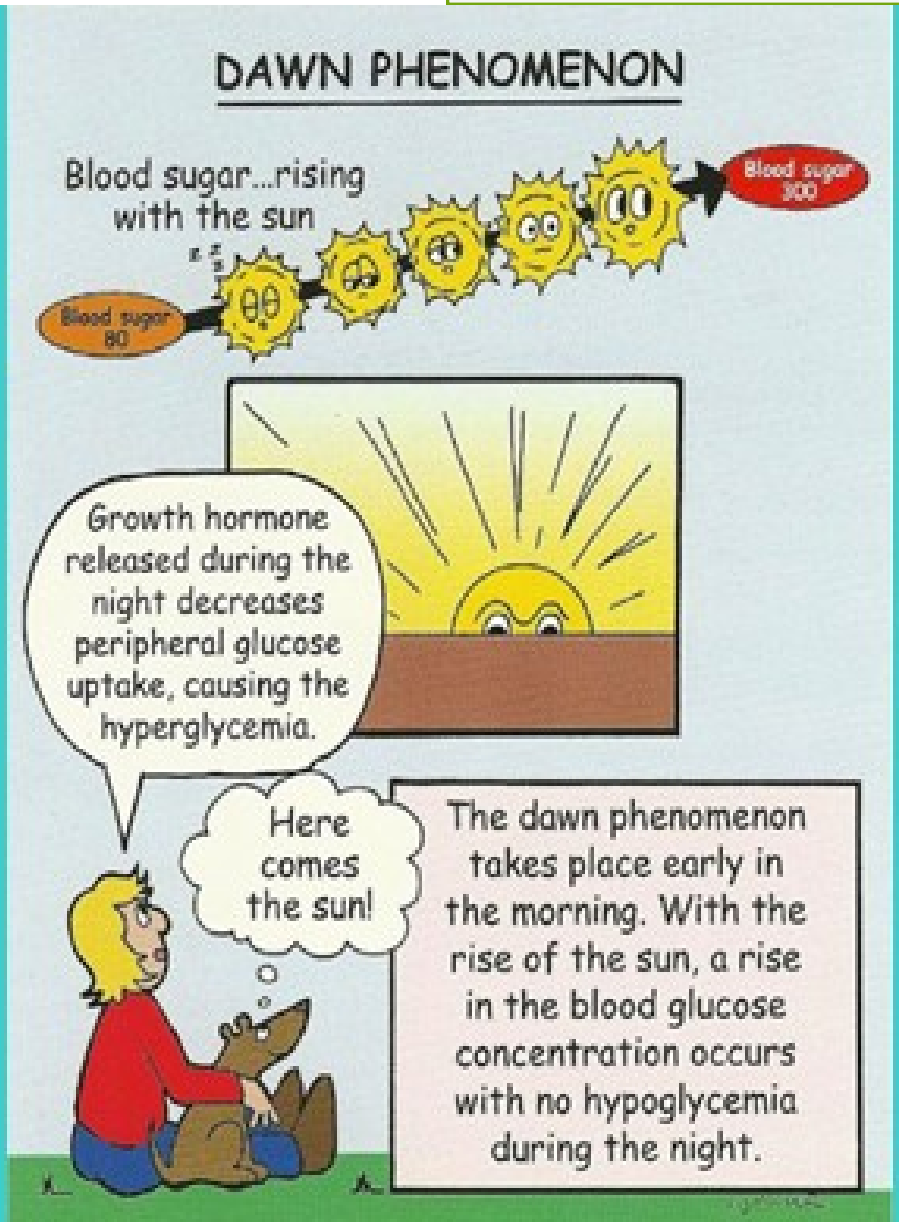



SOMOGYI EFFECT
Blood sugar 55
Blood sugar 300
Epinephrine, growth hormone, cortisol, and glucagon stimulate glucose production to counteract hypoglycemia. Increased glucose production at night can cause hyperglycemia in the morning.
The Somogyi effect is when a hypoglycemic period during the night causes a rebound hyperglycemic period in the morning.
This is more common with type 1 diabetes mellitus. Insulin dose or administration times might need adjusting.

Dawn Phenomenon

- **Dawn phenomenon**
  - Morning hyperglycemia present on awakening
  - Possible R/T release of counterregulatory hormones
    - Growth hormone and cortisol




DAWN PHENOMENON
Blood sugar...rising with the sun
Blood sugar 80
Blood sugar 300
Growth hormone released during the night decreases peripheral glucose uptake, causing the hyperglycemia.
Here comes the sun!
The dawn phenomenon takes place early in the morning. With the rise of the sun, a rise in the blood glucose concentration occurs with no hypoglycemia during the night.

