The child with polyuria

Dr.Reem Al Khalifah

Head of pediatric endocrinology division

Assistant professor paediatric endocrinology

Health research methodologist

Outline

- Define polyuria
- Differential diagnosis of polyuria
- Able to manage a patient presenting with polyuria

Case

- 2 years old girl previously healthy, presented with frequent urination & drinking water for 2 weeks
- What further history you want to obtain?

What is too much ?

- **1 cup** **1L** **2L** **5L**

Polyuria

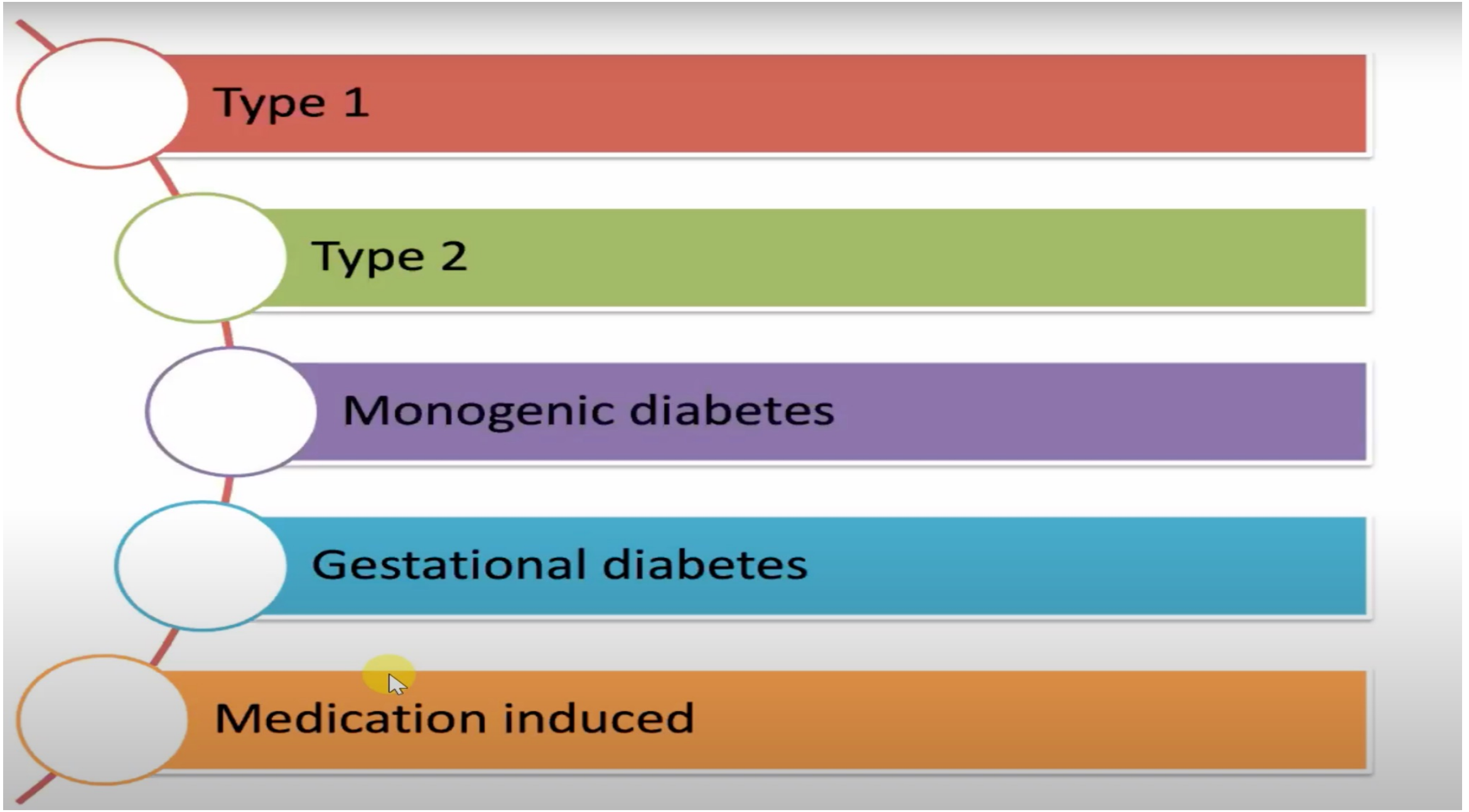
=

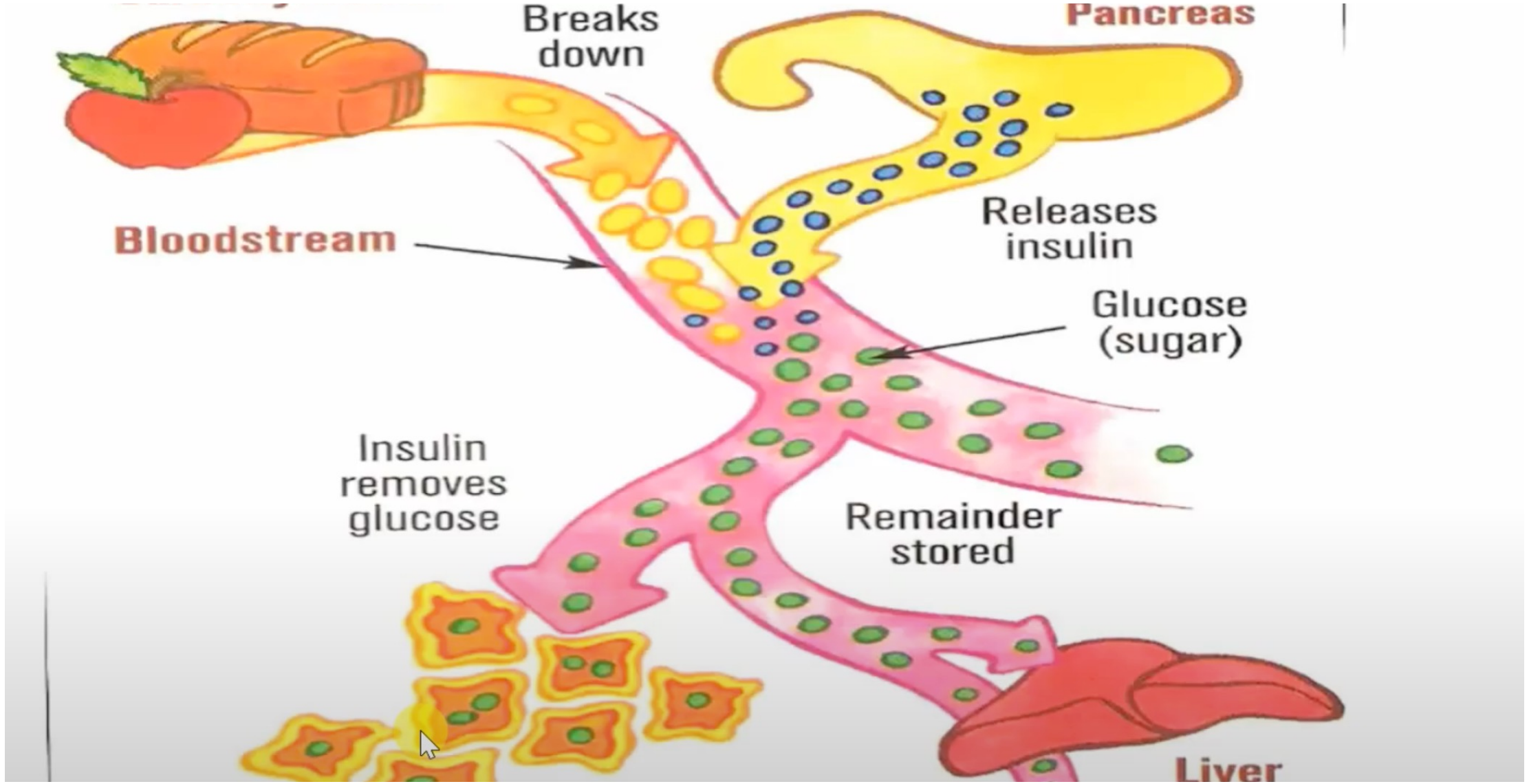
Urine output >2L/m^2/day

What is your differential diagnosis?

