

DIABETIC KETOACIDOSIS (DKA)

State of **Absolute** or **Relative** Insulin Deficiency

Characterized by **Hyperglycemia** & **Ketoacidosis** leading to Dehydration & Other Metabolic Abnormalities

- **Common with Type-1DM**

- First Presentation
- Intercurrent illness
- Self management errors

- Rarely, also in Type-2 Diabetes

- Infection
- Trauma
- Surgery

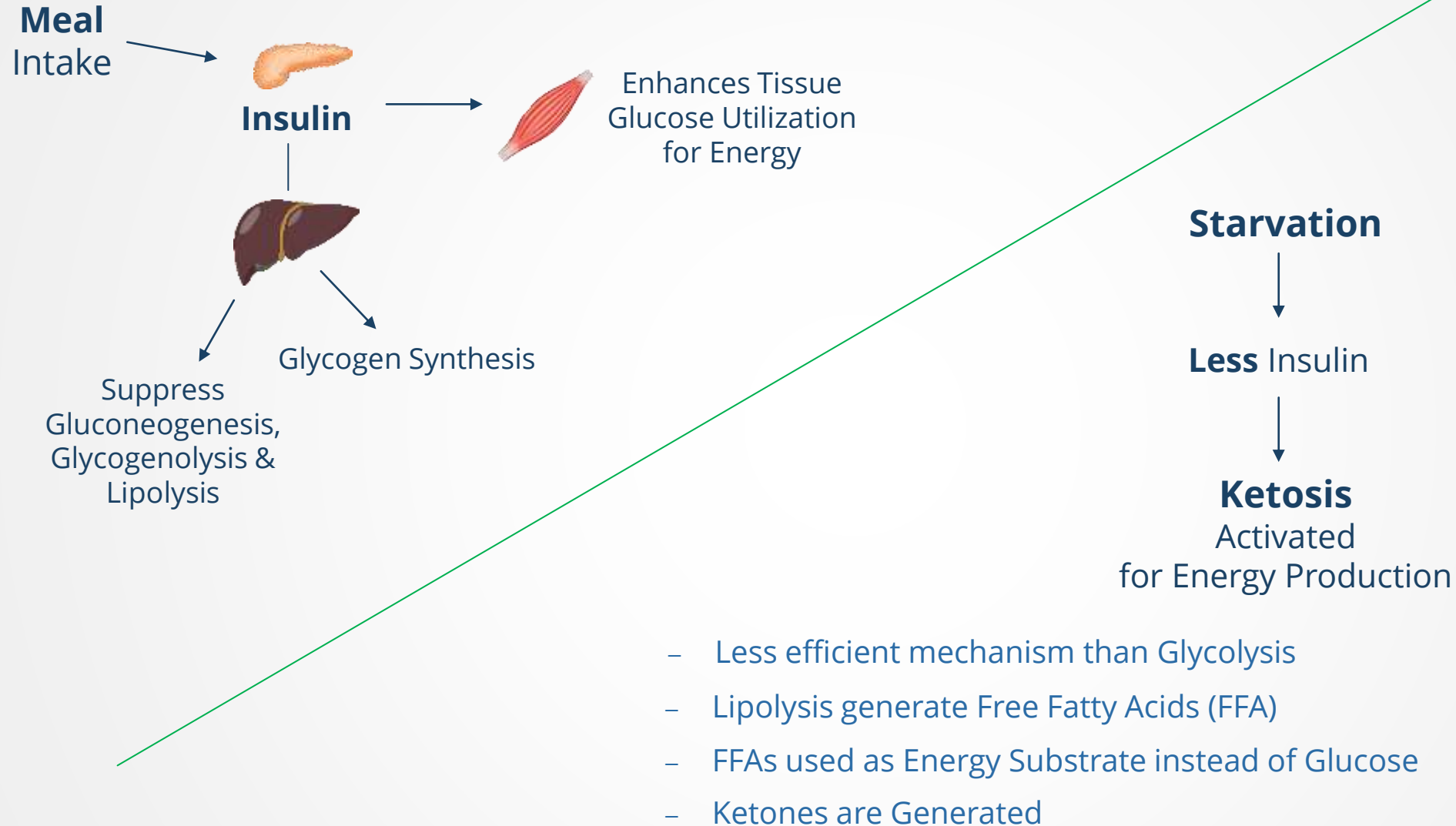
- Serious cause of **Morbidity** in Type 1 DM

