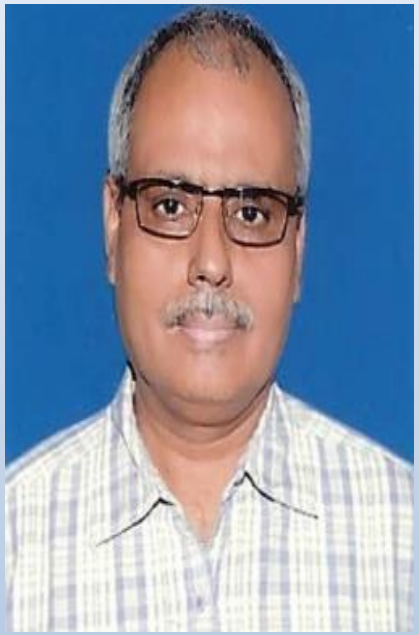
DIABETIC KETOACIDOSIS

Dr.Binod Kumar Singh

Medical Superintendent,NMCH,Patna
Professor & Head
Dept. of Pediatrics, NMCH, Patna
IAP State President, Bihar- 2019
IAP State Vice-President, Bihar- 2018
CIAP Executive board member-2015
NNF State president, Bihar- 2014
IAP State secretary,Bihar-2010-2011
NNF State secretary,Bihar-2008-2009
Fellow of Indian Academy of Pediatrics (FIAP)



Chief Consultant
Shiv Shishu Hospital
K-208, P.C Colony,Hanuman Nagar, Patna – 800020
Web site : www.shivshishuhospital.org,Mob:-9431047667

DIABETIC KETOACIDOSIS

It is a life threatening but reversible complication of type 1 diabetes due to absolute insulin deficiency.

Keto-acidosis:

High anion gap metabolic acidosis due to excessive blood concentration of ketone bodies (Keto-anion).

DEFINITION

- **Hyperglycemia (Serum Glucose >200mg/dl)**
- **Metabolic Acidosis (Blood pH <7.3)**
- **Serum Bicarbonate (<15 mEq/L)**
- **Ketonemia or Ketonuria (> 2+)**

CLASSIFICATION

CATEGORY	VENOUS pH	PLASMA BICARBONATE
Mild DKA	7.2 – 7.3	10 - 15
Moderate DKA	7.1 – 7.2	5 -10
Severe DKA	< 7.1	< 5

RISK FACTORS

In newly diagnosed cases:-

- Younger age <2 yr
- Delayed diagnosis
- Lower socioeconomic status
- Countries with low prevalence of Type 1 Diabetes

In patients with known Diabetes:-

- Insulin omission
- Previous episodes of DKA
- Persistent Vomiting
- Eating Disorders
- Stressful situations like, surgery

Serum Sodium: Usually low secondary to:

-Hyperglycemia leads to ↑ osmotic flux of H_2O from intracellular to extracellular space.

-Obligate sodium loss with ketonuria.

Metabolic Acidosis: Secondary to:

-↑ Production and ↓ utilization of strong acids; acetoacetic acid and β-HBA.

-↓ Alkaline reserve (sodium and K losses).

Physical signs of DKA

CLINICAL FEATURE	UNDERLYING MECHANISM
Weight loss, Impaired skin turgor, Sunken eyes, Delayed CRT, Absence of tears, Hypotension, Tachycardia, Low volume pulses	DEHYDRATION
KUSSMAUL Respiration, Rapid deep Sighing breathing	METABOLIC ACIDOSIS
Changes in Sensorium, Coma, Bradycardia, Hypertension, Papilledema, Cranial Nerve palsies, Posturing	CEREBRAL EDEMA
Fruity odor of breath	KETOSIS

NOTE

- Hemodynamic Instability or Shock is uncommon even with severe dehydration as intravascular volume is preserved.
- Be alert to the development of Cerebral Edema if fluid replacement has already been started.