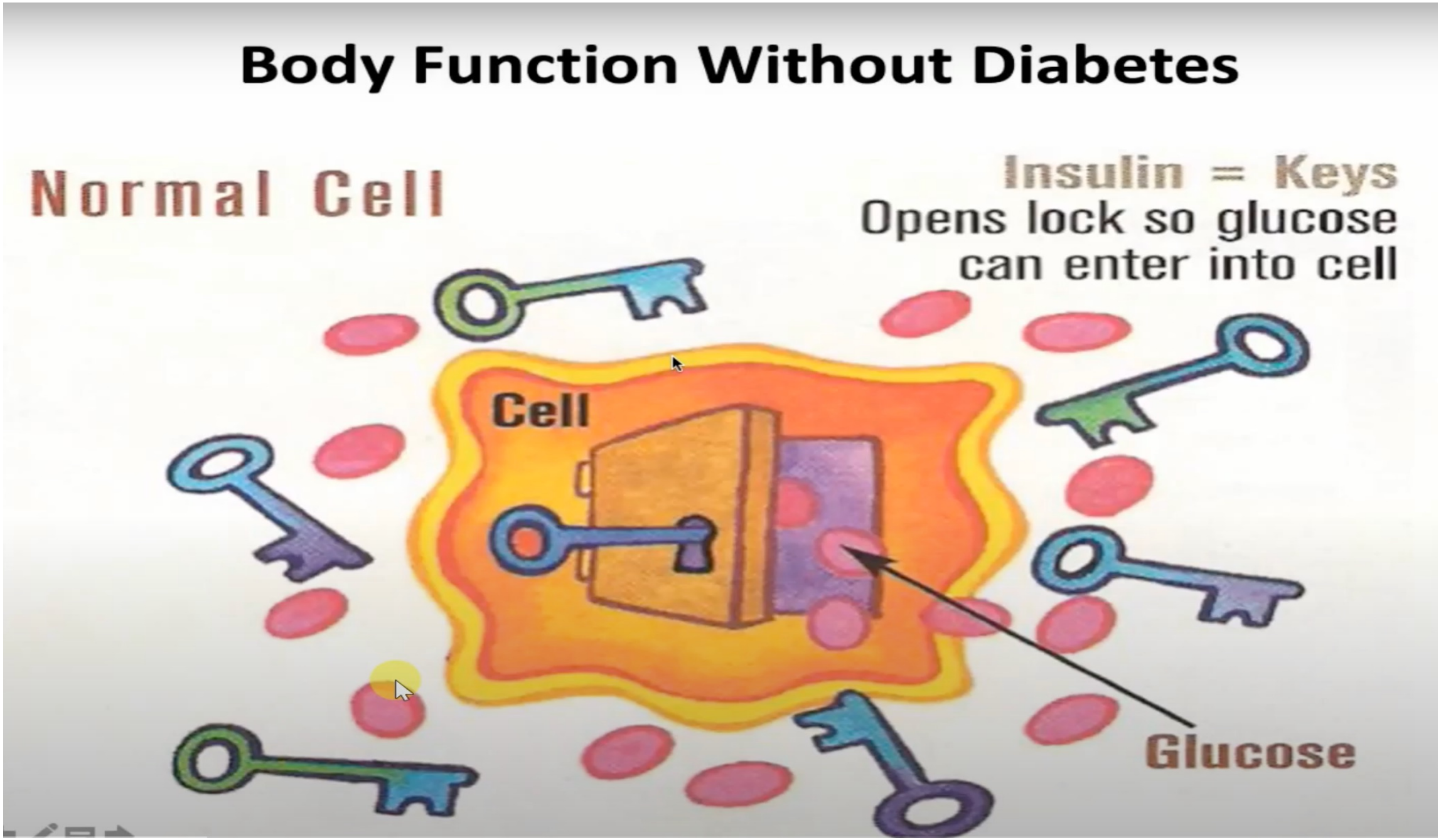
Metabolic	• **Diabetes mellitus** • Hypercalcemia • Hypokalemia
Renal	• Renal tubular acidosis • Barter syndrome • Nephrognic diabetes insipidus
CNS	• **Central diabetes insipidus**
Psychogenic	
Medications	• Diuretics

TYPES OF DIABETES ?

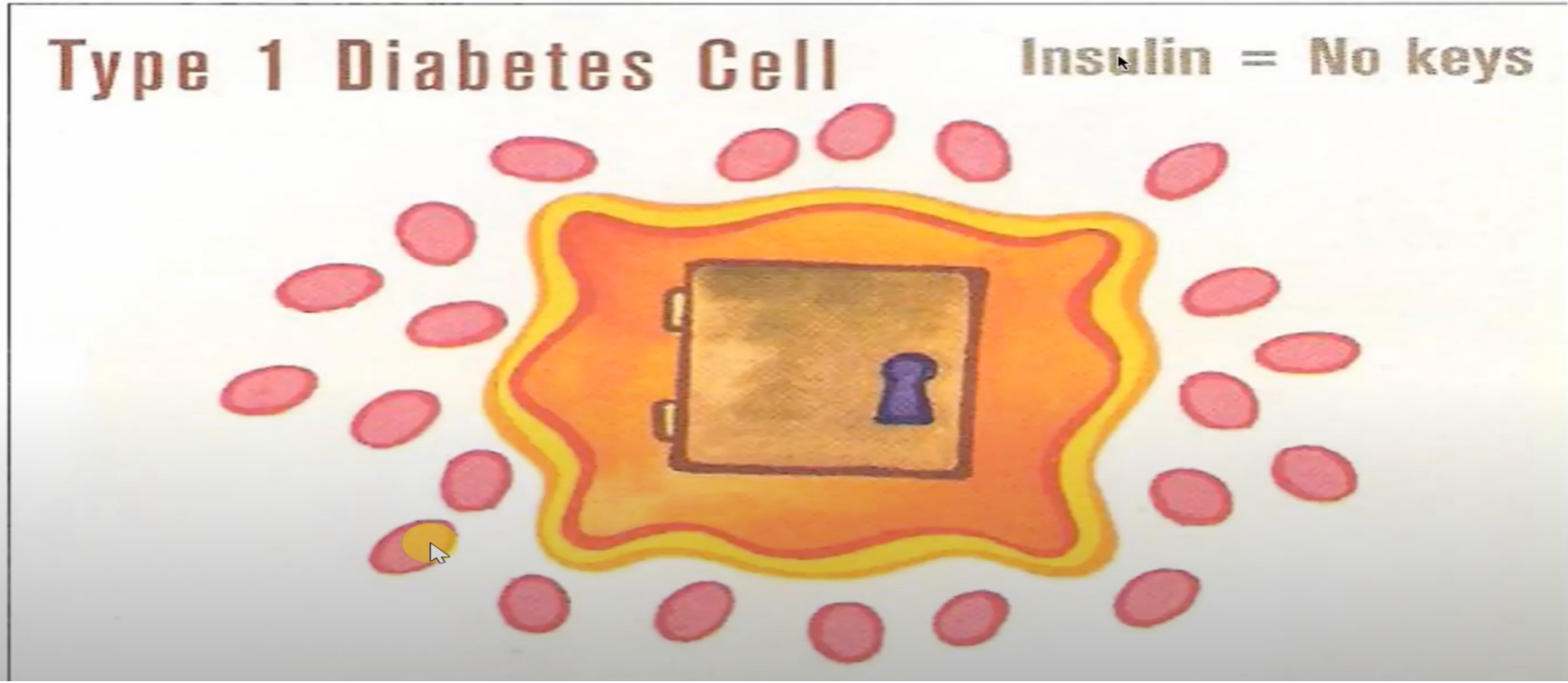

Type 1
Type 2
Monogenic diabetes
Gestational diabetes
Medication induced


Breaks down
Pancreas
Bloodstream
Releases insulin
Glucose (sugar)
Insulin removes glucose
Remainder stored
Liver