- Causes of **Mortality**:

- Children & Adolescents:
 - Cerebral Oedema
- Adults:
 - Hypokalemia
 - ARDS
 - Comorbid – Acute MI, Sepsis, Pneumonia

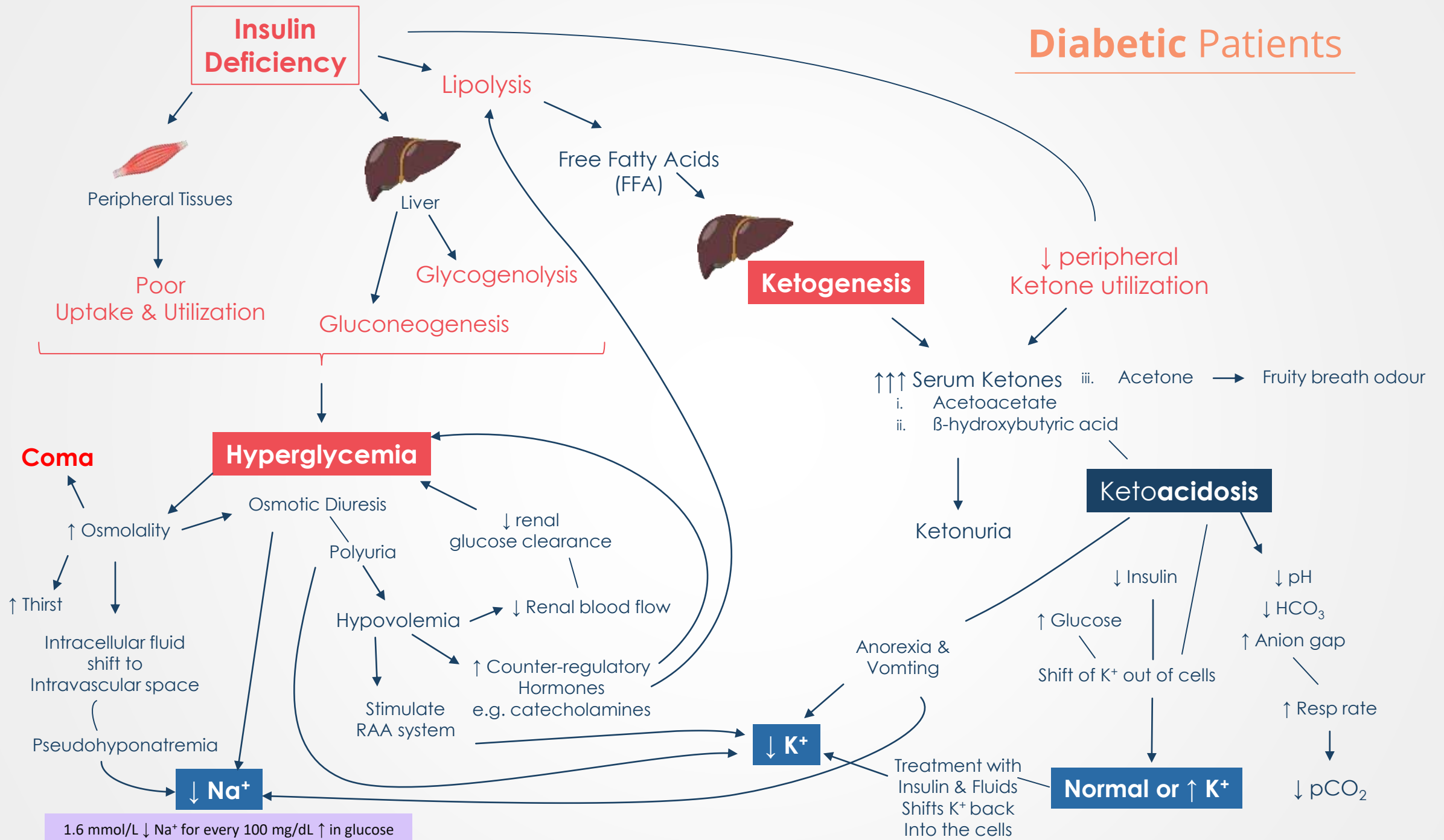
Pathophysiology

Normal Individuals



Residual insulin *prevent* excessive Lipolysis & Ketogenesis
& Allow Peripheral ketone use

Diabetic Patients



Clinical Features & Diagnosis

Clinical Features

Symptoms

- Vomiting
- Lethargy/weakness
- Abdominal pain
- Polyuria
- Polydipsia
- Anorexia
- Nausea/Vomiting
- Coma

Signs

- Ketone breath
- Dehydration
- Acidotic breathing (Kussmaul)
- Coma

Triggering Factor

- Intercurrent Infection
- Surgery
- Acute Myocardial infarction
- Pancreatitis
- Chemotherapy
- Antipsychotics
- Wrong Insulin dose
- Non-compliance

Diagnostic Criteria

1. **Hyperglycaemia** - Blood glucose ≥ 200 mg/dL (≥ 11 mmol/L)
2. **Metabolic acidosis** - venous pH < 7.3 , venous bicarbonate < 15 mmol/L
3. **Hyperketonaemia** - (≥ 3.0 mmol/L) *or* **Ketonuria** ($> 2+$ on standard urine sticks)

Investigations

- Blood

- Glucose
- Ketones
- pH
- HCO_3
- Osmolality
- Urea & Electrolytes
- Complete blood counts (CBC)

Use venous blood and do ABGs only if hypoxia or reduced GCS

- ECG

- Exclude MI
- Electrolyte abnormalities changes

- Chest X-ray

- ARDS
- Pneumonia

- Urine: Dipstick and MSU