HYPOKALEMIA

- PROMOTES UPTAKE OF POTASSIUM BY CELLS
- ACTIVATES A MEMBRANE BOUND ENZYME
- IF TOO MUCH INSULIN SIGNIFICANT HYPOKALEMIA CAN OCCUR
- EFFECTS ON HEART OF BIGGEST CONCERN

LIPOHYPERTROPHY

- ACCUMULATION OF SQ FAT WHEN INSULIN IS INJECTED TOO FREQUENTLY AT S

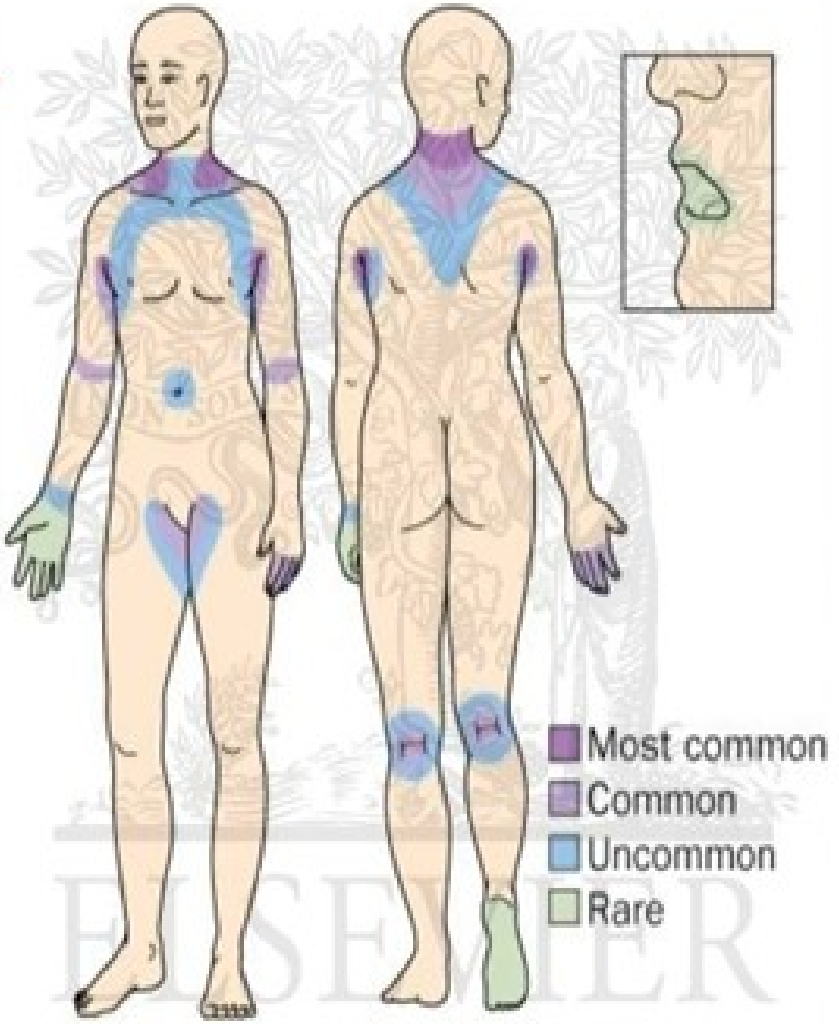
Chronic Complications
Skin Problems

- Diabetic dermopathy
- Acanthosis nigricans

DIABETIC DERMOPATHY

- AKA "shin spots" or pigmented pretibial papules
- Most common cutaneous manifestation of diabetes
- Benign asymptomatic red brown macules on shins
- No treatment needed

Acanthosis nigricans

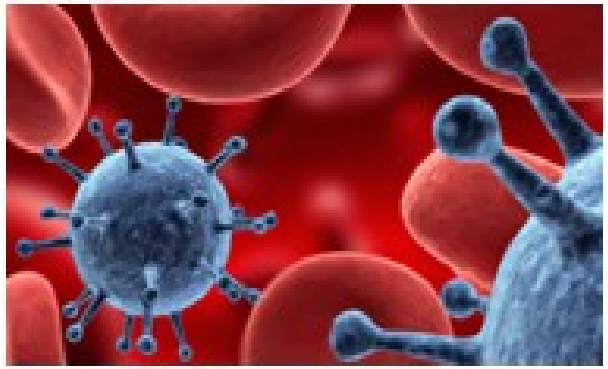


Acanthosis Nigricans

Chronic Complications

Infection

- Defect in mobilization of inflammatory cells & impaired phagocytosis
- Recurring or persistent infections
- Treat promptly & vigorously
- Patient teaching for prevention
  - Hand hygiene
  - Flu & pneumonia vaccine

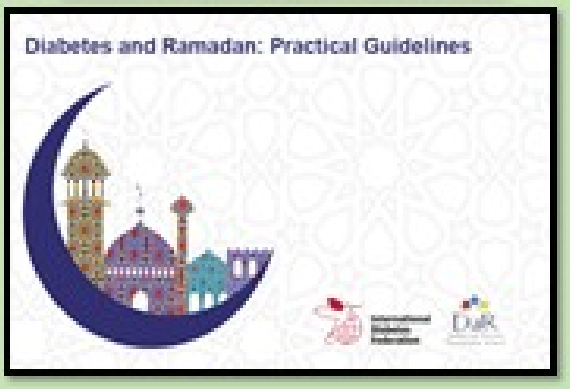


Prevent Complications

- Patient education
- Assess barriers to learning
- Teach in increments – What does pt.. want to learn?
- Promote self care
- Adjust regimen to meet needs