Body Function Without Diabetes



Type 1 diabetes



T1DM etiology

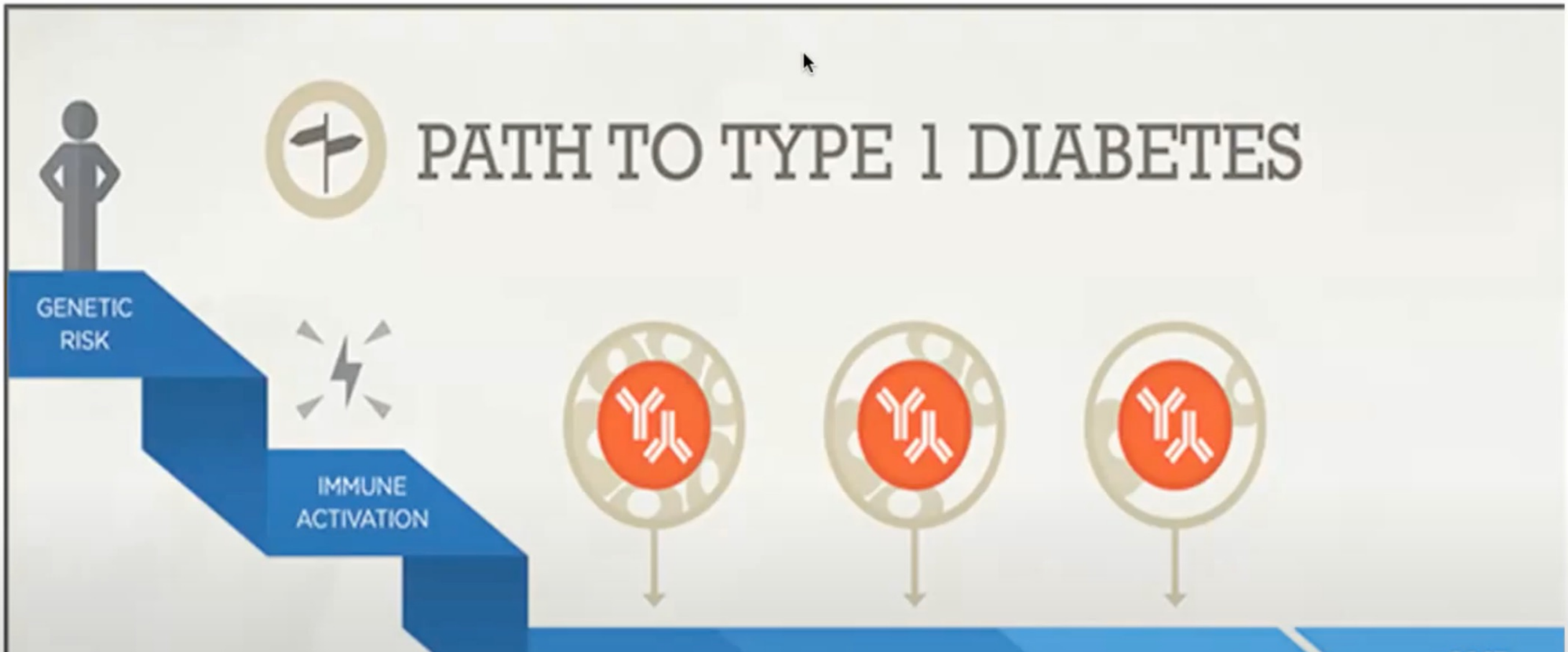
It is not caused by:

X The last weeks- months infection

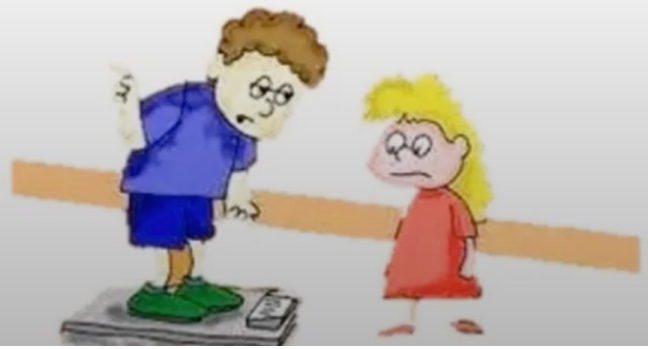
X Emotional stress

X Too much sugar

Stages of T1DM



Symptoms

Polyuria (Frequent Urination) 	Polydipsia (Excessive Thirst) 
Polyphagia (Excessive Hunger/Increased Appetite) 	Involuntary Weight Loss 

Diagnosis

Classic symptoms of diabetes or hyperglycemic crisis, with plasma glucose concentration ≥11.1 mmol/L (200 mg/dL)

Fasting plasma glucose ≥7.0 mmol/L (≥126 mg/dL).

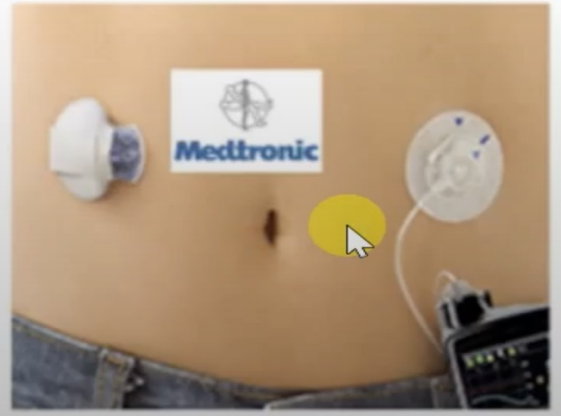
2hr OGTT glucose ≥11.1 mmol/L (≥200 mg/dL)