LABORATORY INVESTIGATIONS

	Baseline	1 hr	2 hr	3 hr	6 hr	12 hr	24 hr
Glucose[2]	√	√	√	√	√	√	√
Urea, electrolytes	√	√	√	√	√		√
Creatinine	√				√	√	√
Bicarbonate	√	√	√	√	√	√	√
Blood gases	(√)		[3]√		[3]√		

- *Urinalysis for ketones*
- *ECG*
- *Infection screen*: full blood count, blood and urine culture, C-reactive protein, chest X-ray. Although leukocytosis invariably occurs, this represents a stress response and does not necessarily indicate infection

MANAGEMENT

ER Evaluation

- ABC
- V/S
- Cardiac monitoring
- Physical examination
- IV access : 2 large bore lines (16-18gauge)
- Blood sugar
- Foley’s catheter

GOALS OF THERAPY

1. Correction of Dehydration & Acidosis
2. Slow correction of Hyperosmolality & restoration of Glucose to near normal.
3. Avoiding complications particularly Cerebral edema.
4. Treatment of precipitating event like infections.

Fluid Replacement

A. Calculation of Fluid Deficit

- Mild DKA→ 50 mL/kg
- Moderate DKA—70mL/kg
- Severe DKA → 100 mL/kg

B. Fluid Bolus

- In Shock→ 20mL/kg NS bolus over 15-30 min
- Additional fluid boluses may be given if required.
- Severe volume depletion without shock→ NS@ 10-20 mL/kg/h over 1-2 h

C.Rate of Fluid administration

Example: A boy 20 kg with severe DKA assuming 10% dehydration received 1 bolus of 20ml/kg 0.9% saline in the 1st h

- Maintenance fluid for 48 h= 3000 ml
- Fluid deficit (10% dehydration)= 2000 ml
- Subtract Fluid bolus (20 ml/kg) = 400 ml
- Total Fluid to be administered in 47 h = 4600 ml
- Administration rate = 98 ml/h

CHOICE OF FLUIDS

Blood glucose level(mg/dl)	Choice of fluid
0-180	N/2 DNS + 2 amp 50% dextrose + 7.5ml Inj KCL
180-300	N/2 DNS + 7.5ml Inj KCL
>300	NS + 7.5ml Inj KCL

INSULIN THERAPY

It is essential to reverse the lipolysis, ketogenesis & to normalize the blood glucose.

A. TIMING

- 1-2 h after fluid replacement.

B. TYPE

- Only IV regular Insulin is used.

C. BOLUS DOSE

- Not indicated
- Occurrence of cerebral edema &
- Exacerbation of Hypokalemia

D. DOSE

- 0.05-0.1 unit/kg/h
- Higher doses increases risk of Hypokalemia, Hypoglycemia, & too rapid decline in serum osmolality
- Time for resolution of DKA- similar
- Therapy related complication –lower in low dose
- Low dose insulin infusion can be a safer approach

Cochrane central register of controlled trial

Indian pediatrics,2021,58(7),617-623 31st May 2021

E. PREPARATION

- 50 units of Regular insulin diluted with 50 ml NS @ 1 unit/ml

F. PRIMING OF TUBING

- Flushing Insulin solution through the tubing prior to infusion.

G. DURATION OF THERAPY

- Until resolution of DKA (pH >7.3, HCO_3 >15 mmol/L, BOHB <1 mmol/L)

H. DOSE ADJUSTMENT

- Blood Glucose expected to fall @ 36-90 mg/dl/h
- Dextrose concentration (from 5% to 12.5%)in fluid increased as required to maintain glucose between 150-200 mg/dl
- Hypoglycemia persists → decrease Insulin by 0.01-0.02 unit/kg/h up to 0.03-0.05 unit/kg/h

POTASSIUM REPLACEMENT

1. 40 mEq/L of KCl to be added to the fluid once child has voided & K^+ <6 mEq/L
2. Concurrent with start of Insulin therapy
3. If patient is HYPOkalemic, give KCl during initial volume expansion.
4. If patient is HYPERkalemic, K^+- replacement is deferred until urine output is documented.
5. Urine output, K^+, & ECG are monitored frequently.

CLINICAL SIGNS TO BE MONITORED

GENERAL SIGNS	NEUROLOGICAL SIGNS
• HEART RATE • RESPIRATORY RATE • BLOOD PRESSURE • HYDRATION STATUS • FLUID INTAKE • URINE OUTPUT	• SENSORIUM • RESTLESSNESS • HEADACHE • RECURRENCE OF VOMITING • INCONTINENCE • CRANIAL NERVE EXAMINATION

SWITCH TO SUBCUTANEOUS ROUTE

A. TIMING

- 1st dose of basal Insulin administered in the evening.
- Insulin infusion is stopped the next morning.