Adherence to Diabetes Management

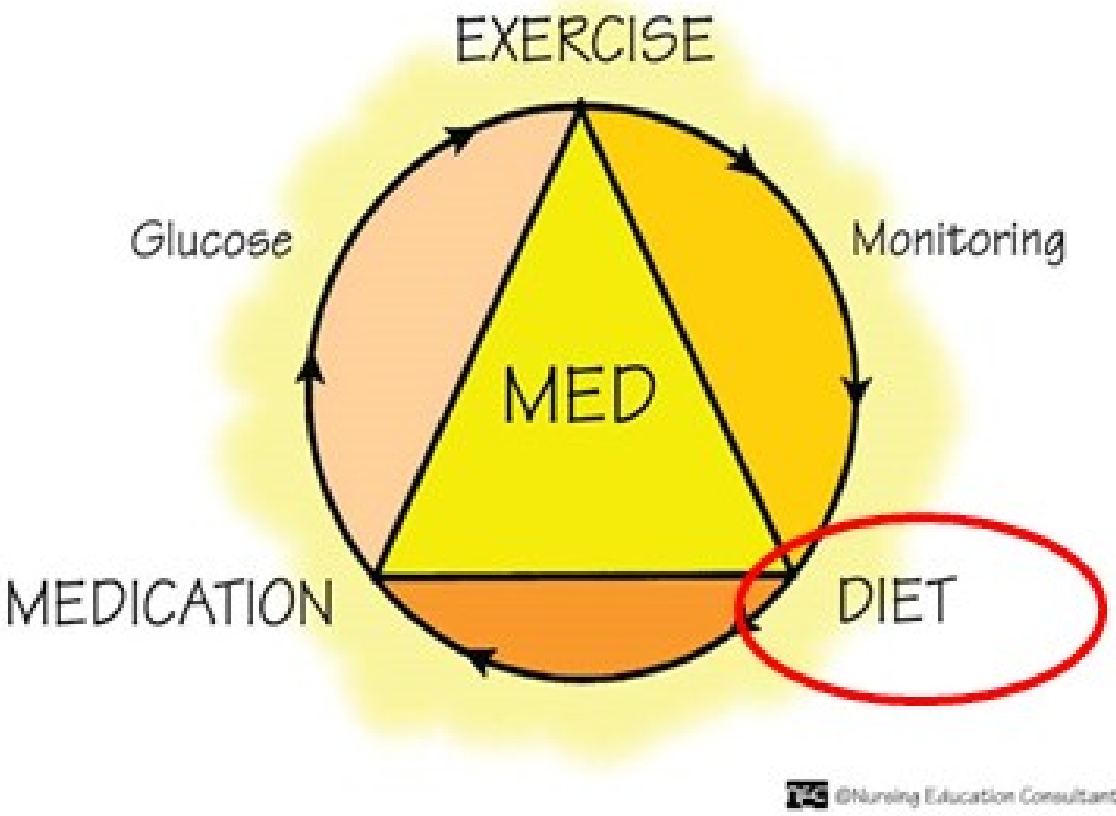
- Barriers
  - Degree of life changes & complexity of management plan
  - Cost of care
  - Cultural factors
  - Lack of family support
  - Other stressors
  - Lack of Knowledge
  - Fears



Strategies to Increase Adherence

- Encourage patient & family to take charge of their health
- Simplify the regimen
- Focus on the normal not the differences
- Teach the tools & help pt.. get supplies
- Provide a safe harbor
- Provide adequate education

TRIANGLE OF DIABETES MANAGEMENT



Goals of Nutrition Thera

- Maintain BG levels
- Lipid profiles & BP levels
- Prevent / slow rate of chronic complications
- Nutritional needs & personal, cultural, & economic needs
- Maintain the pleasure of eating

General Guidelines – T1DM

- **Meal planning**
  - Based on usual food intake and preferences
  - Portion control
  - Balanced with insulin and exercise patterns
- **Day-to-day consistency**
- **More flexibility with:** rapid-acting insulin, multiple daily injections, and insulin pump

General Guidelines – T2DM

- **Emphasis on achieving glucose, lipid, and BP goals**
- **Weight loss**
  - Nutritionally adequate meal plan with ↓ fat and CHO
  - Weight management
  - Spacing meals
  - Regular exercise

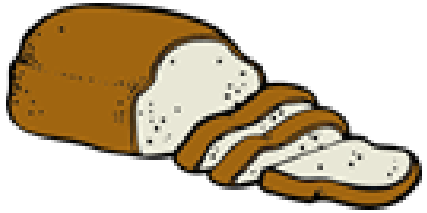
A

B

A, Source: US Department of Agriculture, Center for Nutrition Policy and Promotion, Guidance on Use of USDA's MyPlate and Statements about Amounts of Food Groups