- Blood & Urine culture

Diagnostic Criteria

1. **Hyperglycaemia** - Blood glucose ≥ 200 mg/dL (≥ 11 mmol/L)
2. **Metabolic acidosis** - venous pH < 7.3 , venous bicarbonate < 15 mmol/L
3. **Hyperketonaemia** - (≥ 3.0 mmol/L) *or* **Ketonuria** ($> 2+$ on standard urine sticks)

Severe DKA

1 or more of the following

- Blood ketones > 6 mmol/L
- Venous bicarbonate < 5 mmol/L
- Venous/Arterial pH < 7.0
- K < 3.5 mmol/L
- GCS < 12
- O2 sats $< 92\%$ on room air
- Systolic BP < 90 mmHg
- Pulse > 100 or < 60 bpm
- Anion Gap > 16

Management

Management

- Manage in HDU or ICU
- Regular clinical and biochemical review (particularly during the first 24 hours)

Fluid Replacement

- Rapid fluid replacement in adults
- Caution in elderly & children
- Typical Fluid Deficit \approx 100ml/kg
- Fluid of choice – 0.9% Saline
- If $\text{Na}^+ > 155 \text{ mmol/L}$ – Give 0.45% Saline

- Blood glucose $< 250 \text{ mg/dl}$ - Add 10% Dextrose
- Continue 0.9 % saline to replace Intravascular volume
- Then, 1 L in 4 hours
- Then, 1 L in 4 hours
- Then, 1 L in 8 hours

Insulin Therapy

- **IV** Insulin infusion – 0.1 U/ Kg/ hour , *or*
- If IV not feasible – **IM** soluble insulin
 - Loading dose of 10–20 U, followed by 5 U hourly
- Hourly **SC** Rapid-acting Insulin
 - Initially 0.3 U / kg , then 0.1 U/kg hourly