TREATMENT

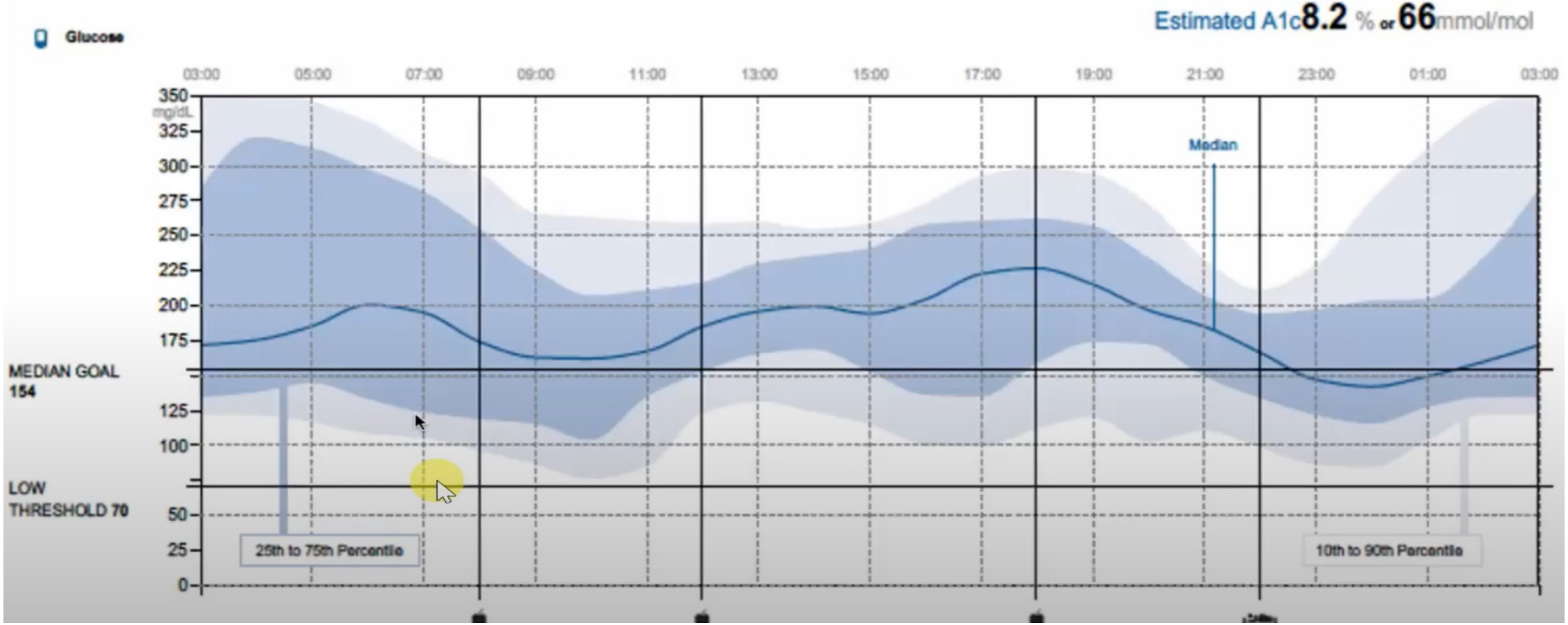
Glucose monitoring

Continuous glucose monitoring

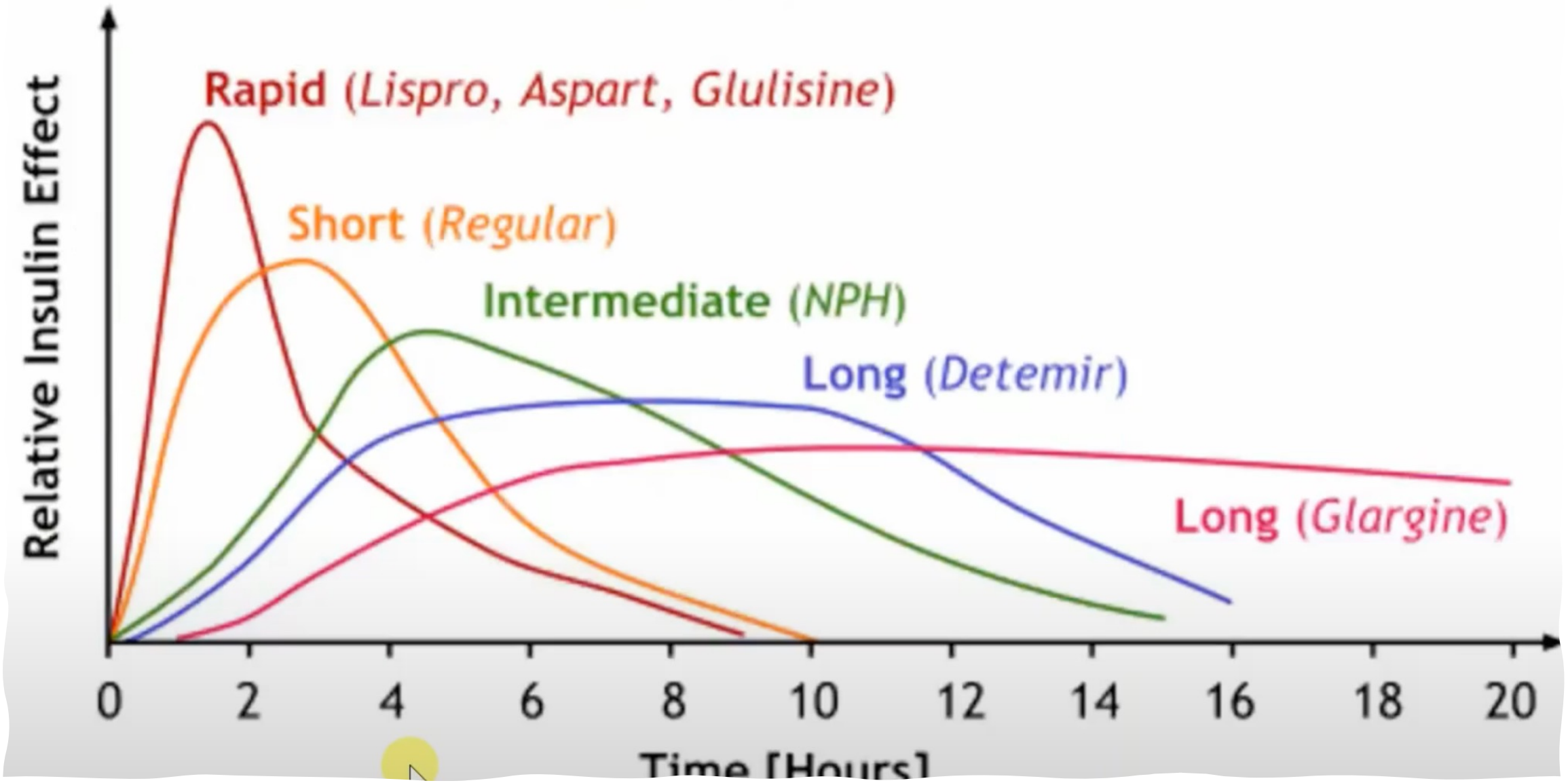
dexcom | G5™ mobile



Continuous glucose monitoring



Insulin type (trade name)	Onset	Peak	Duration
Bolus (prandial) insulins			
Rapid-acting insulin • Aspart (novorapid®) • Glulisine (apidra™) •Lispro (humalog®)	 10 - 15 min 10 - 15 min 10 - 15 min	 1 - 1.5 h 1 - 1.5 h 1 - 2 h	 3 - 5 h 3 - 5 h 3.5 - 4.75 h
Short-acting insulins •Regular (humulin®-r) • Regular (novolin®getoronto)	30 min	2 - 3 h	6.5 h
Basal insulins			
Intermediate-acting insulins • NPH (humulin®-n) •NPH (novolin®ge NPH)	1 - 3 h	5 - 8 h	Up to 18 h
Long-acting basal insulin • Detemir (levemir®) • Glargine (lantus®) •Degludec (Tersiba)	90 min	Not applicable	Up to 24 h (glargine 24 h, detemir 16 - 24 h) Degludec up to 72hr


Relative Insulin Effect
Rapid (Lispro, Aspart, Glulisine)
Short (Regular)
Intermediate (NPH)
Long (Detemir)
Long (Glargine)
0
2
4
6
8
10
12
14
16
18
20
Time [Hours]


Novorapid
Recombinant DNA Origin 3mL
Insulin Aspart
NovoRapid® FlexPen®
100 U/mL
Lantus
Lantus® SoloStar®
insulin glargine (rDNA origin) injection
100 units/mL (U-100) Rx ONLY
Novolog
70/30
NovoLog® Mix 70/30
FlexPen® Prefilled Syringe
Levimer
Levemir® FlexPen®
Humalog
75/25
100 units per mL
Humalog® Mix 75/25™
KwikPen™
75% insulin lispro protamine
Lilly
Degludec
Tresiba®
100
FlexTouch®
units/mL
80

Injection sites

Insulin injection sites:

- Outer arm
- Abdomen
- Hip area
- Thigh

A.D.A.M.

Insulin pump

Sensor for CGM
optional extra

Insulin vial
to fill
reservoir

Reservoir

Insulin Pump

Infusion set
before insertion

Infusion set
after insertion

Diabetes Management 24/7

Constant Juggling:

Insulin/medication

with:

Exercise

&

Food intake

BG

BG

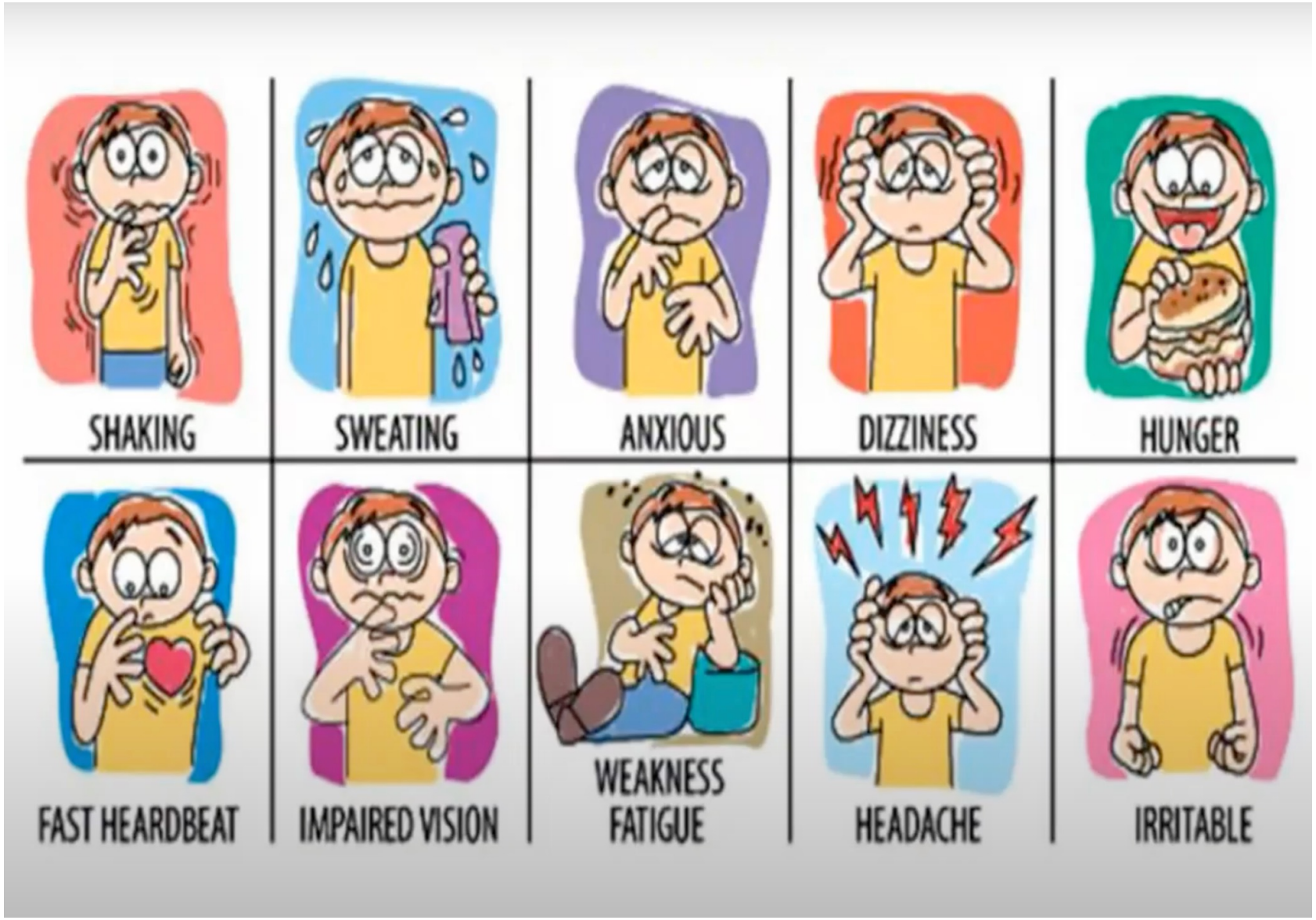
BG

DIABETES COMPLICATIONS

ACUTE

Hypoglycemia

70 mg/dl
4 mmol/l


SHAKING
SWEATING
ANXIOUS
DIZZINESS
HUNGER
FAST HEARDBEAT
IMPAIRED VISION
WEAKNESS
FATIGUE
HEADACHE
IRRITABLE

complications of Hypoglycemia

- Cognitive, psychological changes (eg, confusion, irritability)
- Accidents, Falls
- Low health related quality of life
- hypoglycemia unawareness
- Dementia (elderly)
- CV events: Cardiac autonomic neuropathy, MI, arrhythmia