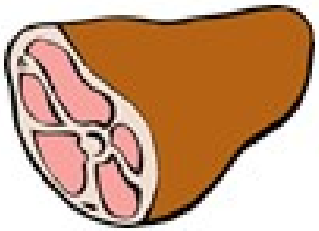
General Guidelines - Carbohydrate

- CHO should be 45%-60% of daily caloric intake
- Grains, fruits, legumes, & milk
- Minimum 130 Grams/day
- Fiber intake of 25-30 grams/day
- Limit refined grains & sugars



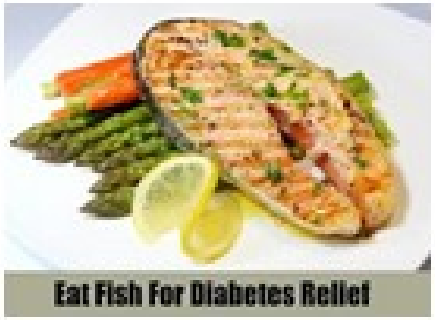
General Guidelines - Protein

- 15 - 20% of total calories consumed
- High protein diets are not recommended
- Protein may reduce in patients with kidney failure



General Guidelines - Fat

- Saturated fat < 7% of total calories
- Minimize Trans fat
- Limit dietary cholesterol < 200 mg/day
- Fish – polyunsaturated fats
- Health fats from plants



Eat Fish For Diabetes Relief

Glycemic Index

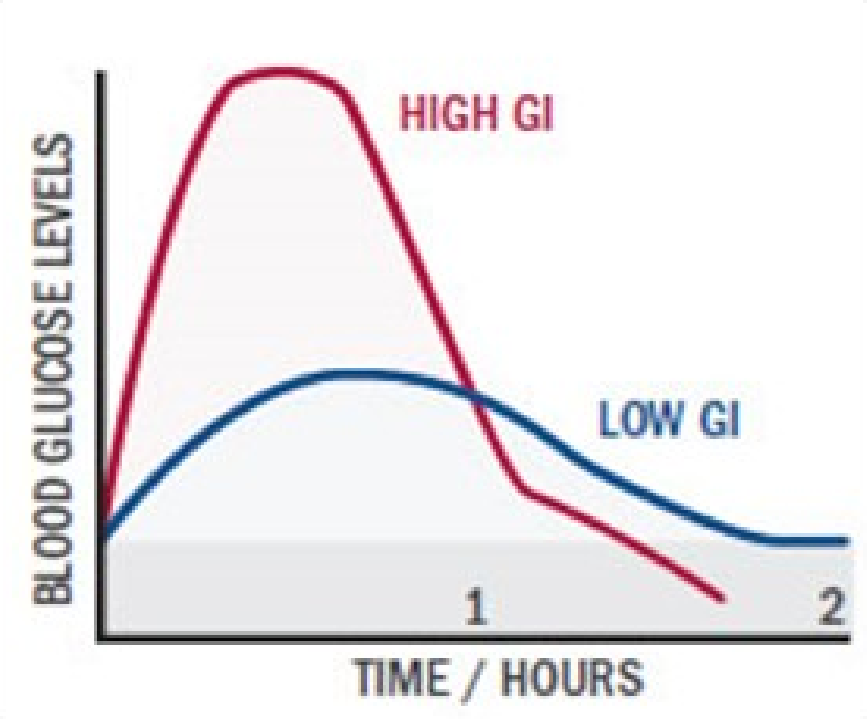
- Glycemic Index of 100 refers to the response to 50 grams of glucose or white bread in a normal person without diabetes
- Foods with a high glycemic index raise glucose levels faster & higher than foods with a low glycemic index
- May provide a modest additional benefit over consideration of total carbohydrates alone

Glycemic Index

Low GI (<55), Medium GI (56-69) and High GI (70>)

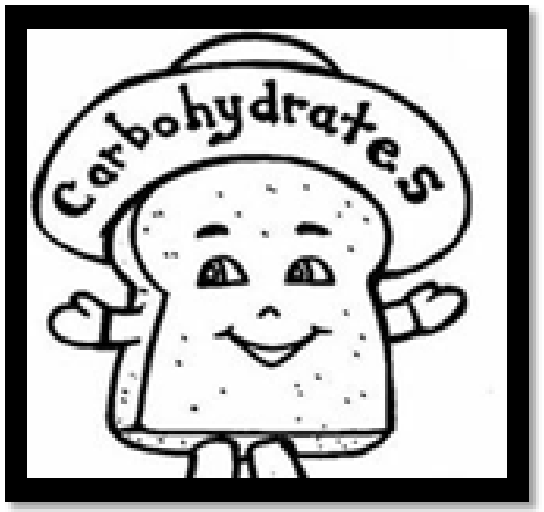
Grains / Starchs		Vegetables		Fruits		Dairy		Proteins	
Rice Bran	27	Asparagus	15	Grapefruit	25	Low-Fat Yogurt	14	Peanuts	21
Bran Cereal	42	Broccoli	15	Apple	38	Plain Yogurt	14	Beans, Dried	40
Spaghetti	42	Celery	15	Peach	42	Whole Milk	27	Lentils	41
Corn, sweet	54	Cucumber	15	Orange	44	Soy Milk	30	Kidney Beans	41
Wild Rice	57	Lettuce	15	Grape	46	Fat-Free Milk	32	Split Peas	45
Sweet Potatoes	61	Peppers	15	Banana	54	Skim Milk	32	Lima Beans	46
White Rice	64	Spinach	15	Mango	56	Chocolate Milk	35	Chickpeas	47
Cous Cous	65	Tomatoes	15	Pineapple	66	Fruit Yogurt	36	Pinto Beans	55
Whole Wheat Bread	71	Chickpeas	33	Watermelon	72	Ice Cream	61	Black-Eyed Beans	59
Muesli	80	Cooked Carrots	39						
Baked Potatoes	85								
Oatmeal	87								
Taco Shells	97								
White Bread	100								
Bagel, White	103								