- Blood glucose $< 250 \text{ mg/dl}$ – Add 10% dextrose infusion but **do not stop insulin**
- Continue **Long-acting Insulin** to maintain basal insulin levels
- Resume SC usual insulin, when patient biochemically stable and eating well

Potassium Replacement

- Both hypo- & hyperkalemia can occur
- Do not give KCl in first bag of IV fluid
- K^+ enters cells with R, so add K^+ to the next Liter of IV fluid

- $\text{K}^+ > 5.5$ – No KCl
- If $\text{K}^+ 3.5\text{--}5.5$ - 40mmol KCl per litre of IV fluid
- If < 3.5 - Review K^+ replacement & seek ICU team advice

- Target $\text{K}^+ 4.0\text{--}5.5 \text{ mmol/L}$
- Cardiac rhythm monitoring

Management

- Manage in HDU or ICU
- Regular clinical and biochemical review (particularly during the first 24 hours)

Fluid Replacement

- Rapid fluid replacement in adults
- Caution in elderly & children
- Typical Fluid Deficit \approx 100ml/kg
- Fluid of choice – 0.9% Saline
- If $\text{Na}^+ > 155$ mmol/L – Give 0.45% Saline

Insulin Therapy

- **IV** Insulin infusion – 0.1 U/ Kg/ hour, *or*
- If IV not feasible – **IM** soluble insulin
 - Loading dose of 10–20 U, followed by 5 U hourly
- Hourly **SC** Rapid-acting Insulin
 - Initially 0.3 U / kg, then 0.1 U/kg hourly

Potassium Replacement

- Both hypo- & hyperkalemia can occur
- Do not give KCl in first bag of IV fluid
- K^+ enters cells with R , so add K^+ to the next Liter of IV fluid

HCO_3 Replacement

- Insulin & fluids resolve acidosis
- Not recommended due to risk of Cerebral oedema

Phosphate

- **No benefit** of Phosphate replacement
- Indicated if Low phosphate along with respiratory/muscles weakness

Ongoing Treatment

- Review & Treat precipitating factors
- Review glycemc control & insulin technique
- Educate about treatment and DKA symptoms

Complications

- Cerebral oedema
- Aspiration pneumonia
- ↓ K^+
- ↓ Mg^{2+}
- ↓ PO_4^{3-}
- Thromboembolism

Prevention of DKA

- Evaluate Compliance
- Educate about Insulin dose & administration
- Educate about triggers

Like

Share

Subscribe

Last Second **Medicine**

State of Absolute *or* Relative Insulin deficiency

Characterized by **Hyperglycemia** & **Ketoacidosis** leading to dehydration and other metabolic abnormalities

- Common with Type-1 DM

- First Presentation
- Intercurrent illness
- Self management errors

- Type-2 Diabetes

- Infection
- Trauma
- Surgery

- Serious cause of **Morbidity** in Type 1 DM

- Causes of **Mortality**:

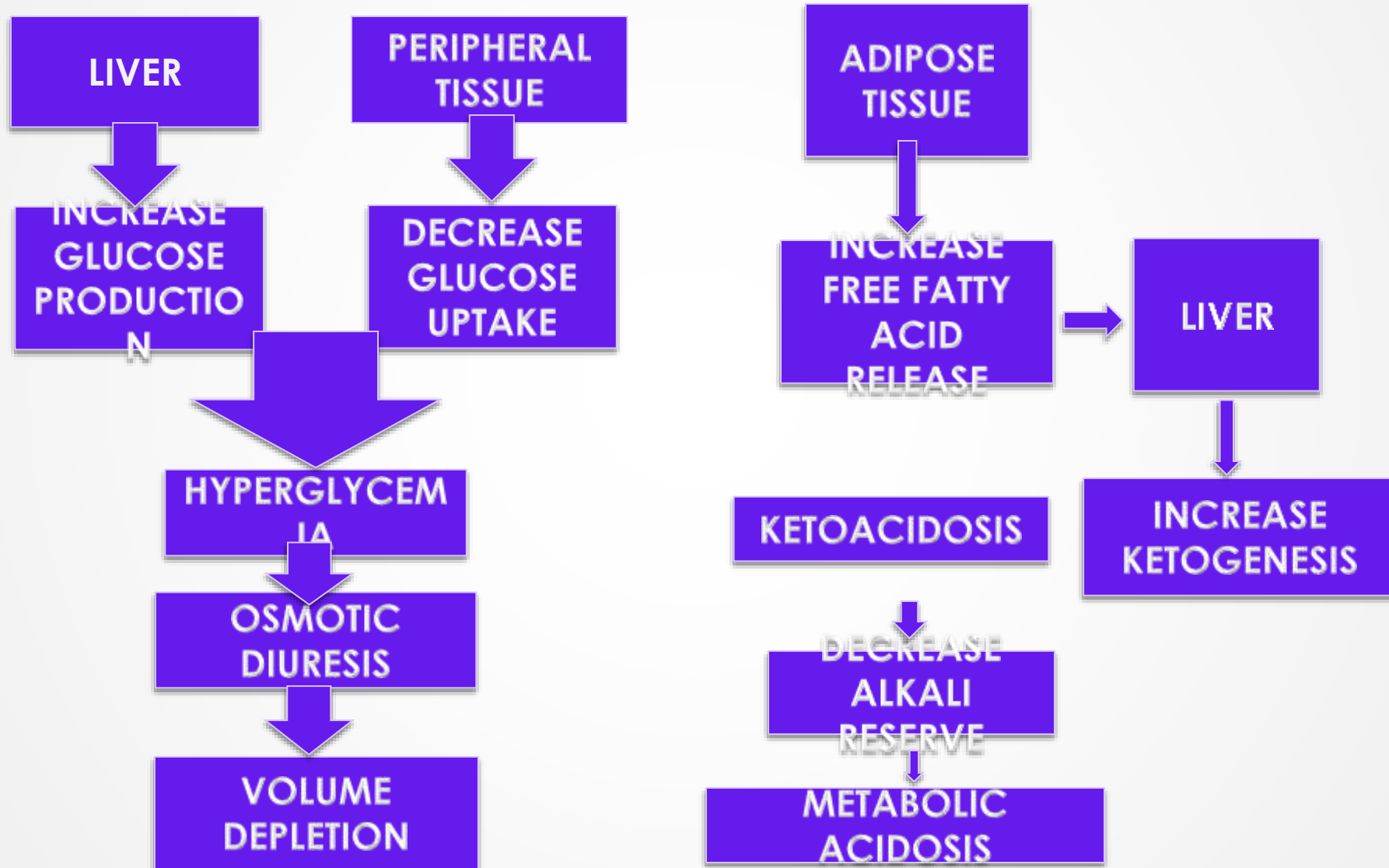
- Children & Adolescents: DM

- Cerebral Oedema

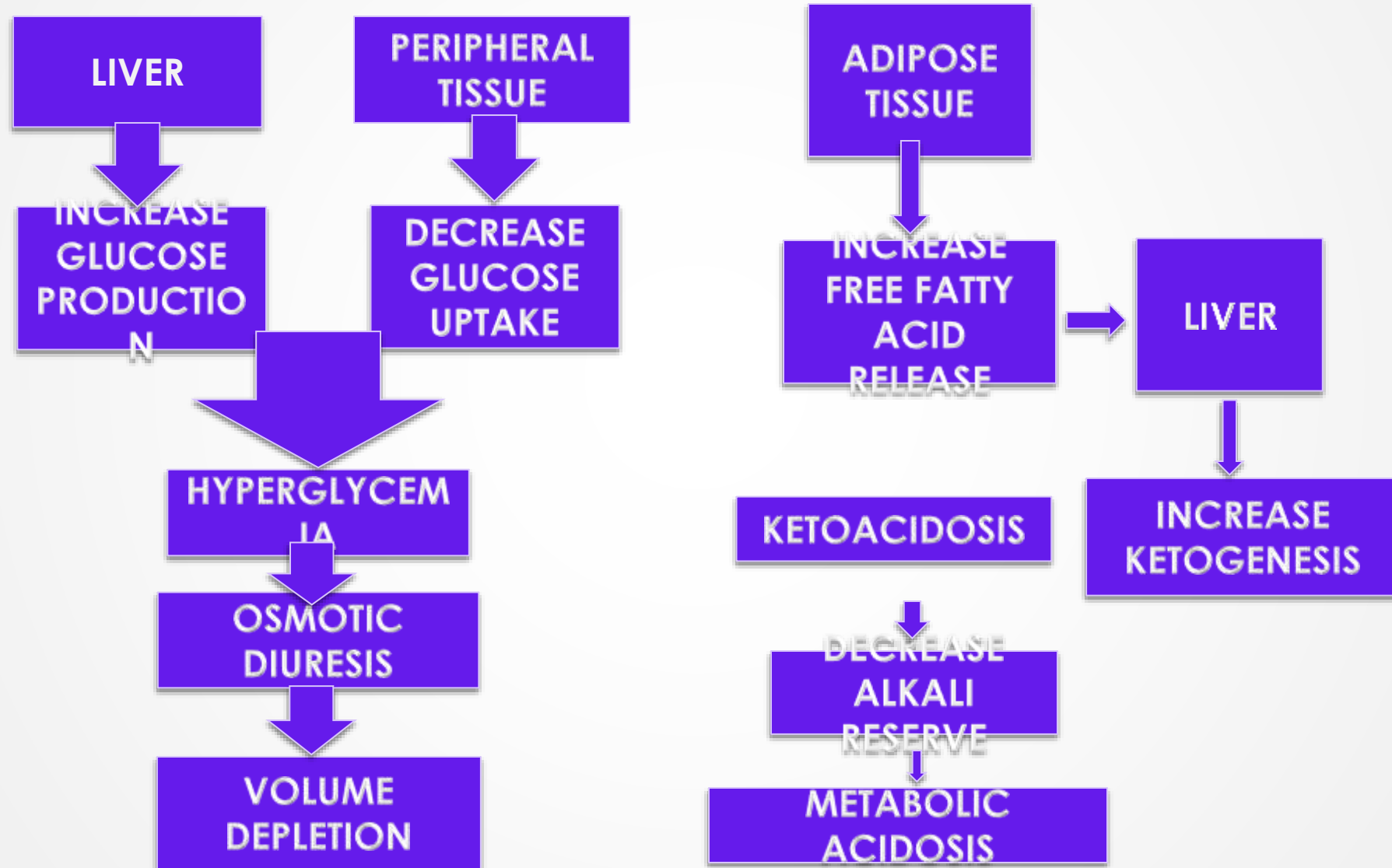
- Adults:

- Hypokalemia
- ARDS
- Comorbidities – Acute MI, Sepsis, Pneumonia

Pathophysiology



Pathophysiology



Triggering Factors

- ▶ Infection
- ▶ Myocardial infarction
- ▶ Non compliance with insulin
- ▶ Pancreatitis
- ▶ Medications (Corticosteroids)
- ▶ Intoxication (Alcohol)

Diagnosis

American Diabetic Association diagnostic criteria for DKA is as follows:

1. Blood glucose > 13.8 mmol/l
2. pH < 7.30
3. Serum bicarbonate < 18 mmol/l
4. Anion gap > 10
5. Ketonemia > 3 mmol/l

Severe DKA

- Blood ketones > 6 mmol/l
- Bicarbonate < 5 mmol/l
- pH < 7.1
- K⁺ < 3.5 mmol/l on admission
- GCS < 12
- Spo2 < 92% without respiratory disease
- Systolic BP < 90 mmHg
- Pulse < 60 or > 100/min
- Anion gap > 16

Management

- ▶ Secure patient's ABC
- ▶ Mental status evaluation
- ▶ Cardiovascular and renal status
- ▶ Source of infection
- ▶ Evaluation of volume hydration status