B. DOSE

- Prepubertal age→ 0.75-1 unit/kg
- Pubertal age → 1-1.2 unit/kg

CORRECTION FACTOR

Designed to help bring a high blood sugar down into goal range

RULE OF 1500(for Regular Insulin)

Ex- If 30 units of Insulin (both long acting & rapid acting) were taken per day

1500/30 = 50

1 unit of rapid acting insulin would decrease blood sugar by 50 points.

CORRECTION FACTOR

RULE OF 1800(for Lispro & Aspart)

Ex- If 30 units of Insulin (both long acting & rapid acting) were taken per day

1800/30 = 60

1 unit of rapid acting insulin would decrease blood sugar by 60 points.

INSULIN PREPARATIONS

1. *SHORT ACTING (REGULAR INSULIN)*

- Agent of choice for IV infusion in DKA
- Should be given 30 min before meal
- Onset of action: 30-60 min

2. *RAPID ACTING (LISPRO, ASPART & GLULISINE)*

- Immediate onset of action
- Can be given after meal
- Better post-meal glycemic control

3. *INTERMEDIATE-ACTING (NPH)*

- Duration of action: 12-18 h
- Used with short acting Insulin

4. *LONG ACTING (GLARGINE, DETEMIR & DEGLUDEC)*

- Provide peakless cover for 18-36 h

INSULIN REGIMEN

1. *BASAL BOLUS REGIMEN*

- Long acting basal insulin (40-50%)
- Meal time rapid acting analogue (50-60%)
- Hypoglycemia is lower

2. *MIXED SPLIT REGIMEN*

- Combination of short & intermediate acting Insulin
- Before breakfast: 2/3rd of daily dose
- Before dinner: 1/3rd of daily dose
- This regimen requires rigid dietary control

3. *CONTINUOUS SUBCUTANEOUS INSULIN INFUSION (INSULIN PUMP)*

- Infuses Insulin at a predetermined rate
- Boluses given at meal time
- Superior to Basal bolus regimen in terms of insulin requirement, glycemic variability & weight gain

COMPLICATIONS OF DKA

1. Hypoglycemia
2. Hypokalemia
3. Infections → Mucormycosis
4. Deep vein thrombosis
5. Renal Failure
6. Cerebral edema
7. Arrhythmia
8. Pulmonary edema

CEREBRAL EDEMA

- It occurs only in children with DKA.
- Very dangerous and increases mortality.
  Responsible for 60-90% of all deaths in DKA.
- ***RISK FACTORS:***

a) <u>Intrinsic or disease related</u>

- Age <5 y
- New onset Diabetes
- Long duration of DKA symptoms
- Severe Acidosis

b) Treatment Related

- Use of bicarbonate
- Rapid decline in serum osmolality
- Higher volume of fluid infused during 1st 4 hr.
- Early administration of Insulin within the 1st hr.

MECHANISM OF CEREBRAL EDEMA

-The brain adapts by producing intracellular osmoles which stabilize the brain cells from shrinking while the DKA was developing.

-When the hyperosmolarity is rapidly corrected, the brain becomes hypertonic towards the extracellular fluids $\rightarrow$ water flows into the cells $\rightarrow$ cerebral edema

MUIR'S CRITERIA for CEREBRAL EDEMA

DIAGNOSTIC CRITERIA

- Abnormal motor or verbal response to pain
- Decorticate or Decerebrate posture
- Cranial Nerve Palsy (III, IV, VI)
- Grunting, Tachypnea, Cheyne-Stokes breathing