Glycemic Index



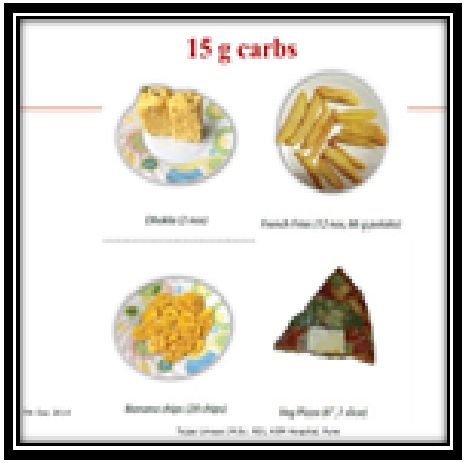
Carbohydrate Counting: Focus on Consistency

- 1 Carbohydrate Choice = 15 Grams
- Spread carbohydrates throughout the day
- Consistency
- Portion sizes



Carbohydrate Goals

- Men: 4 carb. Choices/meal (60 grams)
- Women: 3 carb. Choices/meal (45 grams)
- Snacks: 1-2 carb. Choices (15-30 grams)
- Insulin dose R/T no. of CHO eaten

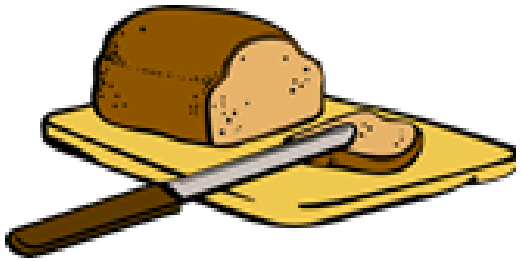


Sugar-Free Foods

- Sugar-free does *not* mean carbohydrate-free
- Sugar-free foods often higher in saturated fat compared to the regular product
- Teach patients importance of reading labels

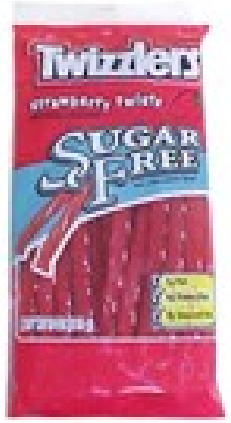
Nature's Own 100% Whole Grain Bread:

	Regular:	Sugar-Free:
Serving Size	1 slice	1 slice
Calories	70	50
Fiber	2 gm	2 gm
Carbs.	12 gm	11 gm



Sugar Alcohols

- **Found in most sugar-free foods**
- **Sugar alcohols include: sorbitol, mannitol, xylitol, & isomalt.**
- **Sugar alcohols eaten in large quantities**
  - Abd cramping, flatulence, & diarrhea



Timing of Meals/Snacks

- Check blood sugar before meals
- Check blood sugar two hours after meals
- Certain oral medications can cause low blood sugars, if patient is not eating at same time every day
- Sulfonylureas - glyburide & glipizide

Timing of Meals/Snacks

- Fixed insulin regimen:

  consistency

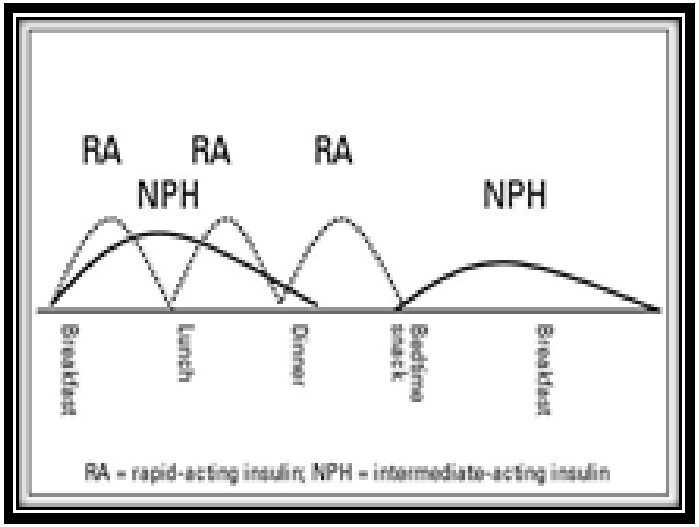
- Rapid-acting insulin:

  can adjust dose before meal

  based on current BG & CHO meal

- Intensified insulin therapy/insulin pump:

  allows more flexibility



Alcohol

- Limit – moderate amount
- Inhibits gluconeogenesis
- Monitor glucose
- No nutritional value
- High in calories