Treatment of Hypoglycemia

- 1 cup of Juice
- Glucose tablets
- Glucagon s.c

١٢٥ ملل من عصير البرتقال أو التفاح

ملعقة طعام عسل أو مربى

٢ مكعب سكر

٣ حبات تمر

Acute complications

DIABETIC KETOACIDOSIS

DKA

- leading cause of morbidity and mortality in children
- **Risk factors :**
  - new-onset diabetes
  - Children with poor control
  - previous episodes of DKA
  - Adolescent
  - Children on insulin pumps or long-acting insulin analogs
  - Children with psychiatric disorders, and those with difficult family circumstances
  - Poor sick day management

Losses of fluids and electrolytes in diabetic ketoacidosis

	Average (range) losses per kg	
Water	70 mL (30–100)	≤10 kg* 11–20 kg >20 kg
Sodium	6 mmol (5–13)	
Potassium	5 mmol (3–6)	
Chloride	4 mmol (3–9)	
Phosphate	(0.5–2.5) mmol	

Clinical manifestations of DKA

- Dehydration
- Tachypnea; deep, sighing (Kussmaul) respiration
- Nausea, vomiting, and abdominal pain that may mimic an acute abdominal condition
- Confusion, drowsiness, progressive obtundation and loss of consciousness

Diagnosis

Hyperglycemia BG > 11 mmol/L (≈ 200 mg/dL)

Ketonemia and ketonuria

Venous pH< 7.3 or bicarbonate < 15 mmol/L

DKA severity

- Mild: venous pH<7.3 or bicarbonate <15 mmol/L
- Moderate: pH<7.2, bicarbonate <10 mmol/L
- Severe: pH<7.1, bicarbonate <5 mmol/L.

Management

- Airway-breathing-circulation
- If shock ……..> give fluid bolus

Fluid replacement

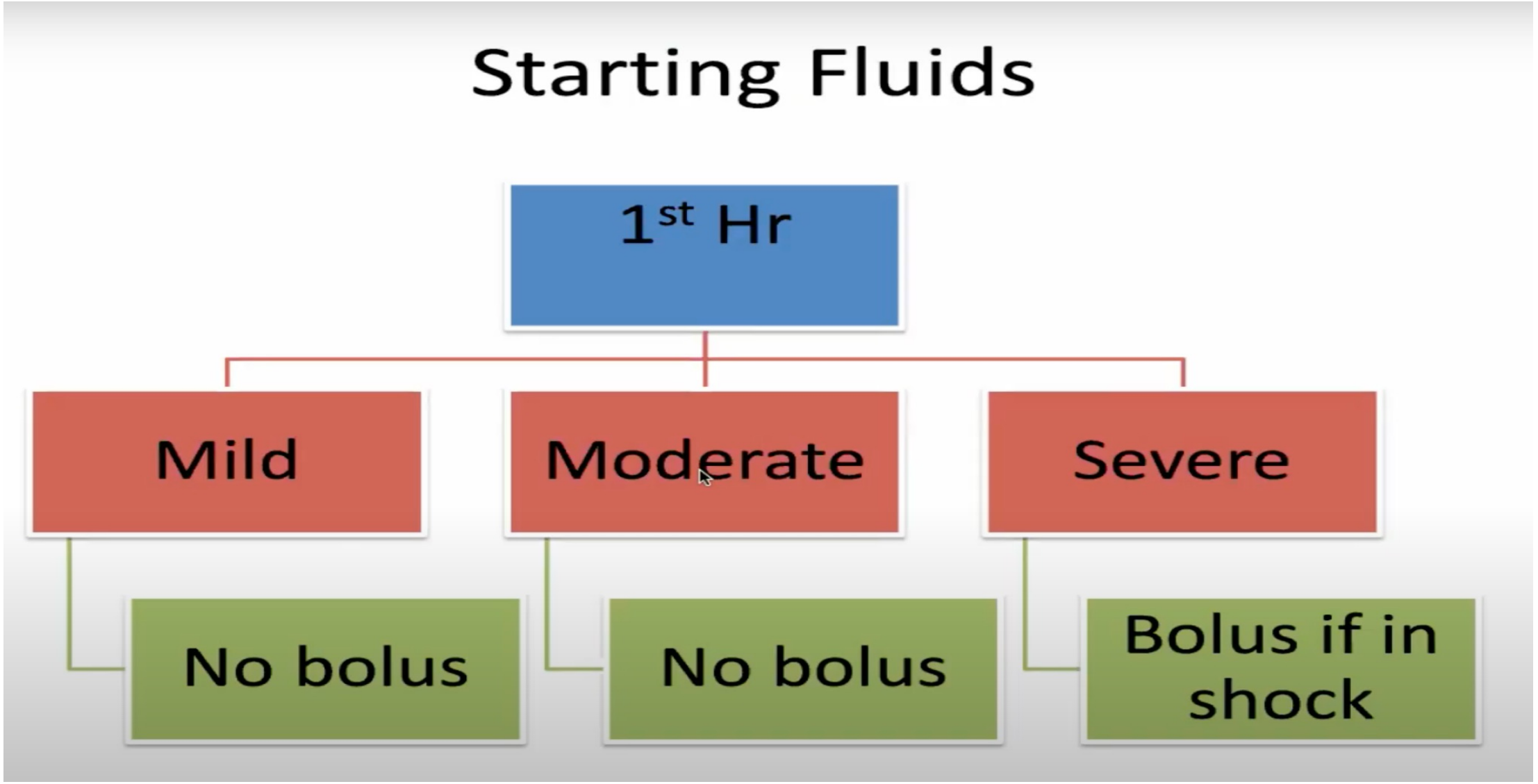
- Deficit + maintenance

DKA severity

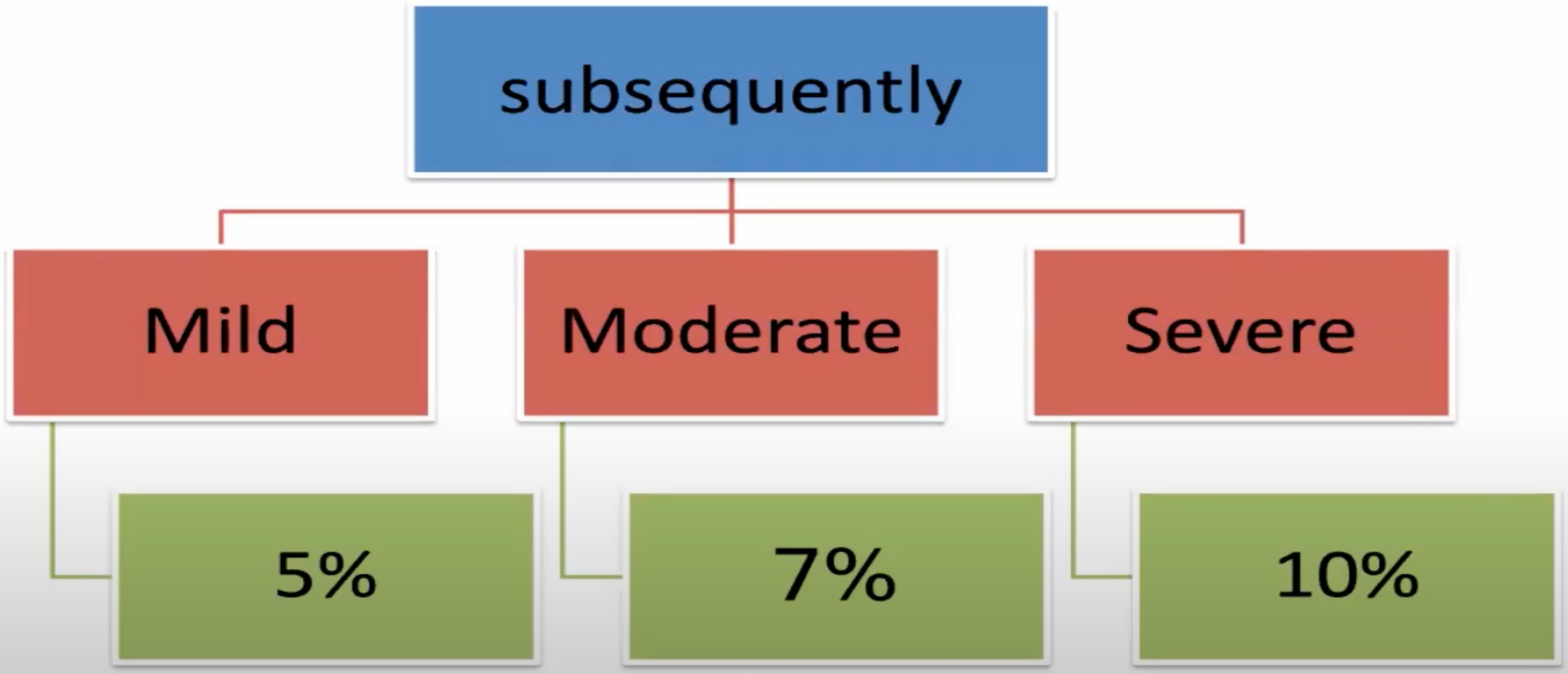
For 24 hr

Deficit: Weight X deficit %(based on DKA severity) X 10

Starting Fluids



Deficit replacement



Type of fluids

NACL	KCl	Glucose
0.9 % NS	40 mmol/l	D 5 W
0.45 % NS	60 mmol/l	D 10 W
		D 12.5 W

Fluid Basics

- Avoid hypervolemia / rapid osmo correction
- No insulin 1^{st} hr
- No insulin bolus
- No $NaHCO_3$
- Replace all electrolyte deficit

Monitoring

- Gas
- Electrolytes
- Glucose
- Renal function
- Urine ketones
- Others

Your turn !