MAJOR CRITERIA

- Altered mentation
- Sustained Bradycardia
- Age inappropriate incontinence

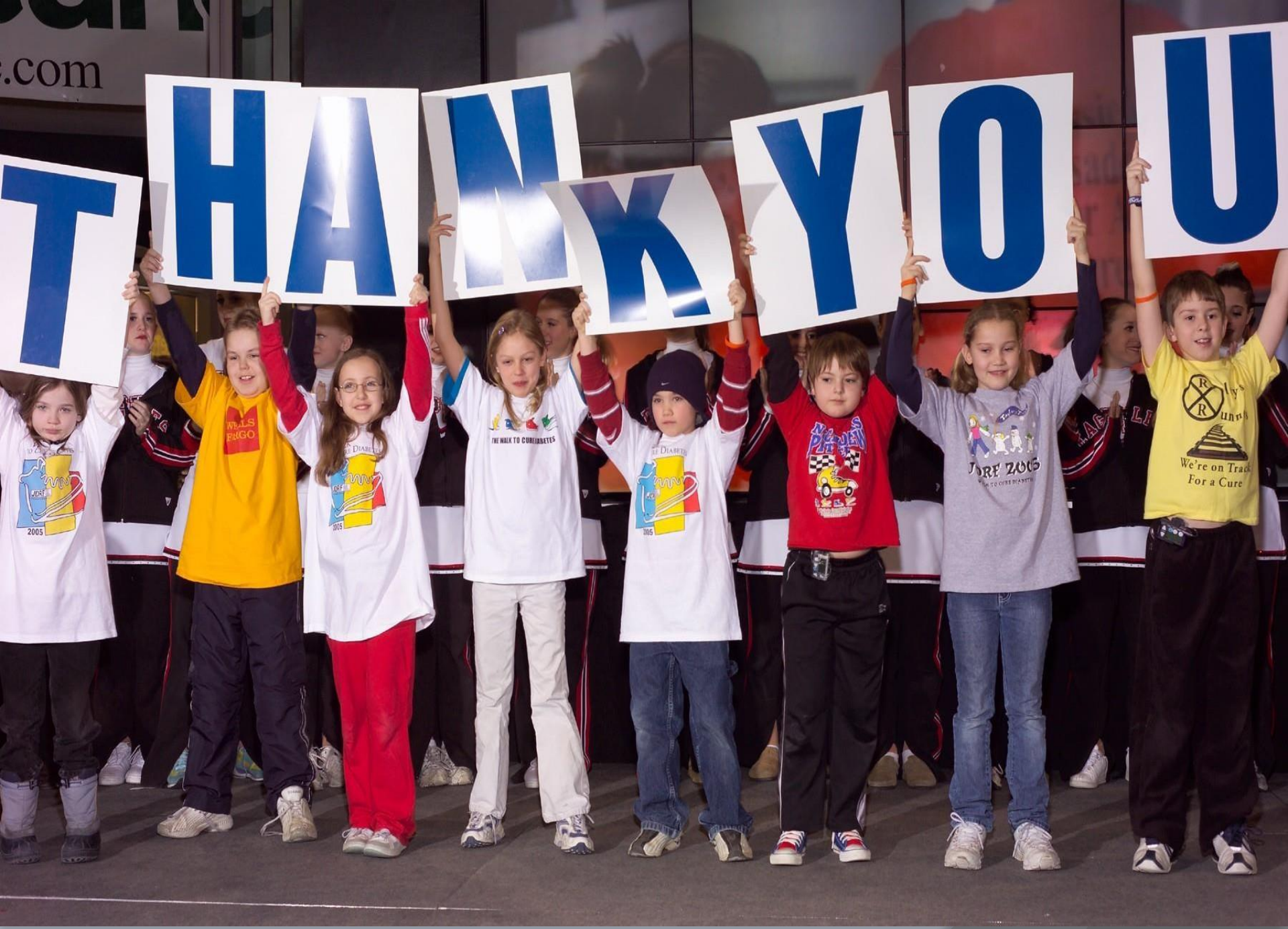
MINOR CRITERIA

- Vomiting
- Headache
- Lethargy
- Diastolic BP > 90 mm Hg
- Age <5 yr

ONE DIAGNOSTIC CRITERION, TWO MAJOR CRITERIA OR 1 MAJOR

MANAGEMENT OF CEREBRAL EDEMA

1. Head end of the bed is elevated.
2. Fluid rate is reduced by 1/3rd
3. Aggressive hyperventilation is avoided.
4. IV 3% saline @ 5-10 ml/kg over 30 min or mannitol @ 0.5-1 g/kg over 20 min
5. Dose is repeated if no response is seen within 30 min-2h
6. Cranial CT to rule out thrombosis or hemorrhage


THANK YOU
WELLS FARGO
JDRF 2005
We're on Track For a Cure