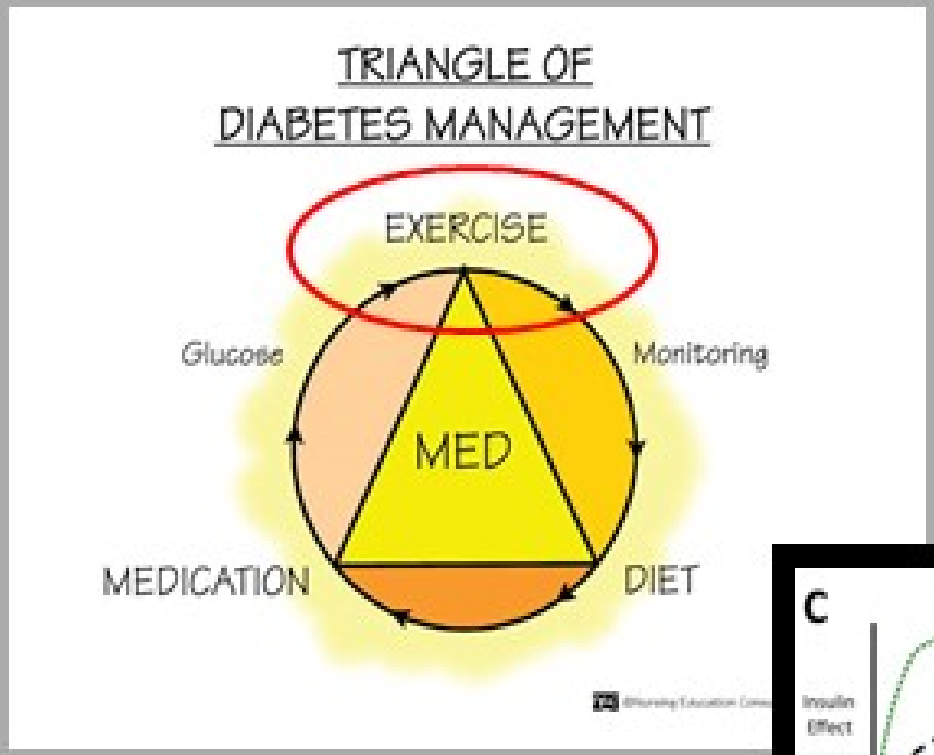
If Drink Alcohol:

- Don't skip meals
- Risk of a low blood sugar
- May increase triglycerides
- Check with diabetes care team

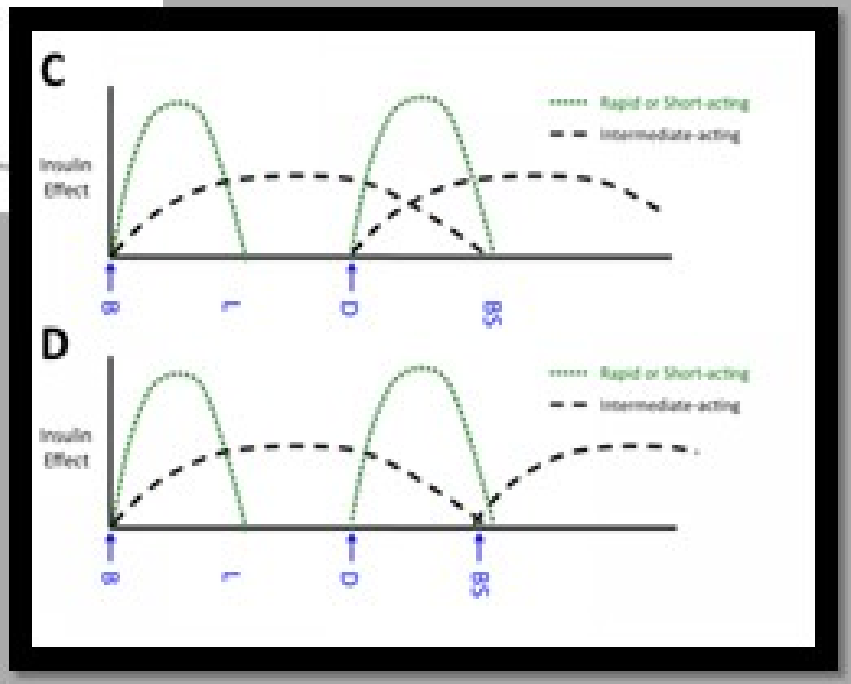
Patient & Caregiver Education

- Disease process
- Exercise
- Meal & Snacks Planning
- Medication Adherence
- SMBG
- Psychosocial
- Risk Reduction & Monitoring

DIABETES AND EXERCISE


TRIANGLE OF
DIABETES MANAGEMENT
EXERCISE
Glucose
Monitoring
MED
MEDICATION
DIET

Exercise


C
Insulin Effect
Rapid or Short-acting
Intermediate-acting
B
L
D
BS
D
Insulin Effect
Rapid or Short-acting
Intermediate-acting
B
L
D
BS