Management

- Immediate determination of blood glucose levels, serum ketones and urinary ketones
- ABGs
- CBC with differential
- Serum Potassium
- RFTS
- Serum ketones
- Cardiac enzymes
- Blood culture

Fluids

Average fluid deficit = 100 ml/kg
For a 70 kg patient = 7 Litres

Systolic BP (SBP) < 90mm Hg → 500 ml bolus N/S
if no response give second bolus

SBP > 90 mm Hg, start as follows

1 litre in 1 hour

1 litre in 2 hours

1 litre in 4 hours

1 litre in 8 hours

CAUTION DURING FLUID MANAGEMENT

- Fluid should be replaced over 12-24 hr
- Patients are generally depleted 3-6 litres
in DKA
- Monitor urinary output, heart rate, blood pressure and respiratory rate
- Care should be taken in patients with CCF and kidney disease

- Start regular insulin IV at 0.1 u/kg/hr by infusion

- **Aim for:**

- Fall in Blood ketone levels 0.5mmol/l/hr

- Rise in venous bicarb 3mmol/l/hr

- Fall of glucose 3mmol/l/hr

Otherwise, increase insulin infusion by 1 u/hr until target levels are achieved

BLOOD GLUCOSE MONITORING IN DKA

- Check initial blood glucose q1h.

Goal : decrease in blood glucose is 50-75 mg/dl

- Once stable (3 consecutive values decrease in target range) change monitoring to q2h.

- Shift to 5 % dextrose when blood glucose < 250 mg/dl

- For DKA, goal of blood glucose 150-200 mg/dl until anion gap closes

TRANSITION TO SUBCUTANEOUS INSULIN

- ▶ **Criteria for resolution of DKA:**
 - ▶ Blood glucose < 200 mg/dl
 - ▶ Serum bicarbonate > 18 mEq/l
 - ▶ Venous pH > 7.3 and anion gap closed
- ▶ Once the patient is stable and eating normally, switch to subcutaneous Insulin.

Serum Potassium

- ▶ On admission serum potassium is frequently elevated due to shift of K from the intracellular to extracellular space
- ▶ Plasma potassium falls with treatment as potassium enters the cell
- Do not add K^+ to the 1st bag
- Monitor urine output and add K only when
urinary output >30ml/hr

Potassium Replacement

$K^+ > 5.5 \text{ mEq/l}$ - No supplement

$K^+ = 4-5 \text{ mEq/l}$ - 20 mEq/l

$K^+ = 3-4 \text{ mEq/l}$ - 40 mEq/l

If on admission $K^+ < 3 \text{ mEq/l}$ give 10-20 mEq/l until it increases more than 3 mEq/l, then add 40 mEq/l to replacement fluid

Bicarbonate Replacement

- pH > 7.0 : No bicarbonate

- pH < 7.0 and bicarbonate < 5 mEq/l:

Add 44.6 mEq/l in 500 ml of 0.45% N/saline over 1 hour until pH > 7.0

Other Measures

- Broad spectrum antibiotics
- Catheterize for urine output monitoring
- Consider CVP line if shocked or previous cardiac or renal impairment
- Start on subcutaneous LMWH

Complications

- ▶ Cerebral edema
- ▶ Aspiration pneumonia
- ▶ Thromboembolism
- ▶ Hypoglycemia
- ▶ Hypokalemia
- ▶ Hypomagnesemia
- ▶ Hypophosphatemia

Prevention

- ▶ Patient education is very necessary regarding insulin compliance
- ▶ Timely management of infection
- ▶ Avoidance of medication like corticosteroids or if needed, should be monitored

Conclusion

- ▶ DKA is a serious medical emergency
- ▶ It is preventable cause of mortality if timely managed
- ▶ Pivots of management include *Insulin Therapy, Fluid Replacement and correction of Potassium abnormalities*, with close monitoring of vital signs and urine output

Thank
You!