- 10 years old girl, has 2 weeks history of polyuria, polydepsia, vomiting for 1 day.
- Glucose 30 mmol/l
- Urine Ketones +4
- Gas: PH= 7.1, Hco3 =4, Co2 =12
- Weight 30 kg

- **Calculate the required fluids in the first 24hr?**

DKA severity

- Mild: venous pH<7.3 or bicarbonate <15 mmol/L
- Moderate: pH<7.2, bicarbonate <10 mmol/L
- Severe: pH<7.1, bicarbonate <5 mmol/L.

Wt 30kg, severe DKA

- Maintenance= 1680ml/ 24hr

Deficit: Weight X deficit %(based on DKA severity) X 10

- Deficit= 30 X 10 X 10= 3000ml/ 48-72hr
  = 1500 ml/24hr

- Required fluids in the 1st 24hr= 1680+ 1500
  = 3180ml/24hr
  = **132ml/hr**

DKA compilations

- Acute
- Chronic

Risk Factors for Developing Cerebral Edema

- 0.7 to 3.0%
- Younger age (<5 years)
- New-onset diabetes
- High initial serum urea
- Low initial partial pressure or arterial carbon dioxide (pCO_2)
- Rapid administration of hypotonic fluids
- IV bolus of insulin
- Early IV insulin infusion (within 1st hour of fluids)
- Failure of serum sodium to rise during treatment
- Use of bicarbonate

Signs and symptoms of cerebral edema

- Headache and slowing of heart rate
- Change in neurological status (restlessness,
- irritability, increased drowsiness, and incontinence)
- Specific neurological signs (e.g., cranial nerve palsies, papilledema)
- Rising blood pressure
- Decreased O2 saturation

Diagnostic criterion:

- 1 Diagnostic criteria
- **or**
- 2 major criteria
- **or**
- 1 major and 2 minor criteria
- Signs that occur before treatment should not be considered in the diagnosis of cerebral edema.

Diagnostic Criteria

- Abnormal motor or verbal response to pain
- Decorticate or decerebrate posture
- Cranial nerve palsy (especially III, IV, and VI)
- Abnormal neurogenic respiratory pattern (e.g., grunting, tachypnea, Cheyne–Stokes respiration, apnea)

2 major criteria

or

1 major + 2 minor criteria

- **Major Criteria**
  - Altered mentation/fluctuating level of consciousness
  - Sustained heart rate deceleration (decrease more than 20 beats/min) not attributable to improved intravascular volume or sleep state
  - Age-inappropriate incontinence
- **Minor criteria**
  - Vomiting
  - Headache
  - Lethargy or not easily arousable
  - Diastolic blood pressure >90mmHg
  - Age < 5 years

Diagnostic Criteria

- Abnormal motor or verbal response to pain
- Decorticate or decerebrate posture
- Cranial nerve palsy (especially III, IV, and VI)
- Abnormal neurogenic respiratory pattern (e.g., grunting, tachypnea, Cheyne–Stokes respiration, apnea)

Treatment

- Initiate treatment as soon as the condition is suspected.
- Reduce the rate of fluid administration by one-third.
- Give mannitol, 0.5–1 g/kg IV over 10–15 min, and repeat if there is no initial response in 30 min to 2 h.
- Hypertonic saline (3%), suggested dose 2.5–5 mL/kg over 10–15 min
- Move patient to PICU.
- Elevate the head of the bed to 30◦.