General Exercise Recommendations

- **Exercise same amount & at the same time**
- **Complications from diabetes: alter exercise type & amount**
- **Type/amount of exercise**
  - Moderate activity a minimum 150 min. /wk. aerobic
  - Resistance training 2 – 3 times/week**
  - No more than 2 consecutive days w/o exercise

T1DM & Exercise

- **Benefit:**
  - Better BG control & require less insulin
  - Prevent/delay complications
- **Glucose lowering effect may last up to 48 hours**
- **Exercise 1 – 2 hours after a meal**
- **Do not inject insulin to extremity about to be exercised**
- **Monitor BG: before, during, & after**
- **Do not exercise if:**
  - BG level > 250mg/dL or if ketones are present in urine
  - BG < 100 Eat snack & recheck BG

T2DM & Exercise

- **Benefits**
  - ↓ Insulin resistance & BG
  - Weight loss
  - ↓ Triglycerides & LDL , ↑ HDL
  - ↓ BP & improve circulation

Medication & Exercise

- Patients who use insulin, meglitinides, & sulfonylureas at increased risk for hypoglycemia
- Do not exercise when medication is at its peak
- Test BG before & after exercise

Food & Exercise

- Eat enough to maintain adequate BG levels
- Always carry a fast-acting source of CHO
- May need small CHO snacks every 30 minutes

EXERCISE GUIDE FOR DIABETIC **FIT**NESS

F Frequency
Regular (3x to 4x Per Week)

I Intensity
60-80% Of Maximal Heart Rate

T Time
Aerobic Activity
20-30 Min.
With 5-10 Min.
Warm Up

General Nursing Assessment of Client with Diabetes

- **SUBJECTIVE data: Information & History**
  - Past health history
    - Viral infections, infection, pregnancy, family H/O diabetes
  - Medications
    - Insulin, OAs, corticosteroids, diuretics, phenytoin
  - Recent surgery

See: Lewis_Table 49-12

Nursing Assessment

- **SUBJECTIVE data: Health Patterns**
  - Health perception & management
  - Nutritional
  - Elimination
  - Activity level or fatigue
  - Cognitive perceptual
  - Sexual - reproductive
  - Coping
  - Value-belief

Nursing Assessment

- **OBJECTIVE data**
  - Eyes
  - Skin
  - Respiratory
  - Cardiovascular
  - GI
  - Neurological
  - Musculoskeletal

Nursing Assessment: Lab work

❖**Objective data**

- Serum electrolyte or acid-base abnormalities
- Fasting BG (FBG) level of 126 mg/dL or higher
- A1C > 6.0%
- Oral glucose tolerance test (OGTT) *and/or* Random glucose level > 200 mg/dL
- ↑ Blood urea nitrogen, creatinine
- ↑Triglyceride, cholesterol, LDL, & ↓ HDL
- Urine - + for glucose, ketones or albumin

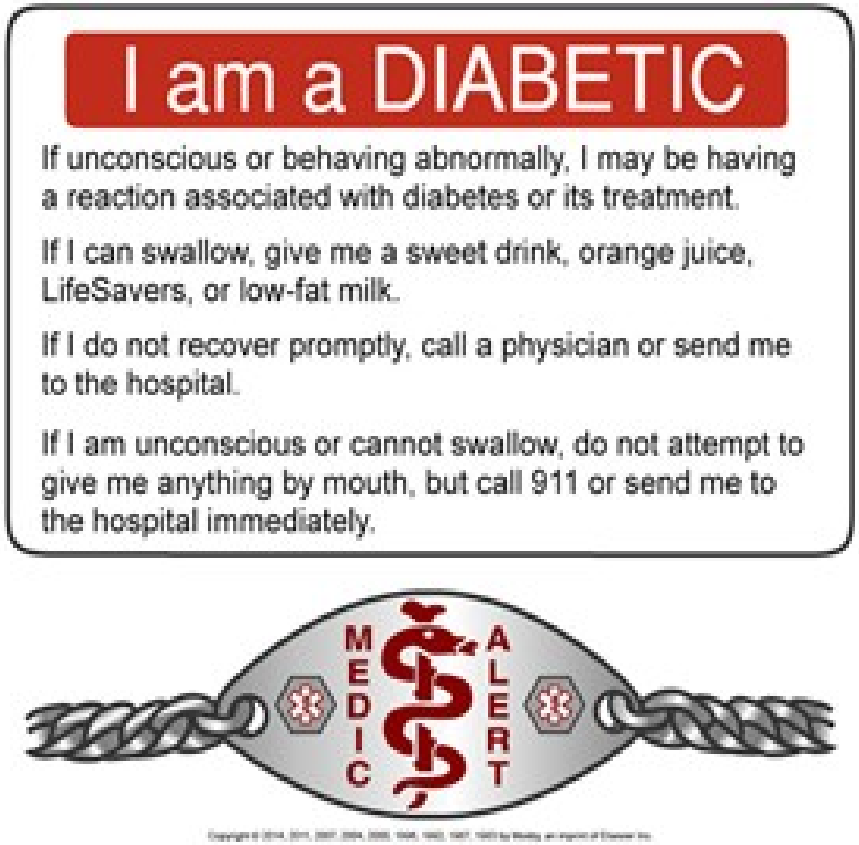
Nurse Planning

❖**Overall goals**

- Active patient participation
- Maintain normal BG levels
- Adjust lifestyle to accommodate diabetes regimen
- Few or no episodes of hypoglycemia or acute hyperglycemic emergencies
- Prevent or minimize chronic complications

Ambulatory & Home Care

Medical Alert



Nursing Implementation

❖**Ambulatory & home care**

- Overall goal patient / caregiver optimal level of independence
- Consult with a dietician
- Use services of certified diabetes educator (CDE)
- Establish individualized goals for teaching
- Include family & caregivers

Nursing Implementation

- **Ambulatory & home care**
  - Assess ability to perform SMBG & insulin injection
    - Utilize assistive devices as needed
  - Assess knowledge & ability to manage diet, medication, & exercise
  - Teach manifestations & how to treat hypoglycemia & hyperglycemia
  - Sick Day Rules

Nursing Implementation

- **Ambulatory & home care**
  - Frequent Oral care
  - Annual exams: eye, lab, feet & other specialties as needed
  - Foot Care
  - Travel needs
    - Medication, supplies, food, activity

Nursing Management: Evaluation

- **Expected outcomes**
  - Knowledge
  - Self-care measures
  - Balanced diet & activity
  - Stable, normal BG levels
  - No injuries

Nursing Care of Special Populations & in Special Situations

Cultural Considerations

- **Cultural perceptions of health may vary**
- **Culture & tradition influence diet & food preparation**
- **Communicate effectively**
  - Literacy, English proficiency, or non-English speakers
  - Appropriate teaching materials
- **Socioeconomic status may effect health care choices**

Gerontologic Considerations

- **Increased prevalence & mortality**
- **Glycemic control challenging**
  - Increased hypoglycemic unawareness
  - Functional limitations
  - Renal insufficiency
- **Diet & exercise: main treatment**
- **Patient teaching must be adapted to needs**

Nursing Implementation in Special Situations

- **Acute illness, injury, & surgery – General Principles**
  - ↑ BG level secondary to counter-regulatory hormones
  - T1DM may ↑ insulin needs
  - T2DM may necessitate insulin therapy
  - Frequent monitoring of BG
    - Urine ketone testing if BG > 240 mg/dL
    - Report BG > 300 mg/dL for two tests *or* moderate to high urine ketone levels

Sick Day Rules

- **Acute illness** "Sick Day Rules"
  - Maintain normal diet if able
  - Increase noncaloric fluids
  - Continue taking antidiabetic medications
  - If normal diet not possible, supplement with CHO-containing fluids while continuing medications

Sick day Rules	Type 1	Type 2
Hydration	8oz. Fluid per hour Every 3rd hour, consume 8oz of a sodium rich choice like bouillon	Same
SMBG	Every 2-4 hours while BG is elevated or until symptoms subside	Same
Ketones	Every 4 hours or until negative	Determined for the individual
Medications Adjustments	Continue as able Adjust insulin doses to correct hyperglycemia Instruct patients to call their healthcare provider for specific instructions	Hold metformin during serious illness
Food & Beverage Selections	Guide patients to consume 150-200g CHO daily in divided doses Switch to soft or liquids as tolerated	Same
Contact healthcare Provider	Vomiting more than once, diarrhea more than 5X or for longer than 6 hrs... BG > 300 X2 Moderate to lg. urine Ketones	Same

Nursing Care in Special Situations

Perioperative care

- Verify orders
- May Hold or reduce insulin dose morning of surgery (NPO)
- During stress such as surgery, BG levels may rise
- IV fluids & insulin
- Frequent monitoring of BG
  - Hyperglycemia leads to loss of fluids & electrolytes

Hospitalization

❖**Factors affecting hyperglycemia**

- Changes in treatment regimen
- Medications (glucocorticoids)
- IV Dextrose
- Overly vigorous treatment of hypoglycemia

Hospitalization

❖**Factors affecting hypoglycemia**

- Overuse of sliding scale
- Lack of dosage changes when dietary intake is changed.
- Overly vigorous treatment of hyperglycemia
- Delayed meal after lispro or aspart insulin

Alterations in Meal Plan

- **If pt. is NPO**
  - insulin dose may need to be held or changed
  - Frequent BG monitoring.
- **If pt. on Clear Liquids:** the CL need to be caloric
- **Enteral Feeding**
  - Monitor BG & give insulin at *regular* intervals
- **Parenteral nutrition**
  - intravenous nutrition solution – may contain insulin

Resources

- Certified Diabetic Educators – inpatient & community
- Local ADA 806-794-0691
- National 1-800-DIABETES
- www.diabetes.org

Persons with diabetes mellitus can live a long and healthy life if they control their diabetes instead of letting the diabetes control them!

THE END !!!!!