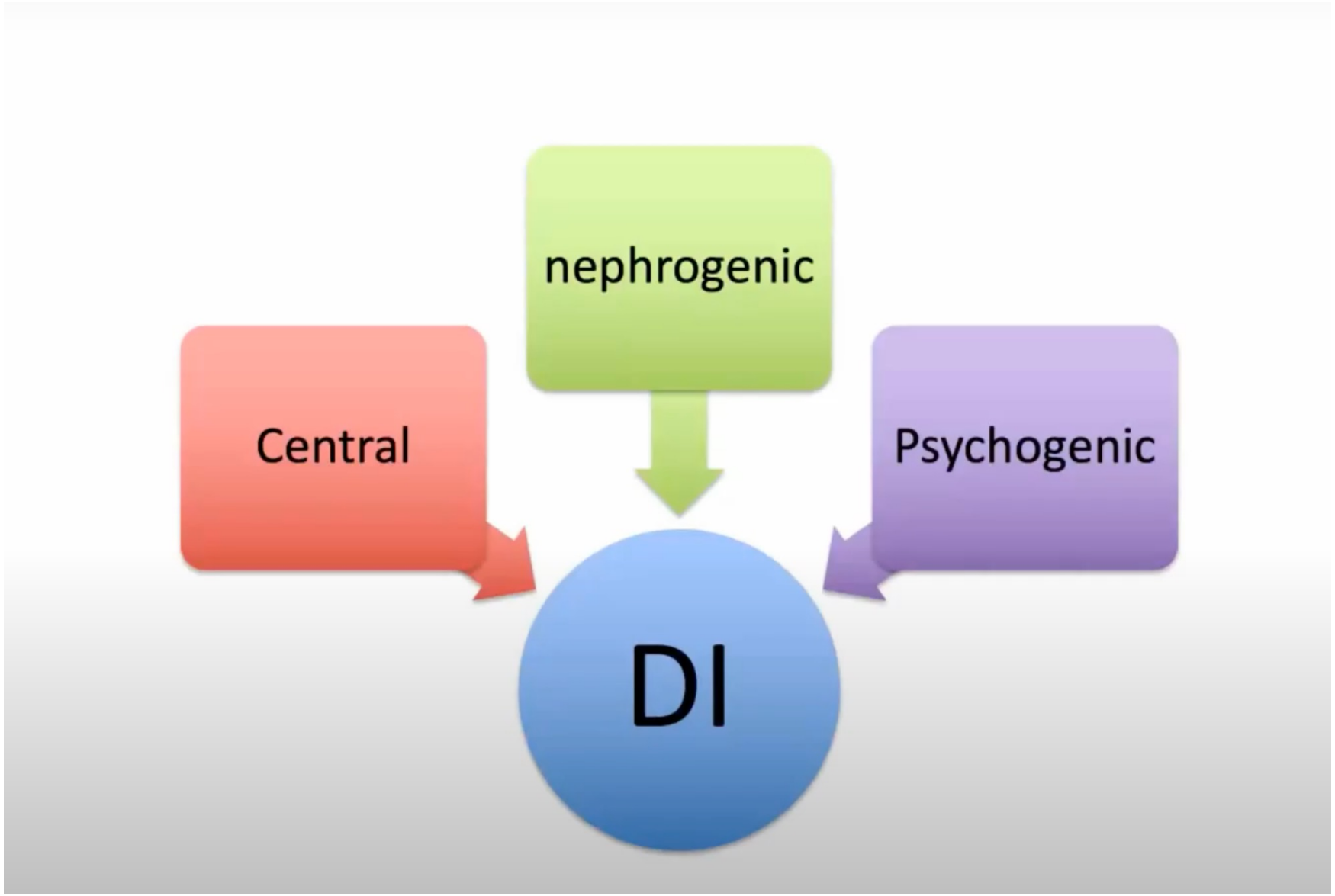
DIABETES CHRONIC COMPLICATIONS

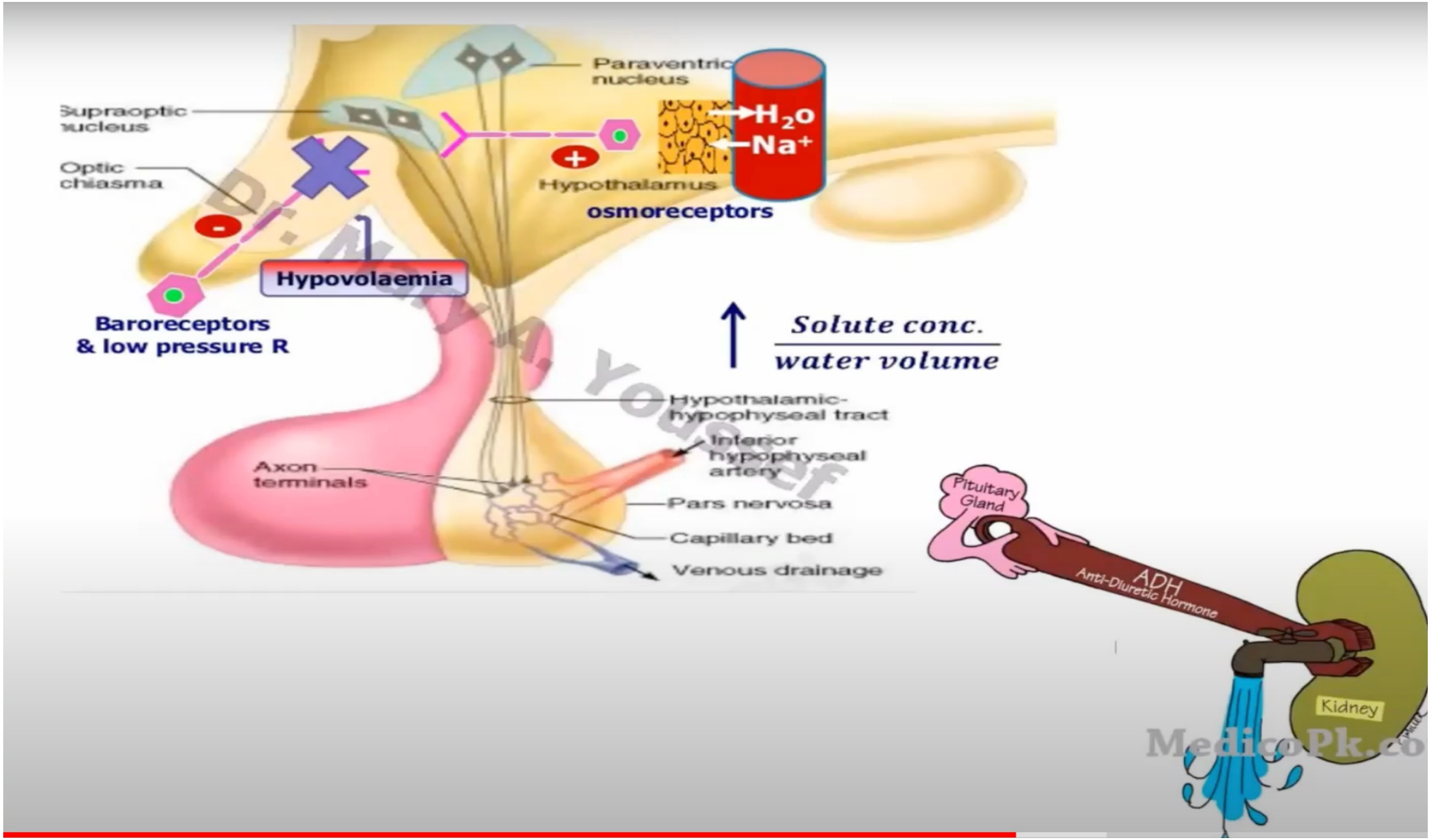
Diabetes Complications – Key Messages

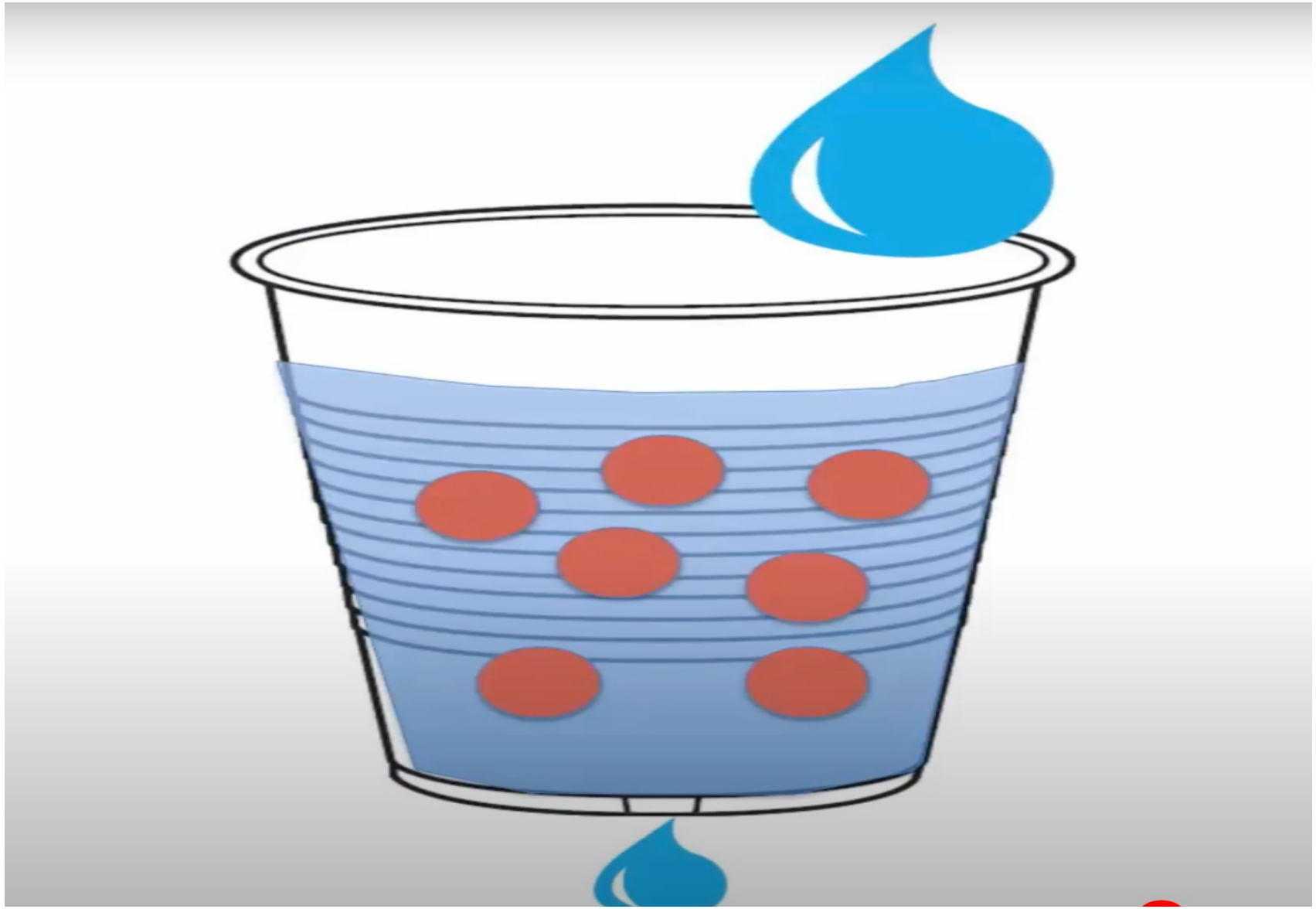
- Nephropathy, retinopathy, neuropathy and hypertension are relatively rare in pediatric diabetes

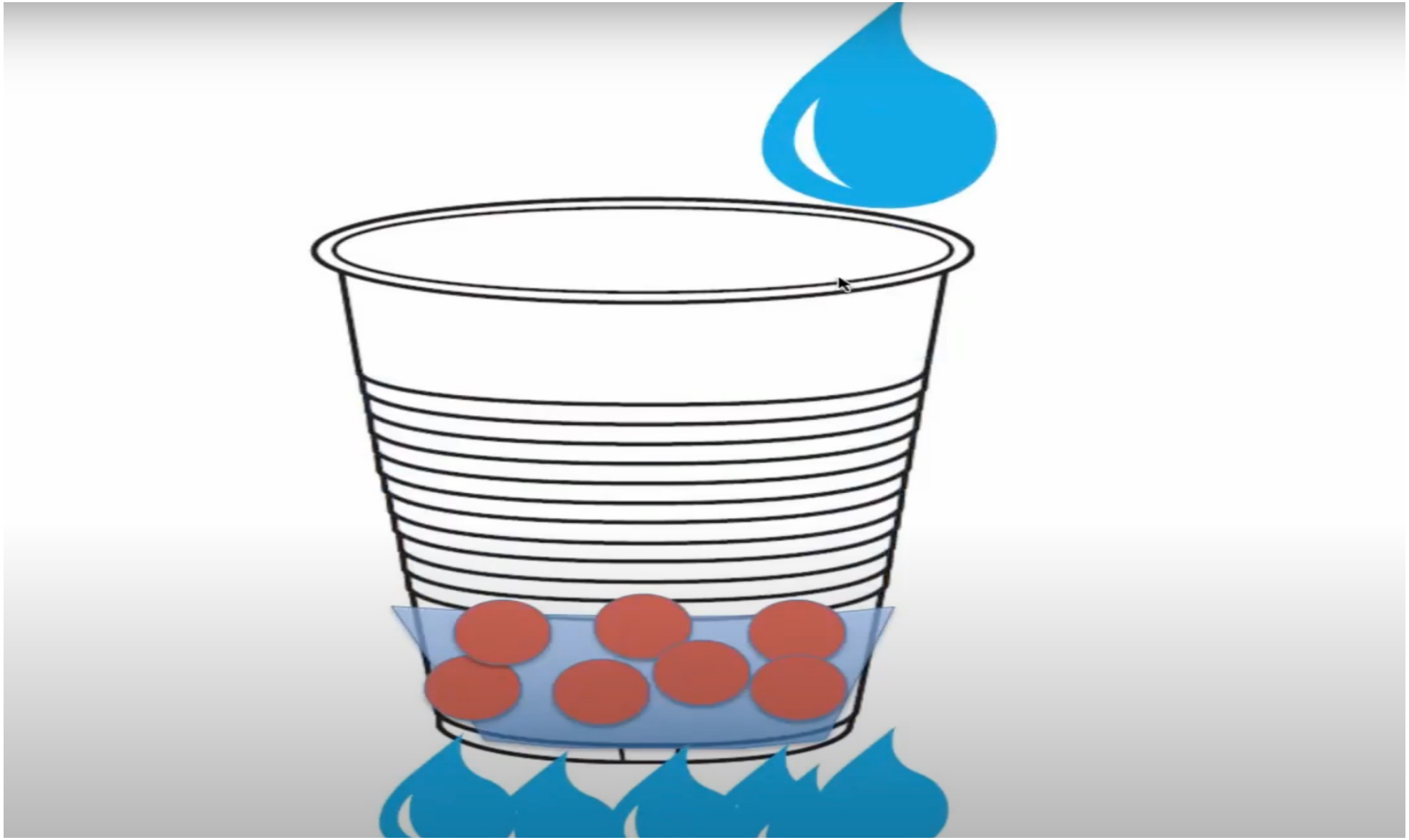
- Start Screening after pubertal and 5 years of DM duration.

Diabetes insipidus


nephrogenic
Central
Psychogenic
DI


Paraventricular nucleus
Supraoptic nucleus
Optic chiasma
H_2O
Na^+
Hypothalamus
osmoreceptors
Hypovolaemia
Baroreceptors & low pressure R
Solute conc. / water volume
Hypothalamic-hypophyseal tract
Inferior hypophyseal artery
Axon terminals
Pars nervosa
Capillary bed
Venous drainage
Pituitary Gland
ADH
Anti-Diuretic Hormone
Kidney
Dr. Mohamed Yousef
MedicoPk.co





Symptoms

- Polyuria
- Polydipsia
- Dehydration
- Irritability
- Growth failure
- Hyperthermia
- Weight loss

Investigations

- ↑ Na
- ↑ serum osmolality
- ↓ Urine osmolality
- ↓ Urine Na
- ↓ Urine Specific gravity

Water deprivation test 8-10hr

- Q1hr:
  - serum Na
  - serum osmolality
  - Urine osmolality
  - Urine Na
  - Urine Specific gravity
  - Weight
  - +/- desmopressin injection

Causes

Congenital	• Agenesis of the pituitary • Septo-optic dysplasia
Tumor	• Craniopharyngioma • Histocytosis
Iatrogenic	• Surgical removal • Radiation
Infectious	• Meningitis

Treatment

- Desmopressin
- Free water access

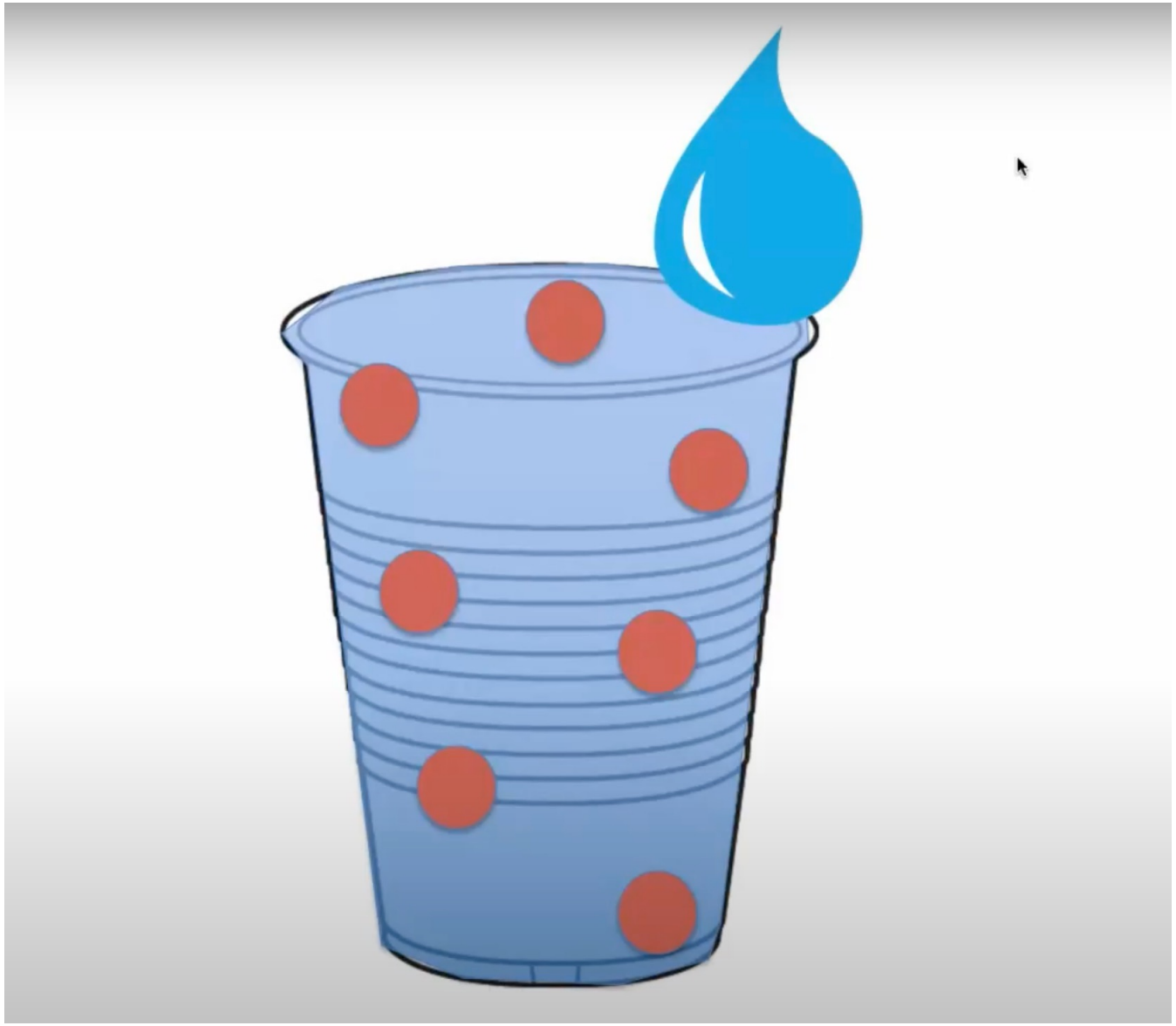
Fluid replacement

- Deficit + maintenance + ongoing

Water deficit	For 24 hr	Urine output

Deficit: $0.6 \times \text{weight} \times \frac{(\text{actual Na} - \text{target Na})}{\text{target Na}}$

SYNDROME OF INAPPROPRIATE ANTIDIURETIC HORMONE



Symptoms

- Anorexia
- Nausea
- Muscle cramps
- Weakness
- Confusion
- Seizure
- Coma

Causes

Tumor	• Small cell Lung ca
Iatrogenic	• Postoperative fluid load • Postoperative pituitary stalk injury
Infectious	• Meningitis • GBS
Medications	• Anti seizure • Chemotherapy • Lithium

Investigations

- ↓ Na
- ↓ serum osmolality
- ↑ Urine osmolality
- ↑ Urine Na
- ↑ Urine Specific gravity

Treatment

- Free Water restriction

weight =20
Na=120
water excess: -1.7 L
Na= 155
water deficit: 1.28 L

Fluid management

- Deficit + maintenance + ongoing

Fluid excess

For 24 hr

Urine output

Deficit: 0.6X weight X $\frac{\text{(actual Na-target Na)}}{\text{target Na}}$

Case

- A 3-year old boy polyuria/polydipsia since age 10 months
- He drinks about 2.5 to 3 litres of fluid per day
- He gets up twice at night to drink, mother changes dippers 12 times daily

- What is the most likely test to confirm your diagnosis?
  - Serum Glucose
  - Serum Na
  - Blood gas
  - Urine culture


I wish you all the best!
Good health, joy and prosperity